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Hawaii's Vanishing Species

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By ELIZABETH ROYTE

Photographs by CHRIS JOHNS

On the Brink

Hawaii's Vanishing Species

Belayed 2,000 feet above Kauai's Kalalau Valley, botanists Ken Wood, foreground, and Steve Perlman risk their lives to rescue Hawaii's imperiled plants from extinction.

Out of reach of goats and other alien invaders, such cliffs are among the last strongholds of the state's native flora. With the unhappy distinction of being the country's endangered species capital, the Hawaiian Islands have already lost hundreds of original life-forms while hundreds more teeter on the verge of oblivion.

Descended from a California wildflower, the flamboyant Haleakala silversword offers a shining example of adaptation. A few hundred castaway species, marooned on these once lifeless volcanic outposts by winds and tides, blossomed into at least 8,800 endemic plants and animals. The process begins afresh along Hawaii's southeast coast as molten lava lays a new foundation for life.

To mainland eyes, this musical glen on Maui appears as Hawaiian as the hula. In fact, none of the plants nourished by Wailua Falls are native. Introduced competitors have usurped much of the islands' natural heritage, so that today even the lei, or flowered necklace, is typically strung with foreign flora.

Handled with care, Cooke's *koki'o* (below) is one of scores of Hawaiian plants whose survival depends on cultivated specimens nurtured in botanical gardens. As go the plants, so go the birds that evolved with them. The *'i'iwi*'s bill (facing page) is specially suited for sipping nectar from long-throated native lobelias.

THE PIGS ARE OUT THERE. We see their hoofprints, their mud wallows, the plants they've gnawed and crushed. This tract of forest, one of the most protected tropical rain forests in Hawaii, does not look healthy. Casey Cho and Howard Hoshide, large men in camouflage clothing, walk lightly. The hunting dogs dart ahead of us through the thick brush.

We are not out here today for sport. Howard and Casey work full-time for Hawaii Volcanoes National Park on the Big Island of Hawaii, hunting the feral pigs that are destroying this rare ecosystem. Casey slashes through tree ferns and tangled vines with his trail knife. Then, from a distance, we hear the muffled bark of a dog pursuing a pig.

"Got one!" Howard cries.

We take off through the forest, leaping over logs and sliding between muddy branches. The barking fills the afternoon air. The voice of another animal, hoarse and desperate, soon rises above the din. "Sounds like a big one," Howard yells back over his shoulder. We arrive at a clearing to see a sow pinned by the dogs and squealing in terror.

Casey approaches the pig with his knife poised. He avoids hunting with guns as much as possible—the sound of gunfire sends the forest's pigs into hiding. Placing his right foot on her neck, Casey quickly severs two major arteries and the windpipe. She collapses in the mud.

Scenes like this occur in Hawaii every day, where wildlife managers are scrambling to set the islands' natural balance right, to undo some of the environmental damage humans have wrought. Agriculture and development long ago obliterated the islands' wilder side in most of the lowlands. But away from the beaches and golf courses, in the high mountains and the isolated valleys, the last refuges for a unique natural heritage are under siege of another sort. These areas are threatened by introduced species—the pigs we were chasing, for instance—that have destroyed much of the native landscape and the creatures that rely on it.

For weeks field specialists have escorted me through the islands' misty forests, pointing out native marvels like flowers that match the shape of birds' beaks. They told me about ferns that resemble four-leaf clovers, predatory caterpillars that ambush insects, and *wēkiu* bugs that live on icy mountaintops, surviving on tiny insects delivered by the wind.

There was a celebratory aspect to this litany of wonders, but

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Filling its abdomen with blood, a *Culex* mosquito delivers a lethal dose of avian malaria to an ‘i‘iwi. Probably brought to Hawaii in a whaling ship’s water casks, the disease-carrying stowaways have taken a heavy toll on native birds. During recent outbreaks “birds literally dropped out of the trees,” says biologist Carter Atkinson.

Requiem or recovery?

it was overshadowed, always, by a sense of loss.

The plight of endemic species has become so dire that conservationists call Hawaii the endangered species capital of the nation. Although its islands represent just two-tenths of one percent of total U. S. land area, three-quarters of the nation's extinct plants and birds once lived only in Hawaii. More than a third of the 526 plants and the 88 birds on the U. S. endangered and threatened species list come from there.

Remote oceanic islands like Hawaii are more vulnerable to ecological invasion than any other landmasses. Only a few types of birds, insects, and plants colonize such places, often evolving into scores or even hundreds of unique species. These islands shelter no large land mammals or reptiles, only creatures that gradually lose their natural defenses against such predators.

The causes of Hawaiian species' decline are numerous and complicated, but if conservation biologists had to name the most significant threat to native rain forest species today, they would, without hesitation, indict the feral pig.

Sloshing through the forest with Casey and Howard, I can easily see why. In search of grubs and worms, pigs uproot shrubs and rototill the soil with their snouts. They sow seeds of alien plants in their droppings. Those seeds grow into tangles of vines like the South American banana poka and small trees like

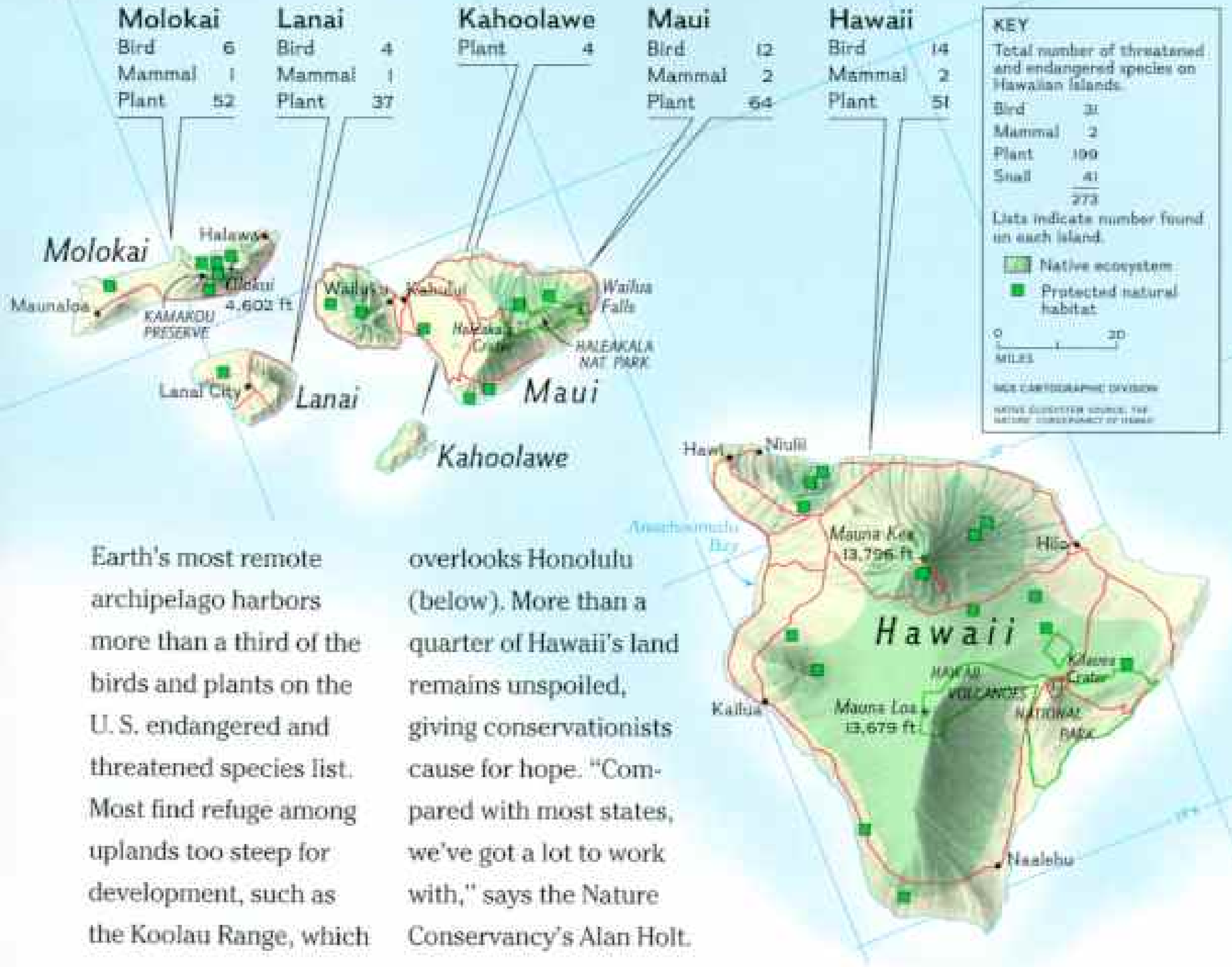
the Brazilian strawberry guava, which form dense thickets that crowd out native trees.

Non-natives such as rats and mongooses also spread alien seeds, and goats also devour fragile tree shoots. But pigs are more destructive and more widespread. Despite the best efforts of hunters, as many as 4,000 pigs remain in the park; more than 100,000 roam the islands.

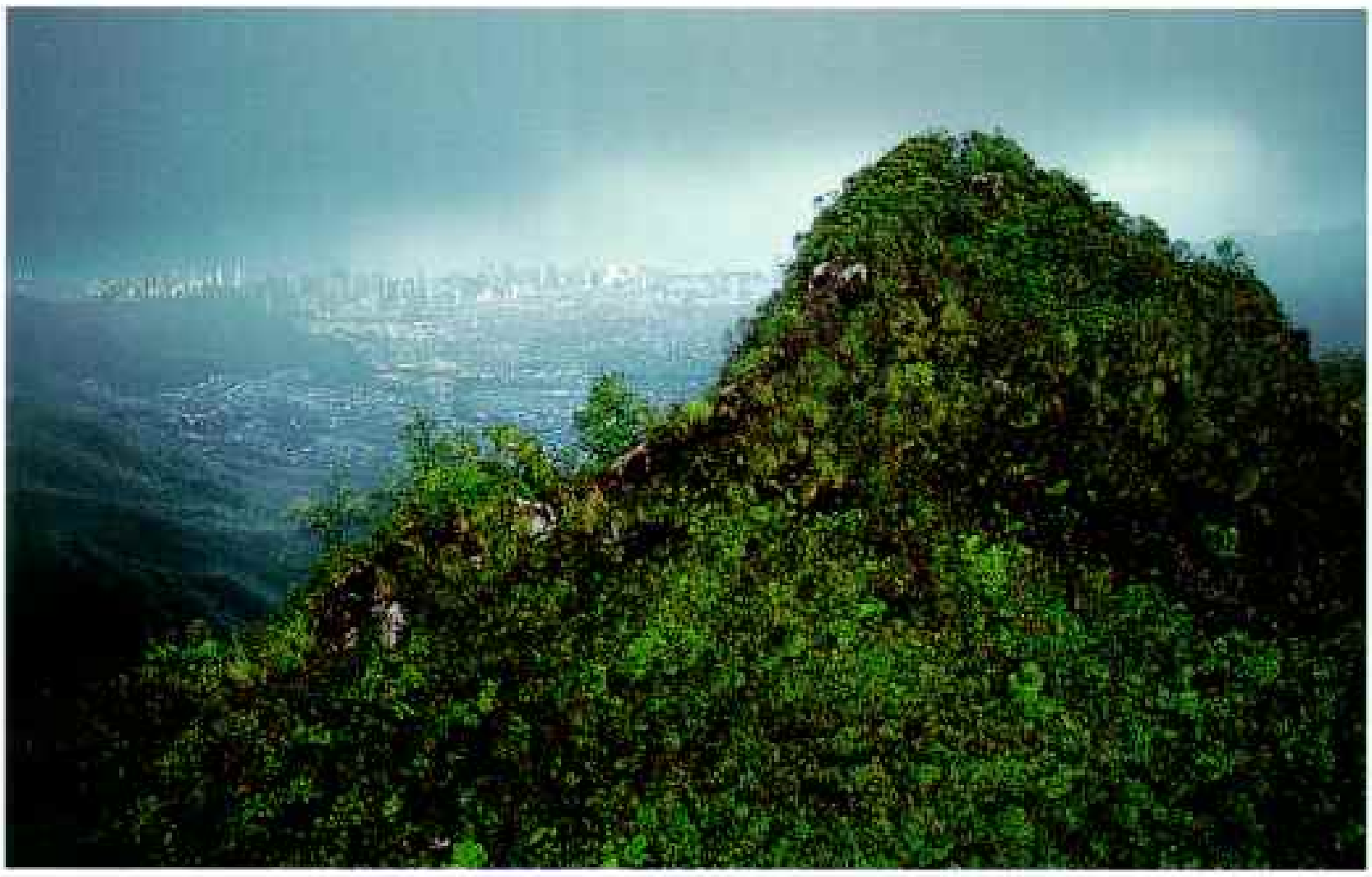
Fewer pigs in Hawaii seems like an idea Hawaii's people would easily accept. But the pig has become a flash point in a conflict between hunters who want to maintain a sizable population for food and sport and conservationists who wish to eradicate pigs in certain areas to protect native flora and fauna.

Conservationists, who work in state reserves and federal parks and for private organizations like the Sierra Club and the Nature Conservancy, stress that the loss of even one species may contribute to the decline of entire ecosystems and that native plants and animals contain genetic information that could lead to new foods and medicines.

They know that the survival of hundreds of endangered species now depends on human intervention. Their work crews kill feral animals, erect fences to keep ungulates away from fragile plants, breed birds in captivity, pollinate flowers by hand, and destroy nonindigenous plants. By restoring and maintaining healthy ecosystems, conservationists hope to give Hawaii's native species the respite and protection they need to survive.



Earth's most remote archipelago harbors more than a third of the birds and plants on the U.S. endangered and threatened species list. Most find refuge among uplands too steep for development, such as the Koolau Range, which overlooks Honolulu (below). More than a quarter of Hawaii's land remains unspoiled, giving conservationists cause for hope. "Compared with most states, we've got a lot to work with," says the Nature Conservancy's Alan Holt.



Gullied by erosion, a goat-scoured slope along Kauai's Na Pali Coast offers a lone billy no place to hide. European explorers imported the destructive grazers to provide fresh meat for ships' crews. State game laws backed by sport hunters maintain their numbers and, according to critics, perpetuate their damage.

IT'S RAINING LIGHTLY as Ed Misaki and I walk through the rain forest of the Kamakou Preserve. Ed manages the 2,774-acre preserve for the Nature Conservancy here on Molokai, one of the least developed of Hawaii's seven inhabited islands. He leads me through the dense understory. Great troughs of mud suck at our rubber boots. Fallen trees clutter the narrow trail. Thick, velvety moss and tall ferns grow atop the logs, hiding every inch of ground. Everything is soft, oozing, decaying, wet. When we walk off trail, the forest thickens, the light grows dim. It seems as if Ed's picking out the densest routes, but then, with a few slashes of his machete, a curtain of green drops to the forest floor.

We come to a tree fern, eight feet tall, lying dead in the mud. Its feathery leaves are crushed and dirty. "A pig did that," Ed says. "They knock the ferns over and eat them." These delicate ferns have no defenses against the animals.

"It's all about isolation," Ed explains. "Hawaii is the most isolated island group in the world. And it began as just these volcanic peaks with no life on them. Once life arrived—insects blown by the wind, seeds carried by birds, the wind, or ocean currents—it developed with little influence from the outside world."

No land reptiles or amphibians could swim that far. The only mammals that arrived under their own steam were the hoary bat and the monk seal.*

We slash on through the forest. Ed stops short. "Oh, wow," he says. "Take a look at this." He points to the delicate pink blossoms of a mint vine and plucks a leaf for me to smell. It has a slight fragrance, but I'd hardly call it minty. The mint-oil scent so pleasant to humans actually deters browsers, but this plant has no such protection.

"Hawaiian species didn't need such defense mechanisms," Ed says. "Some plants lost their thorns, some birds lost their ability to fly. It makes sense: A plant that

*See "Last Refuge of the Monk Seal," by Diane Ackerman, in the January 1992 NATIONAL GEOGRAPHIC.

Unfurling leaves as big as beach umbrellas, endemic *'ape'ape* plants dwarf a 1921 visitor to the Waikamoi rain forest on Maui. Spared the logging, grazing, and other assaults that have

GILBERT M. GROSVENOR

mutated and didn't spend energy making an oil could spend more energy making bigger fruits or flowers."

From a biologist's point of view, mutations like this make Hawaii one of the most remarkable places on earth, surpassing even the Galápagos Islands for the number and variety of species that evolved from a common ancestor. One lobelia, for example, diversified into more than a hundred kinds of shrubs and small trees with J-shaped blossoms of pink, purple, green, or white. One finch-like bird radiated into more than 50 species of honeycreeper. Some evolved

desolated half of Hawaii's original rain forest, the same tract today (below) is still tapped for its silt-free water and affords scientists a living laboratory for environmental research.

crossed beaks that are good for prying open flower buds or probing bark for insects. Others evolved long, curving beaks to drink nectar from the lobelia blossoms.

Today only 21 species of honeycreeper remain. Fourteen of those are endangered.

"I wish I could show you a Molokai creeper," Ed says wistfully. "But no one has seen one since 1963." Ed has searched for signs of the creeper for ten years. He saw the small scarlet bird only once—a stuffed male specimen in the Bishop Museum in Honolulu.

Ed brings me to the edge of a ridge to look 3,000 feet down into Pelekunu Valley. A soft wind blows shrouds of mist up the fern-covered slopes. A dozen shades of green shimmer in the light rain. Ed stands beside me, chewing absentmindedly on a blade of grass. For him the valley is not only beautiful but also inspiring: More than 90 percent of the plants around us are native.

"When I was in school, they didn't teach us about the uniqueness of Hawaiian species," he says. "Green was green." Today Hawaiian children learn the difference in classrooms. Ed escorts them to this ridge to let them see and feel the difference.

FIFTY MILES southeast of Molokai, on the island of Maui, the upper reaches of Haleakala National Park's Kipahulu Valley hold such a wealth of native plants and birds that access is strictly controlled. The National Park Service has declared the valley off-limits to the 2.2 million people who visit the island annually. Pigs are banned as well—park crews strung miles of fence across the valley in the late 1980s to keep them out.

To see this success story, I join Steve Anderson, a park resource manager, as he sets out with his assistant, Patti Welton, for a week in the field. Steve manages vegetation. In a typical week he'll uproot or spray herbicides on alien plants, record the locations of endangered species, and check fence lines for gaps the pigs could squeeze through.

This morning, at a base camp near the coast, he helps his crews prepare for the week ahead. In giant nets spread over the grass they pile up buckets of food and cans of water, machetes, fence posts, rain tarps, and other supplies. A helicopter arrives to carry the load and the crews up Kipahulu.

From the air I can see streams roaring down the steep walls of the seven-mile-long valley, cascading in waterfalls over rugged cliffs. In the upper reaches, *'ōhi'a lehua* trees, with small leaves and brilliant red flowers, dominate the canopy.

Under the canopy the forest floor undulates with a lush carpet *(Continued on page 26)*

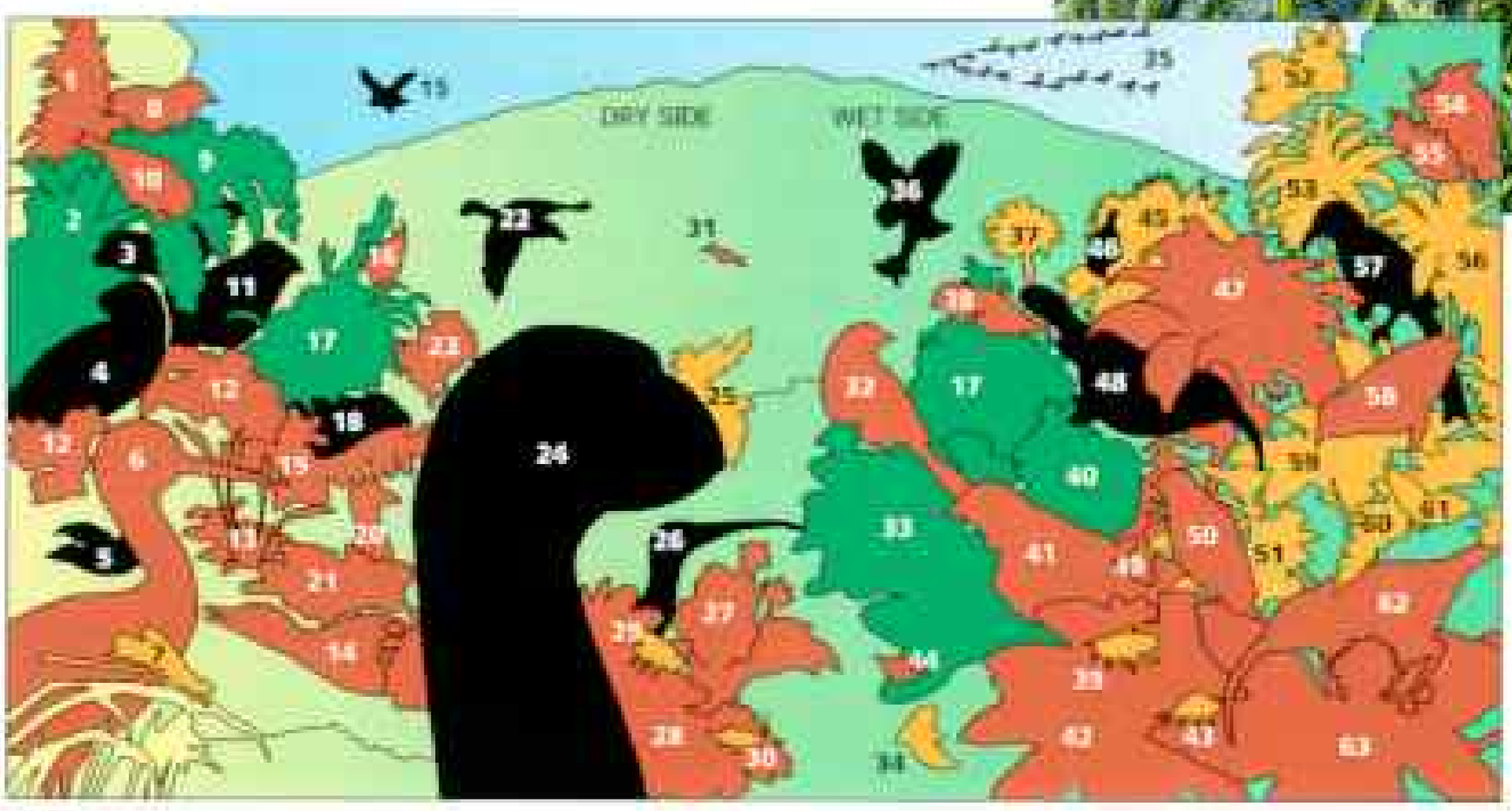
Hawaii's lost world

At least a thousand creatures that once enlivened Hawaii's landscape have vanished since Polynesian voyagers—and later European explorers—first set foot here about 1,500 years ago. Having evolved in isolation, native species were not equipped to survive the onslaught of predators and competitors introduced with human arrival. Among the first to go were 20 species of flightless birds—easy prey for hunters—including the large tortoise-jawed *moa nalo*, foreground, known today only from skeletal remains.

This painting offers an over-the-shoulder glimpse of some of Hawaii's bygone creatures and others now living on borrowed time. More than 60 native plants and animals are portrayed. Of the 27 birds included, 13 are extinct, four are probably extinct (neither the Kauai *'akialoa* nor the Molokai creeper, for instance, has been sighted in more than 30 years), and ten are endangered.

Many of the state's 150 recognized ecosystems have been blended in this composite scene, from sea-level marsh at the bottom of the painting to alpine desert at the top. Birds and other animals are grouped on or near vegetation common to their habitats. Natural communities associated with wet, windward, northeast-facing slopes are depicted on the right, while those that occupy drier, leeward slopes appear on the left.

- Extinct
- Endangered
- Rare but not officially endangered
- Common plants



1. *Argyroxiphium sandwicense* ssp. *sandwicense*, Mauna Kea silversword, 'āhinahina
2. *Myoporum sandwicense*, bastard sandalwood, naio
3. *Chloridops kona*, Kona grosbeak
4. *Chloridops regalkongi*, King Kong finch
5. *Porzana sandwichensis*, Hawaiian rail, moho
6. *Himantopus mexicanus knudseni*, Hawaiian stilt, ae'o

PAINTING BY LAWRENCE W. DUKE; CONCEPT BY STEVEN L. MONTGOMERY

7 ● *Megalagrion xanthomelas*, orangeblack damselfly, pinao
8 ● *Pterodroma phaeopygia sandwichensis*, Hawaiian petrel, 'ua'u
9 ● *Sophora chrysophylla*, māmane
10 ● *Loxioides bailleui*, palila
11 ● *Rhodacanthis palmeri*, greater koa finch, hōpue
12 ● *Kokia drynarioides*, tree cotton, koki'o
13 ● *Achyranthes splendens* var. *rotundata*, round-leaved chaff-flower
14 ● *Anas laysanensis*, Laysan duck
15 ● *Haliaeetus* sp., Hawaiian sea eagle
16 ● *Hemignathus munroi*, 'akiapōlā'au
17 ● *Acacia koa*, koa
18 ● *Dysmorodrepanis munroi*, Lanai hookbill
19 ● *Chamaesyce celastroides* var. *kaenana*, spurge, 'akoko
20 ● *Gallinula chloropus sandvicensis*, Hawaiian common moorhen, 'alae'ula
21 ● *Scaevola coriacea*, dwarf naupaka
22 ● *Corvus impluviatus*, deep-billed crow
23 ● *Kokia cookei*, Cooke's koki'o
24 ● *Chelychelynechen quassus*, tortoise-jawed moa nalo
25 ● *Hibiscadelphus giffardianus*, ka'u hau kuahiwi
26 ● *Apteribis glenos*, flightless ibis
27 ● *Hibiscus brackenridgei*, ma'o hau hele
28 ● *Sesbania tomentosa*, 'ōhai
29 ● *Hylaeus hula*, hula yellow-faced bee
30 ● *Banza nihoa*, coneheaded katydid
31 ● *Lasiurus cinereus semotus*, Hawaiian hoary bat, 'ope'ape'a
32 ● *Palmeria dolei*, crested honeycreeper, 'ākohekohe
33 ● *Metrosideros polymorpha*, 'ōhi'a lehua
34 ● *Lentipes concolor*, goby, 'o'opu alamo'o
35 ● *Branta sandvicensis*, Hawaiian goose, nēnē
36 ● *Grallistrix erdmani*, long-legged Maui owl
37 ● *Delissea undulata*, 'ōhā
38 ● *Loxops coccineus ochraceus*, Maui 'ākepa
39 ● *Coleotichus blackburniae*, koa bug
40 ● *Metrosideros polymorpha*, 'ohi'a lehua
41 ● *Psittirostra psittacea*, 'ō'ū
42 ● *Tetraplasandra gymnocarpa*, 'ohe'ohe
43 ● *Micromus swezeyi*, Swezey's flightless brown lacewing
44 ● *Achatinella rosea*, rosy tree snail, pūpū kani oe
45 ● *Pritchardia schattaueri*, fan palm, loulu
46 ● Ciridops anna, 'ula 'ai hāwane
47 ● *Clermontia lindseyana*, 'ōhā wai
48 ● *Drepanis pacifica*, Hawaii mamo
49 ● *Vicia menziesii*, Hawaiian vetch
50 ● *Paroreomyza flammea*, Molokai creeper, kākāwahie
51 ● *Isodendrion longifolium*, aupaka
52 ● *Geranium humile*, hinahina
53 ● *Clermontia drepanomorpha*, 'ōhā wai
54 ● *Geranium arboreum*, nohoanu
55 ● *Pseudonestor xanthophrys*, Maui parrotbill
56 ● *Cyanea recta*, hāhā
57 ● *Moho nobilis*, Hawaii 'o'o
58 ● *Melamprosops phaeosoma*, po'ouli
59 ● *Gardenia mannii*, nānū
60 ● *Ctenitis squamigera*, pauoa
61 ● *Kauaiina ioxantha*, pala 'ehu looper moth
62 ● *Hemignathus procerus*, Kauai 'akialoa
63 ● *Hesperomannia arborescens*, tree thistle

Trailing hunting dogs through the thickest reaches of Hawaii Volcanoes National Park, rangers conduct a search-and-destroy mission for feral pigs. "It's like warfare," says Larry Katahira, a park resource manager, of the grueling, hazardous hunts. "Many of the dogs get hurt." As for the estimated 4,000 pigs that ransack the park, rangers purge about 300 a year from areas subsequently kept pig free by fences.

Proud to be a pig hunter: Holbron Bustamente's wild boar tattoo (above) reflects the importance of swine in traditional Polynesian culture. Conservationists counter that today's tusked troublemaker (left) is more akin to the European boar than to the small, domesticated pig ancient Hawaiians imported aboard their canoes.

Guarded by sturdy fencing, healthy forest inside Hawaii Volcanoes National Park, at left, abuts scrubby rangeland now roamed by cattle and feral goats and pigs but slated for protection. Seventy miles of fence encloses about a third of the park's rain forests.

(Continued from page 19)

of ferns, vines, shrubs, and fallen 'ōhi'a, which, with their abundance of mosses, ferns, and lichens, could be considered miniature forests in their own right.

"Fifteen hundred years ago almost all of Hawaii, at least on the islands' windward, wet sides, looked like this," Steve tells me over the roar of the engine.

I try to imagine the first Polynesian settlers, who beached their canoes on the Big Island about A.D. 400, exploring this forest, hunting birds for food and for their colorful feathers, gathering leaves for medicine.

These original Hawaiians were not as benign a presence as once was thought. The settlers cleared lowland forests to cultivate the plants they brought with them—breadfruit, bananas, sugarcane, taro. They brought small pigs. Their presence led to the extinction of at least 35 species of birds.

Captain James Cook, who arrived in 1778, took matters further. Word of his discovery spread throughout the West, and other ships soon followed. Over the next several decades outsiders introduced cattle, goats, sheep, and large European pigs. Eventually, many of these animals escaped and flourished in a paradise without cold winters or natural predators. The Europeans and those who came after changed the islands more in 200 years than the Polynesians had in 1,400.

As time went on, a vast agricultural empire arose. By 1900 the demand for wood and pastureland had denuded much of the upland forest. Government agencies reforested hillsides with alien trees like eucalyptus and pine in the early 1900s. In the following decades developers poured concrete over beaches and drained wetlands.

BUT HIGH OVER KIPAHULU I see only what Hawaii once was. The helicopter drops off Steve, Patti, and me at Charlie Camp, a workstation at 4,750 feet. Crews spend as long as a week here, returning each damp night after a day of poisoning alien plants or repairing the

Runoff from sugarcane fields and slopes prone to landslides stains Kauai's Anahola Bay after a downpour. Hawaii suffers soil loss at one of the highest rates in the nation. Consequences include fouled streams and coral reefs smothered by silt.

fence. The camp is an eight-by-eight-by-eight-foot metal-roofed cube with three rope hammocks slung one above the other. A deck runs around the cube. Rats run around the deck.

Rats came ashore in Polynesian canoes and European ships. The rats ate bird eggs and spread alien seeds carried in their fur and droppings. Trapping rats in thick rain forest doesn't make sense, so Steve's colleagues have been granted federal approval to poison rats near bird-nesting areas.

Today Steve and Patti will inventory plants between Charlie Camp and Ginger Camp, our destination at 3,180 feet. I'm wondering what fauna we'll see at Ginger and why we've allotted six hours for a two-mile route. I soon find out. The valley is steep, with trails not so much marked as suggested by snippets of blue plastic tied to shrubs. The idea is to take a step into the thigh-high green mystery and hope your foot hits solid ground. Invariably, I stumble over hidden logs, trip on roots, slide in mud. It rains 250 inches here each year, and it's raining now. Hard.

As we walk, Patti and Steve poke at plants. The *Carex alligata*, a grassy marsh plant, is spreading at the fence line—a native flourishing. Patti is ecstatic about a blue-petaled *Lobelia grayana* also growing naturally along the ground. "This is great!" she yells. "Yeah, terrific," says Steve, turning to me. "They've got pretty weak stems, so . . . " He doesn't have to finish. I know by now what that means. No pigs. Success.

We hear the guttural calls of an endangered crested honeycreeper and spot an *'apapane*—a red honeycreeper with a short, curved bill used for gleaning nectar and insects from blossoms. Somewhere out there in the rain and the fog are the endangered *nukupu'u* and *'akepa*. Like all Hawaii's native birds, these honeycreepers are threatened by diseases like avian pox and malaria and by non-native birds that compete with them for food and territory.

Avian diseases along with competition

Weeding out non-indigenous plants, a Park Service employee takes a swipe at *kāhili* ginger, one of the most problematic of the 900 or so species threatening to crowd out native flora. To stem the flow of exotic animals, beagles are trained to sniff out unwelcome arrivals at the Honolulu airport.

from newcomers, predation, and habitat loss have contributed to the extinction of 27 species and subspecies of birds since the arrival of Captain Cook.

Researchers readily admit that they don't understand all the biological intricacies of the Hawaiian forest. But they do know that even seemingly innocuous interactions with foreign species often affect the health of natives.

"Pigs threaten native birds," Steve says. "They hollow out giant tree ferns to eat the starchy core. Then water collects in the stems, and mosquitoes breed in these little pools." Mosquitoes, which didn't reach Hawaii until the 1820s—probably in a whaler's water casks—spread avian malaria throughout native bird populations that had no resistance to the disease. One of the few ways of fighting it is by removing the pigs.

Unraveling the complexities of species' decline takes time. Goats in Haleakala Crater were long blamed for the demise of the silversword, a silvery green plant that grows for as long as 50 years before it sends up a tall spike that bursts into hundreds of magenta flower heads. After that one spectacular bloom the plant dies.

Argentine ants appeared near the rim of the crater in the mid-1960s, but it was years before scientists realized that the ants were preying on the native yellow-faced bee, a key pollinator of the silversword. If the silversword disappears, not only will people miss seeing a strange and radiant plant but also the bee will lose one of its food sources and the world will lose a library of chemical compounds and a link in the evolutionary chain.

DESPITE THE ODDS, the park has had definitive successes: The lushness of Kipahulu Valley inside the pig fence proves that. Everywhere, I see evidence of humans working to restore the forest. We pass small square plots, delineated with blue tape, for the study of changes in vegetation. We pass several garbage bags that a crew has filled with *kāhili* ginger, an import from the Himalaya.

"Ginger forms a dense carpet that keeps anything else from taking root," Steve says. "And it's frost tolerant, so it could grow high up mountainsides. The pigs spread it."

Steve's crews have succeeded in keeping the ginger from the upper valley, but at lower elevations, where habitat degradation is often severe, battling invaders would be a losing game. So few native plants are left there that if one weed was killed, another would spring up in its place.

Devouring a *nēnē*—Hawaii's endangered state bird—a mongoose presents a classic case of biocontrol run amok. Imported during the 19th century to rid cane fields of marauding rats, the weasel-like, diurnal predators seldom encounter the nocturnal vermin but prey instead on nēnē and other ground-nesting birds.

Thus sometimes it seems that no sooner is one problem solved than another emerges: Intensive hunting rescued the Haleakala silverswords from the goats, but now the Argentine ants threaten the plant's long-term survival by preying on the yellow-faced bee.

None of this dampens Patti and Steve's enthusiasm. It's late afternoon and raining harder as we make our way downhill, but they still seem jolly, dashing off trail to show me rare orchids and delicate mints.

When we reach 3,180 feet, we clamber over a hog-wire fence and arrive at Ginger Camp, a three-sided tent on a platform. It has more room than Charlie, plenty of hooks for wet clothes, and rats.

Exhausted by nine o'clock, I retire to my sleeping bag, on a cot under the tarp. It is pleasantly cool, and I tell myself that the sound of scampering feet is just branches in the wind. I think about the work crews—laboring in the rain, hauling fence posts, digging up weeds. And I start to wonder: Aren't all plants, at some point in their history, immigrants? Aren't humans—and the fruits, vegetables, and animals they have brought here—part of the islands' evolution?

The people of Hawaii have wondered about these questions and more: Over the past decades many natives have agitated for sovereignty. Those who claim Hawaiian ancestry make up nearly 20 percent of the state's 1.2 million people. Though they differ on exactly what form self-governance should take, dozens of political factions do agree on one point: They want control of Hawaiian land.

Damselfly in distress is no match for a Jackson's chameleon, a lightning-tongued African lizard sold by exotic-pet shops. Set free by owners who tire of tending them, they compete with native birds for insect prey.

For some natives this includes the right to hunt feral pigs whenever and wherever they want. Pigs have long been an important part of Hawaiian spiritual life: They are essential to traditional ceremonies such as those marking the birth of a child, the building of a canoe, or graduation from hula school.

Pua Case Lapulapu, a 34-year-old hula teacher and a founder of the Hawaii State Wildlife Conservation Association, speaks for about 400 hunters who want pigs to roam free.

"Who are these people to tell me how to use the land of my ancestors?" asked Pua over breakfast at a roadhouse on the Big Island's northeast coast, an area marked by dramatic sea cliffs and sprawling sugarcane plantations. Pua is a graceful woman with long brown hair. She grew up on Hawaii, spending her summers with her grandmother at Anaehoomalu Bay, dependent on the land and the sea for food.

"My grandmother expected me to learn Hawaiian values and traditions," she said. "She was teaching me *lokahi*—spirit, harmony, unity." She opened her hands in a symbol of balance.

But today Anaehoomalu Bay is dotted with luxury hotels. It is difficult for Pua to bring her daughter there to fish and gather plants. "There are many angry people," Pua said. "There is a lifestyle we follow, and developers, the state, and scientists are taking that away."

Pua told me that although pigs cause some harm to the forest, they are an essential part of lokahi, that in Hawaiian legend the pig is a tiller of soil.

As she rose to leave, Pua patted a plastic bag at her side. It contained leaves she had collected that morning for making leis, the flowered necklaces she would give to her hula students.

"This plant has a hundred uses," she said, smiling. It isn't native, I reminded her. "If it has a use," she said, "it has value."

That night I met a Hawaiian conservationist who's trying to bring the two sides together.

"The locals have a lot of knowledge; it shouldn't be discounted," said Julie Leialoha, land manager for the Natural Area Reserves System, a state conservation agency. "But as a biologist, I know that if we lose something here, it's gone to the entire world. Each side needs to be educated: The conservationists need to learn more about cultural sensitivity; the local community needs to learn more about conservation."

COMPROMISE of any sort is alien to Keith Robinson. A horticulturist on the island of Kauai, Robinson is blunt and forceful, and he conducts his life with a survivalist's fervor. He refuses to drink water during a hike. He wears a hard hat even in hotel lobbies and carries a machete almost all the time. A 53-year-old bachelor with a grim mouth and cold eyes, Robinson doesn't swear, drink, or smoke—but he does steal seeds.

Hiking miles over public land, he searches for the rare and the threatened. He spreads fertilizer on plants in the field and collects seeds to propagate in his own hundred-acre private reserve. When they mature, he'll disperse their offspring through an underground network of 20 like-minded green thumbs on five other islands. His purpose: to save a fraction of Hawaii's native flora from extinction.

I meet Robinson one morning for a hike at 5:30, but the hour still isn't early enough for him. He would have preferred 3:30. He doesn't speak to me, nor I to him, as we career up the switchbacks of Waimea Canyon State Park in his truck.

I'm subjecting myself to Robinson's early morning ire because I've heard he has some strong opinions on how government and private agencies manage endangered species.

"If you can keep up with me, you'll see

Outnumbered five to one, an endemic inchworm is overwhelmed by African big-headed ants. The aggressive aliens have exterminated many insect species that once pollinated native plants and provided food for birds.

Working by lantern light, biologists Jon Giffin, kneeling, and Robert Covington repair a fence around one of the last *Delissea undulata.* "It was hanging from a few roots inside a sinkhole," says Giffin. "Any disturbance would have killed it." Seeds germinated in test tubes offer hope for the species' survival.

something," he promises as we hike down a serpentine trail to the canyon floor. We trot a few miles along a riverbed and then scramble, hand over hand, up the eroded canyon wall. The air is filled with the thick, pungent smell of goat urine.

Goats are wreaking havoc here. Decades ago tens of thousands roamed the canyon, pounding the ground to bare red dirt. Hunting reduced their numbers, but today's 1,500 animals still knock boulders and avalanches of soil onto what little vegetation remains. In the interest of keeping the island well stocked with game, state land managers allow Kauai hunters a bag limit of only two goats a year.

Robinson shows me a wire fence built by state biologists to protect an endangered tree from the ravages of goats. Boulders have crashed into the fence, and the goats are eating the tree. "Idiots," he mutters, meaning the biologists.

Marching back along the trail, he rails against the feds, the state, environmentalists, hunters, and anyone else in the world, he says, "who isn't willing to do the W-O-R-K the way I do.

"They're not willing to hike into these places and collect the seeds!" he yells, swinging his machete. "They won't save an endangered tree if it's outside the reserve boundary!" he yells, kicking a rock from the path. "They can't do a thing about these alien species, and they don't even know *how* to grow the endangered plants in the field!"

Robinson directs many of his broadsides at the National Tropical Botanical Garden, in Kauai, and Steve Perlman, a botanist there, resents it—with good reason. Robinson has brought seeds to the botanical garden, and the two have worked successfully on numerous projects.

Perlman is no wimp himself when it comes to fieldwork. He spends 12-hour days in pursuit of endangered plants, hiking canyons and dangling from ropes on 2,000-foot cliff faces to pollinate rare flowers.

IT DOESN'T TAKE a day with Keith Robinson to know that neither the state nor the federal government is doing a stellar job of protecting native species from alien introductions. Even the bland language of a 1993 congressional report, "Harmful Non-Indigenous Species in the United States," indicts the federal handling of such problems.

The system, according to the report, "is piecemeal, lacking adequate rigor and comprehensiveness." The country's regulations and programs "are not keeping pace with

Sleuthing for insects at 2.6 miles above sea level, conservation biologist Steven Montgomery scrutinizes the snowcapped summit of Mauna Kea, Hawaii's highest peak. Among his finds: a *wēkiu* bug with "antifreeze" in its blood. Hawaii harbors at least 5,000 species as yet unknown to science. Barring unprecedented action, many may vanish undiscovered.

new and spreading non-indigenous pests."

The idea that every living creature has a right to exist greatly appeals to me. But all the species in Hawaii can't share the same space. And science cannot save every endangered species. There is never enough time, never enough money. The U. S. Fish and Wildlife Service has an annual budget of four million dollars to save threatened and endangered species in Hawaii; federal agencies estimate the state needs 25 million dollars more.

For the 1994 breeding season alone the state and federal governments spent more than a million dollars to keep the *'alalā*, or Hawaiian crow, from extinction: Fewer than 20 birds remain in the wild, 15 in captivity on Maui at the Olinda Endangered Species Propagation Facility. Ornithologists have

begun releasing captive-bred birds. Despite the crows' small population and the difficulties of finding suitable habitat, researchers believe the species can be saved.

So it goes with the *nēnē* (pronounced neh-neh), a cousin of the Canada goose that is Hawaii's state bird. By the early 1900s, when scientists realized that overhunting and predation by rats and mongooses had decimated the population, Hawaii's lowlands, where the birds thrived in pre-European times, had already been converted into sugar and pineapple plantations. By 1951 no more than 30 birds survived in the wild.

I spent some time with Cathleen Hodges, an endangered species specialist at Haleakala National Park who studies the ecology of the nēnē. Through rolling grasslands we searched, unsuccessfully, for nēnē nests. It was still early in the nesting season. We ran the trapline. Seven held the oozing carcasses of rats. From trap 44 we removed an intact dead mongoose and carried him to a picnic table for an impromptu necropsy.

"We get a couple dozen rats a month and about one mongoose," Cathleen said, making deft incisions with my Swiss army knife. "I don't see any subcutaneous body fat, so he probably lived lower down, where it's warmer. My guess is he froze to death last night." She checked his stomach for bird feathers or bones but found only fur.

Even if Cathleen captured all the rats and mongooses in Hawaii and the nēnē's habitat was restored, the goose would still face another threat. Captive breeding has boosted the nēnē population to 800, but all those birds are closely related. With so much genetic similarity between individuals, the birds may be especially vulnerable. Clearly, the nēnē will require hands-on management for some time. But how much further should we go? How much money should we spend?

FOR SCIENTISTS like Steve Perlman the answer is simple. "We save species because they took millions of years to evolve and they have a right to exist. These species tell us about the evolution of life."

The dedication of people like Perlman is why Hawaiian conservationists refuse to give up hope.

"I would sell cars or do something else if I didn't think we were making a big difference," says Alan Holt, science director of the Nature Conservancy's Hawaii office. "We can't go backward or stay the same. We will lose some species, but we can save thousands of others." Holt projects a positive image, and he supports his outlook with an anecdote. One summer, 15 years ago, Holt and a team of scientists spent six days surveying Molokai's Olokui, the only mountain in Hawaii that has never sheltered an ungulate. Exploring each valley and ridge, the team plucked every non-native species it found. The results filled only a one-gallon bag.

That excursion reminded Holt why resource managers and researchers work such grueling days to turn the invasive tide.

What's left of Hawaii is simply too precious to waste. □

The Farthest Horizon

Messengers from four million years ago, fossils recently exhumed from East Africa's Lake Turkana region are helping scientists etch a portrait of a species on the cusp between apes and humans. Highlighting the latest discoveries of limb and skull fragments, artist John Gurche roughed out a "transitional" hominid with many apelike features. This is a small-brained, bipedal creature, whose upright posture was the hallmark of the first creatures on the human family tree. Larger brains and more intelligence would come later, with the emergence of the genus *Homo* about two million years ago.

By MEAVE LEAKEY
Photographs by KENNETH GARRETT
Art by JOHN GURCHE

"SURELY this is where we came from," Kamoya almost whispered as he gazed in awe at three strange-looking teeth that he held delicately in his hands. I knew exactly what he meant. Looking very apelike, but at the same time vaguely human, the teeth had come from sediments four million years old at a place called Kanapoi in northern Kenya. That made them significantly older than the most ancient evidence of the human lineage then known. Were the teeth from a new species? If so, could they have belonged to humanity's earliest ancestor? Such questions raced through my mind.

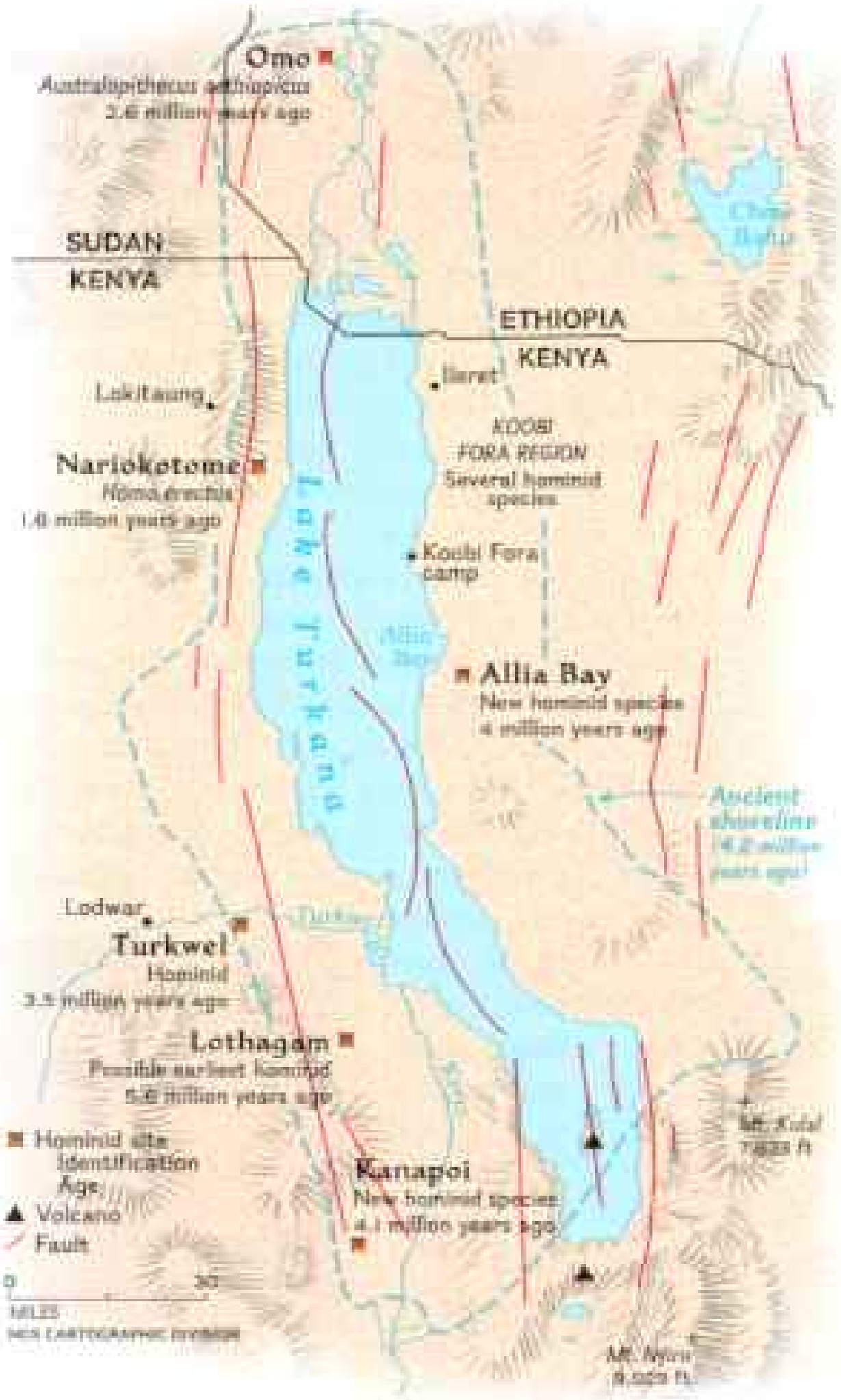
When our associate Peter Nzube Mutiwa found the teeth a few days earlier, I was back in Nairobi, tending to commitments as head of the paleontology department at the National Museums of Kenya. Then Kamoya called me on the radio telephone. Kamoya Kimeu leads the museums' team of fossil hunters we call the Hominid Gang. Hominids are the animals on the human family tree—ourselves and all our ancestors or close relatives since we diverged from the apes—and over the past three decades Kamoya's men have unearthed some of the most important specimens.

"We have something for you," Kamoya had said.

I made the daylong drive back to Kanapoi as quickly as the rutted roads and tracks allowed. After I congratulated Nzube, who had discovered the teeth among a carpet of lava pebbles, we began planning how to recover more. We marked out a large area and removed the bigger stones. Then we passed the loose soil and smaller rocks through a sieve.

Gradually we collected an almost complete

MEAVE LEAKEY met her husband, Richard—the son and protégé of famed fossil hunters Louis and Mary Leakey—when she joined the Hominid Gang at Koobi Fora as a young zoologist in 1969. KENNETH GARRETT has photographed archaeological sites from Mesoamerica to the Alps for the GEOGRAPHIC. Denver artist JOHN GURCHE, who specializes in reconstructions based on bare bones, brought dinosaurs to life for the January 1993 issue.



set of this mysterious animal's lower teeth, in all but perfect condition. We also found tooth fragments from another individual. My hunch that Kanapoi would produce some remarkably early hominids seemed to be right.

The site lies about 30 miles southwest of Lake Turkana, an immense jade green inland sea. Although crocodiles bask on the lakeshore, the Turkana Basin quickly turns to desert as one travels inland. The earth here bakes all year in heat well above a hundred degrees.

Yet I feel at home. Since 1969 I have worked in the Turkana Basin with teams led by my husband, Richard Leakey, a paleoanthropologist. Almost certainly our first apelike ancestors emerged in Africa, and few places offer as rich a fossil record as this region. Tectonic activity has uplifted ancient sediments, exposing to rapid erosion the soils in which the early hominids' bones were fossilized. Thus each rainstorm can bring new fossils to light. In addition, volcanism over the eons has deposited many layers of ash. Radioactive minerals in the ash decay at known rates, letting us

The cradle of humankind

From the latest finds at Kanapoi to *Homo* remains at Nariokotome and elsewhere, the Turkana Basin harbors a remarkable 4.1-million-year record of hominid evolution. Lined with volcanic hills, Lake Turkana lies at the heart of the East African Rift, the most fertile ground on earth for hominid fossils. At times over the ages the lake has dried up and then swelled to great size, as it did four to five million years ago.

date each layer and the fossils in between.

In recent years Richard has become deeply involved in wildlife conservation in Africa, so I have taken over the coordination of our research in the Turkana Basin, much of which has been supported by the National Geographic Society. Richard's expeditions had mostly focused on the period between one and three million years ago, when our ancestors developed larger brains. Increasing brain size led to the emergence of our genus, *Homo*, and eventually our species, *Homo sapiens*. The Turkana Basin offers abundant sediments of the right age for revealing that process.

It also contains older sediments, and in the late 1980s I decided to search for the more ancient and elusive fossils of the first hominids.

Until the 1994 season scientists had only the scantiest evidence for hominids older than 3.6 million years. Our earliest known ancestor was a short, apelike creature called *Australopithecus afarensis*, whose most famous representative is Lucy, a partial female skeleton discovered by Donald Johanson in 1974 at Hadar in Ethiopia.* Lucy had long arms like an ape, but her pelvic and leg bones indicate that she walked on two legs. She lived about 3.18 million years ago, yet we know she had older relatives. Footprints left in volcanic ash by three earlier members of her species were found by my mother-in-law, Mary Leakey, at Laetoli in Tanzania in 1978. They have been dated to 3.56 million years ago.

Hominids and African apes share a common ancestor. No one knows what that animal looked like, but we can guess that, like our closest living relatives, chimpanzees and gorillas, it lived in forests and moved through the trees, swinging from its arms and climbing on all fours. At some point one group of those ancestors took the critical first step on the road to modern humans: They began developing the habit of walking on two legs. We do not know why they became bipedal, but over time that adaptation required such profound anatomical changes—especially in the limbs and pelvis—that it marks the separation of the hominid lineage from the apes.

Comparing differences in the genes and blood proteins of humans, chimps, and gorillas, molecular biologists estimate that the hominid line split off from other African apes between five and seven million years ago, a time poorly known in the African fossil record.

I knew of a site in the Turkana Basin called Lothagam that held sediments of exactly this age. In 1967 an American team led by Bryan Patterson recovered a fragment of a possibly hominid mandible from there (right, at left).

I had often flown over Lothagam and gazed at its red rocks, standing out like an island in the desert. Long ago a great river meandered through this land, making it green and lush. Woodlands along the river supported elephants, two rhino species, many pigs, giraffes, antelopes, three different horse species, and multiple carnivores, including large saber-toothed cats.

Unfortunately, in five years of collecting abundant animal fossils we found only two possibly hominid teeth. I had to conclude that our ancestors between five and seven million years ago preferred a more forested environment.

I decided to move to slightly younger sites, with four- to five-million-year-old sediments. That in itself posed problems. For much of that time a lake far bigger than today's Lake Turkana filled most of the basin, yielding crocodile, fish, and turtle fossils but few terrestrial animals. But I knew from Rutgers University geologist Craig Feibel that Kanapoi, submerged 4.2 million years ago, was exposed by the fluctuating lake level during the following 200,000 or so years. Moreover, Patterson's team had found a fragment of a hominid arm bone there. There was also Allia Bay, a slightly younger site with sediments deposited along a river after the great lake began to recede.

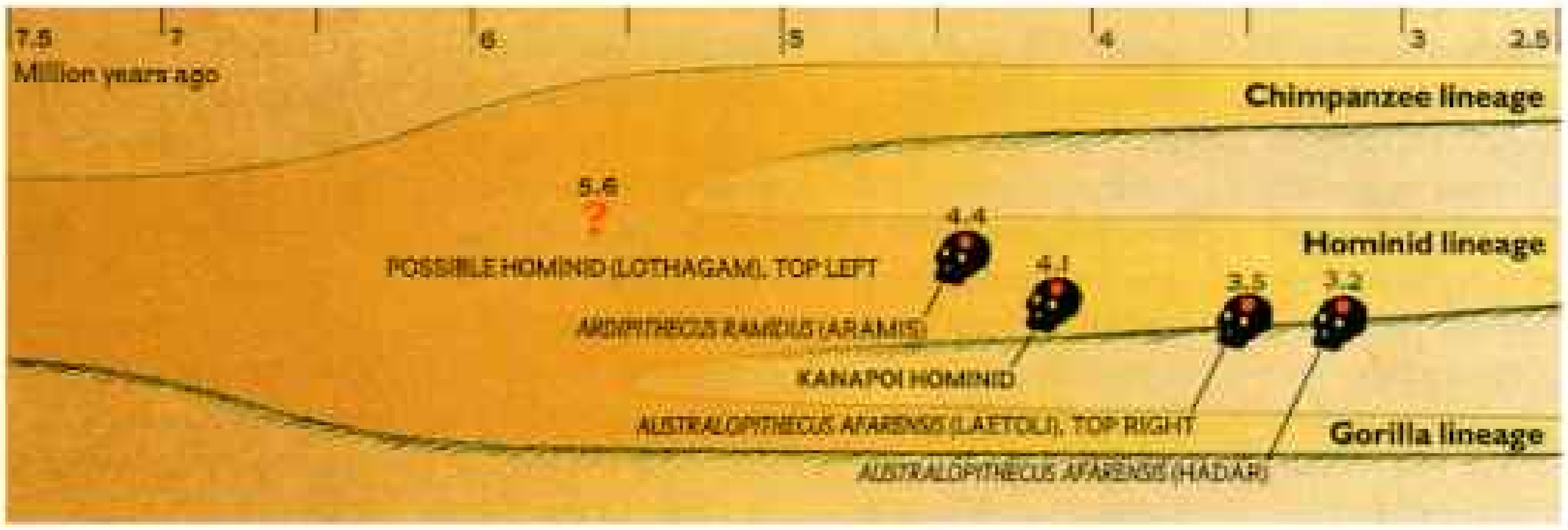
I would work Kanapoi first. During the cool evenings the team sat together in camp and speculated what our first hominid fossil would be. An isolated tooth? Perhaps a jaw? Better still, a leg bone? *(Continued on page 48)*

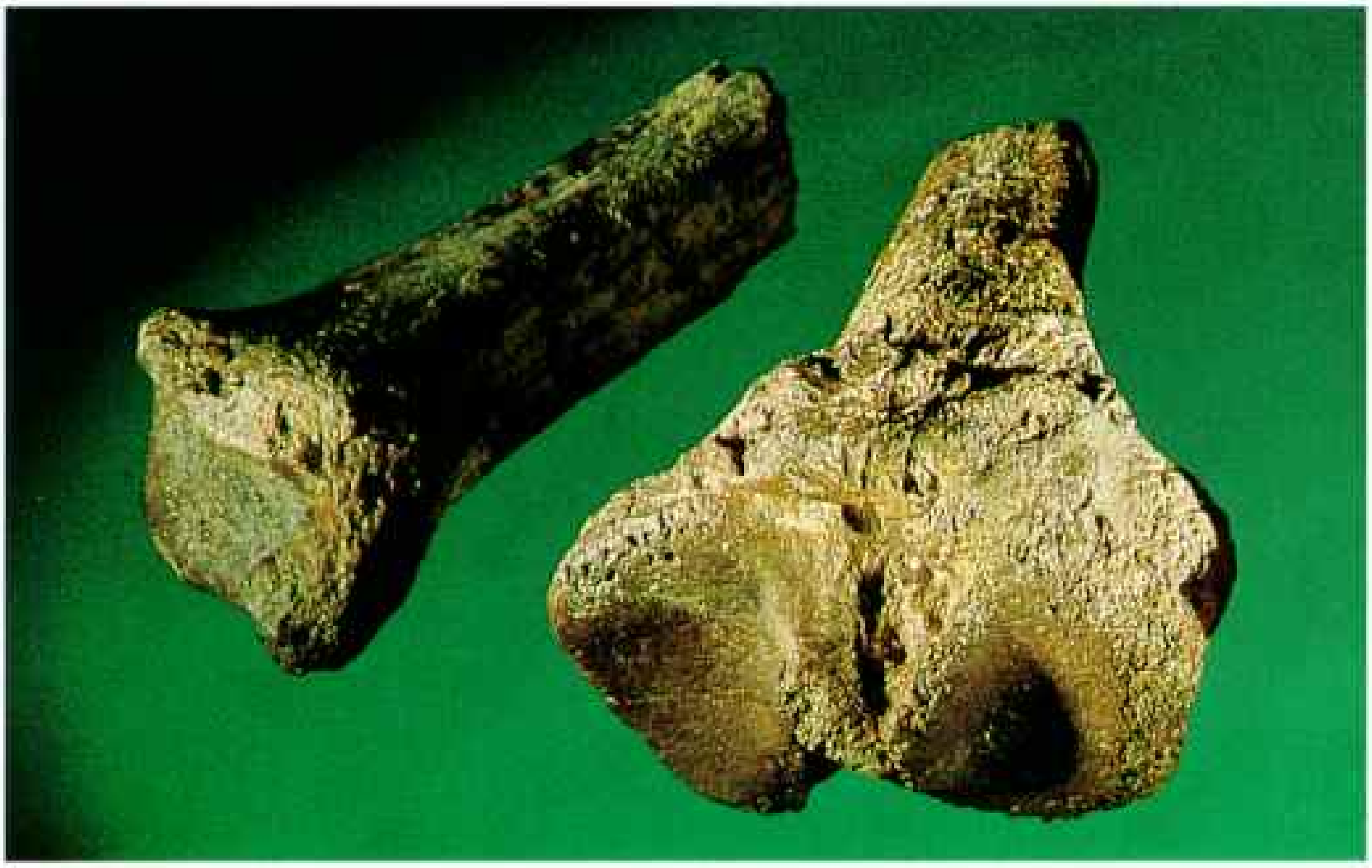
Future articles in this series will focus on early members of our own genus and the hominids that preceded them. Much of this research was supported by your Society.

*See "Ethiopia Yields First 'Family' of Early Man," by Donald C. Johanson, December 1976.

The earliest hominid?

Ape, hominid, or something in between? Based on the shape of the embedded tooth, some researchers believe that a 5.6-million-year-old jaw fragment (above, at left) discovered at Lothagam in 1967 is the oldest hominid fossil yet found. Skeptics say the fragment is too meager to classify. Other finds, in the 1970s, have been identified as specimens of the early hominid *Australopithecus afarensis:* a partial skeleton called Lucy from Hadar in Ethiopia and a 3.5-million-year-old mandible from Tanzania, at right, exhumed by the author's mother-in-law, Mary Leakey. With the 1994 Turkana expedition the horizon was pushed back another 600,000 years. Meanwhile, research in Ethiopia by Tim White of the University of California, Berkeley, has uncovered even older fossils, which he has identified as a new genus, *Ardipithecus.*





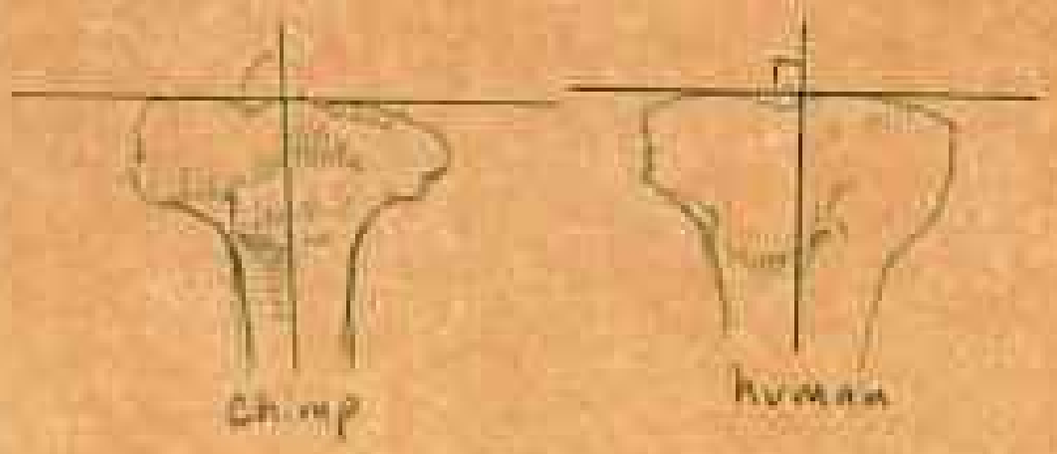
Early steps on the road to humankind

Bipedalism

Sifting through the fossil-rich sediments at Turkana's Allia Bay site, a research team under Alan Walker (right, at rear right) of Pennsylvania State University leaves no sand unturned in the search for fossils exposed by erosion and fragmented by the elements. Though tedious, only interminable sieving can yield the tiny pieces of bone and teeth that make up a vital part of the fossil record.

Since bipedalism is the primary factor separating apes from hominids, the Turkana researchers were particularly interested in leg bones. From the Kanapoi site, two sections of a tibia—the larger bone of the lower leg—show clearly that its owner walked upright. The socket-like condyles at the knee (top, at right) are both concave—a hominid trait; in an ape one would be convex. And a buttress of flared bone at the bottom of the tibia, at left, where it joins the ankle, is also hominid-like. A built-in shock absorber, the bone enlargement indicates an animal that bore more upright weight than an ape could. Another indication of the animal's bipedalism is the relative delicacy of the fibula implied by its small junction at the knee. Too frail to support a muscle large enough for a toe-grasping ape, the fibula might have been large enough for a hominid with toes more dexterous than a modern human's. To what extent these hominids were tree dwelling, or even tree climbing, remains a question.

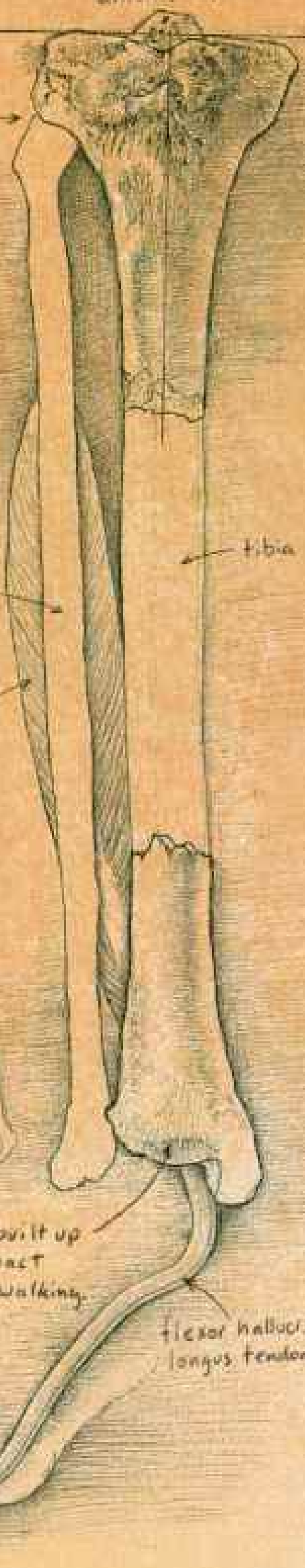
Condyles are at right angles to shaft as in modern humans.



Bone below condyles has been built up to absorb impact during bipedal walking.

Kanapoi hominid, posterior view

Kanapoi hominid, anterior view



chimp

human

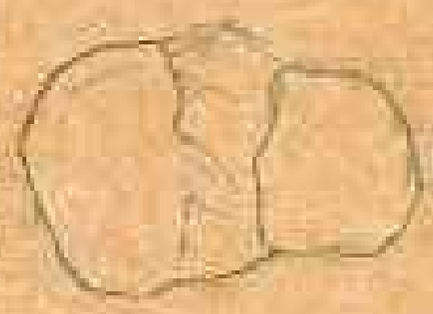
tibia-fibula joint

Reduced space for articulation with fibula implies a reduction in the fibula and associated flexors of the great toe.

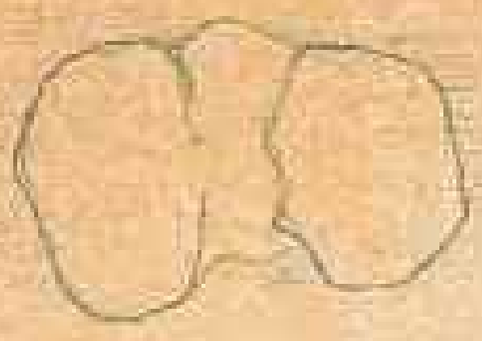
Kanapoi hominid, superior view

Condyles are unequal in size (lateral condyle has been enlarged for weight transfer)

chimp



human

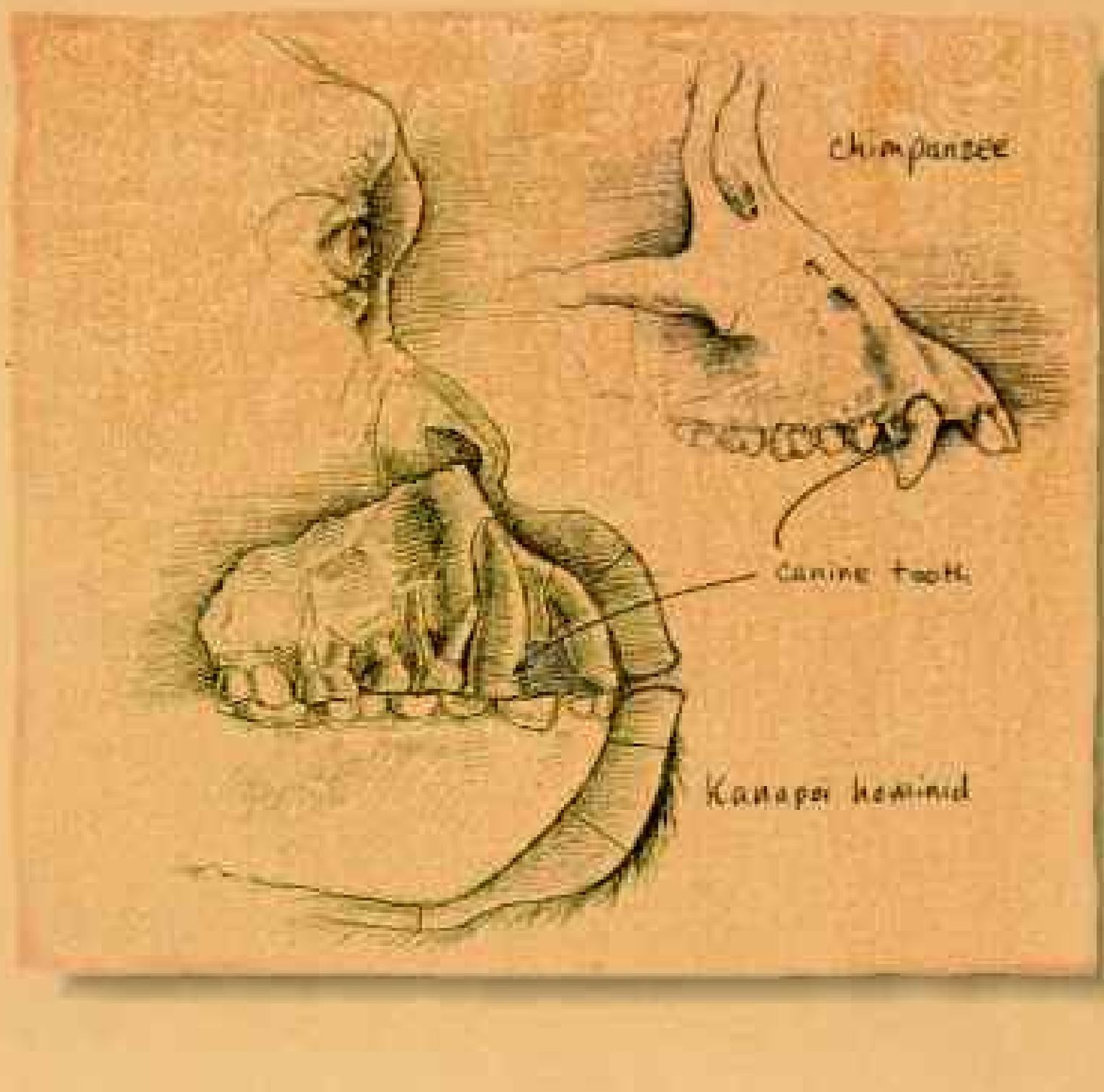


CONSULTANT: BRUCE LATIMER, CLEVELAND MUSEUM OF NATURAL HISTORY

hook

hamate bone

carpal tunnel



More clues to hominid development

Transitional jaw

Like a primordial grin from across the eons, a 4.1-million-year-old jawbone delights the author (right) moments after it was discovered at Kanapoi by a member of the fossil-hunting team called the Hominid Gang. Both this mandible (above, at left) and an upper jaw, or maxilla, with protruding teeth that was found nearby are significant discoveries—though a complete skeleton remains the ultimate goal. Before the 1994 season there was scant evidence of hominids older than 3.6 million years.

ROBERT M. CAMPBELL

Arboreal arms

Several fragments from Lake Turkana's Turkwel site turned out to be carpal bones from a hominid 3.5 million years old. One of these—a hamate bone—provides a valuable clue for inferring the creature's hand strength.

As illustrated at far left, the wrist bones form a "carpal tunnel" through which tendons pass from the arm muscles to the fingers. Because the hook of the Turkwel hamate is about twice the size of that in modern humans, Leakey reckons that the tunnel was deeper, holding larger tendons for stronger hands. This supports the thesis that early hominids were still heavily engaged in tree climbing.

The Kanapoi mandible proved more "chinless" and thus more apelike than specimens of *Australopithecus afarensis*. But the teeth tell us that this primate was a hominid, not an ape. The vertically placed root of the heavily worn canine in the upper jaw (inset, facing page) is clearly more humanlike than the angled root in chimps. Such differences lead Leakey to believe that she has discovered a new species.

We also discussed what those early hominids would have looked like. We suspected that their jaws and teeth would resemble a chimpanzee's, while below the neck they would look like later hominids, such as *A. afarensis*.

ONE DAY, while I was recording details about two pig jaws we had found, one of the Hominid Gang, Wambua Mangao, called out excitedly. I followed him to a spot where I could see five small areas of bluish tooth enamel embedded in a rock. I turned the rock over to find that it held half of the upper jaw of a hominid. It was from an animal about the size of a chimpanzee—an old individual, because the teeth were quite worn. I shook Wambua's hand enthusiastically.

A few days later Kamoya discovered the upper part of a tibia, the main bone of the lower leg. Slightly bigger than that of the largest *afarensis* yet found, its size surprised us—especially since the jaw nearby was chimp size.

Soon Kamoya, Wambua, and Samuel Ngui, another Hominid Gang member, found the lower end of the tibia. It closely resembled that of *afarensis*, strongly suggesting that this hominid was also bipedal.

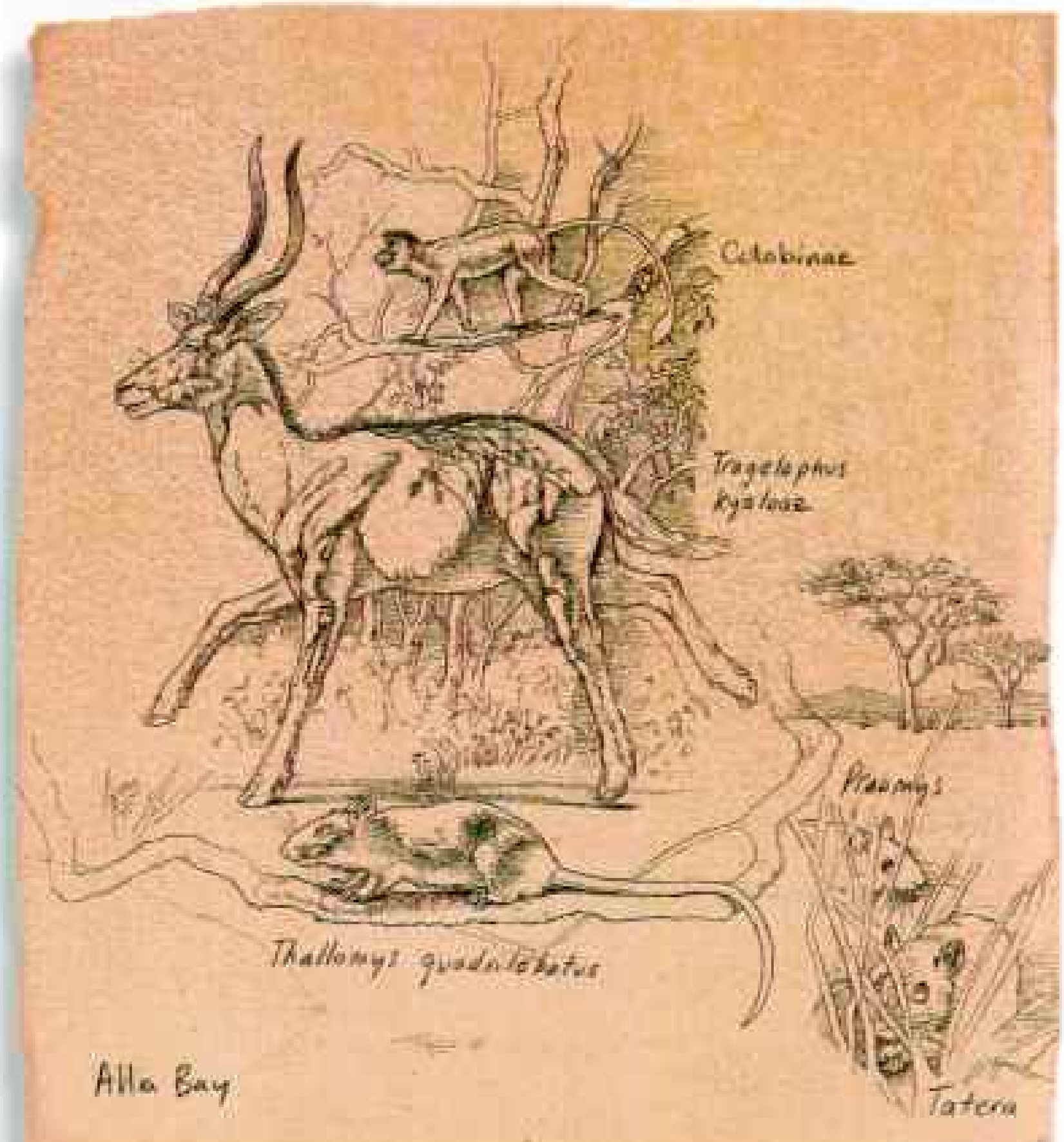
These were major discoveries, and I returned to Nairobi reluctantly—only to receive Kamoya's phone call about the teeth unearthed by Nzube. The more I studied the teeth, the more they convinced me that this animal was strikingly different from later hominids and from all known fossil apes. Indeed, it appeared that the Hominid Gang had found an altogether new species, with some features found in both chimp and *afarensis* and others that were unique.

What did this blend mean? About diet, for instance. Was the large canine for breaking nuts or hard fruits? Or was it for display or defense? Were our specimens male or female?

Back at Wambua's site we began recovering the teeth of a second, very young individual as well as the rest of the upper jaw of the first. Thus we had a complete upper jaw with most of the teeth. Now we hoped to find a

Out of the woods . . .

. . . and onto the plains: Hominids may have become bipedal as a result of their forays into unfamiliar and dangerous environments. Supporting this idea is the mosaic nature of the East African Rift, where galleries of woodland—like this one along the dry Turkwel riverbed—wind across the great savanna. That similar conditions existed here four million years ago is borne out by the fossil record. The remains of forest-dwelling monkeys, antelope, and rats were discovered at Allia Bay in sediments that also contained grassland creatures such as field rats and gerbils.



complete skull, but the season was ending.

On the last weekend Richard flew up to join us. The previous year he had lost both his legs following an airplane accident. He walks now with artificial legs, but his enthusiasm for fossils is undiminished. We were applying a protective coat of plaster to a large elephant skull found earlier. Nzube was with us, even though he was supposed to be overseeing work at another site nearby. He was enjoying having Richard around so much that he hesitated to leave his side. Finally I insisted Nzube go, and he headed off.

It was a walk he had taken often, but this time his route, or perhaps the angle of the light, might have differed slightly. A few minutes after he left, Nzube ran back, shouting in Swahili, "Come quickly. It is wonderful."

I couldn't believe what I saw sticking out of the sediment—a complete lower jaw and right next to it a piece of the ear region of a skull. I hurried back to Richard and asked him if he would excavate a hominid for me.

Nzube's new fossils resembled those we had already found that season, showing the same mixture of chimp, *A. afarensis*, and unique features. The smaller canines suggested that this individual might be female.

The part of the lower jaw that in humans forms our chins sloped sharply backward. *Afarensis*'s lower jaw slopes also, but much less so than this new individual's. Nzube almost immediately recovered a lower molar of another individual. This was the third site in which we had found the remains of more than one hominid. Perhaps they were the leftovers from some carnivore's meals.

Returning to Nairobi, I was thrilled with the finds we would report—the most complete known specimens of a hominid of this age, and almost certainly a new species older than Lucy. Moreover, we could argue convincingly that this animal was bipedal.

Then came the news that my colleague Tim White, a paleoanthropologist at the University of California, Berkeley, was also about to announce a new hominid species from a site called Aramis in Ethiopia that was even

Hominid hunter

After 35 years in the field Kamoya Kimeu still displays an uncanny knack for spotting fossils. His 1984 discovery of a *Homo erectus* skull fragment led to the recovery of a nearly complete 1.6-million-year-old skeleton. The longtime leader of the Hominid Gang, Kimeu sometimes imagines that the fossils speak to him from the stones and rubble, revealing the secrets of our oldest kin.

older—4.4 million years. He had found teeth and arm bones of an animal he believed was bipedal. His descriptions and photographs indicated that it might be the same animal as we had at Kanapoi. He had tentatively named it *Australopithecus ramidus*, the species name coming from the Afar word for "root."

Tim and his Ethiopian colleague Berhane Asfaw generously invited me to Addis Ababa last January to see the Aramis fossils for myself. Tim had just returned from his latest field season with more surprises. Another of his Ethiopian collaborators, Yohannes Haile Selassie, had found a partial skeleton of *ramidus*, including the pelvis and a tibia—critical in understanding this animal's degree of bipedalism. By spring Tim would conclude that the fossils were sufficiently different from previous finds to warrant placing them in a new genus—*Ardipithecus*, or "ground ape."

Comparing the casts of bones and teeth from Tim's first discoveries with our Kanapoi

finds, my longtime colleague Alan Walker of Pennsylvania State University and I now believe that the Kanapoi teeth look more like *Australopithecus afarensis* than *Ardipithecus ramidus*. I suspect that the Kanapoi fossils may represent Lucy's ancestor and that *Ardipithecus* may belong on another branch of the hominid tree.

Many hominid species may have evolved in those early years. Bipedalism was a profound new anatomical idea, and hominids must have developed many variations on that theme, although only one survives.

After my visit to Addis Ababa I flew to Allia Bay with Alan Walker and Johns Hopkins University graduate student Katey Coffing, who was joining our crew. We planned to excavate an unusual site where thousands of bone fragments were concentrated on the banks of a river just less than four million years ago. Several years ago we found hominid teeth and a jaw fragment there. In 1988 our field crew had recovered an unidentified hominid radius, or forearm bone, not far from the site.

After my first day of prospecting, I returned tired and overheated to camp to see Kamoya beaming. I knew that smile.

"What have you got?" I demanded.

"Hominid," he said.

I laughed and hugged him. No one can find them like Kamoya.

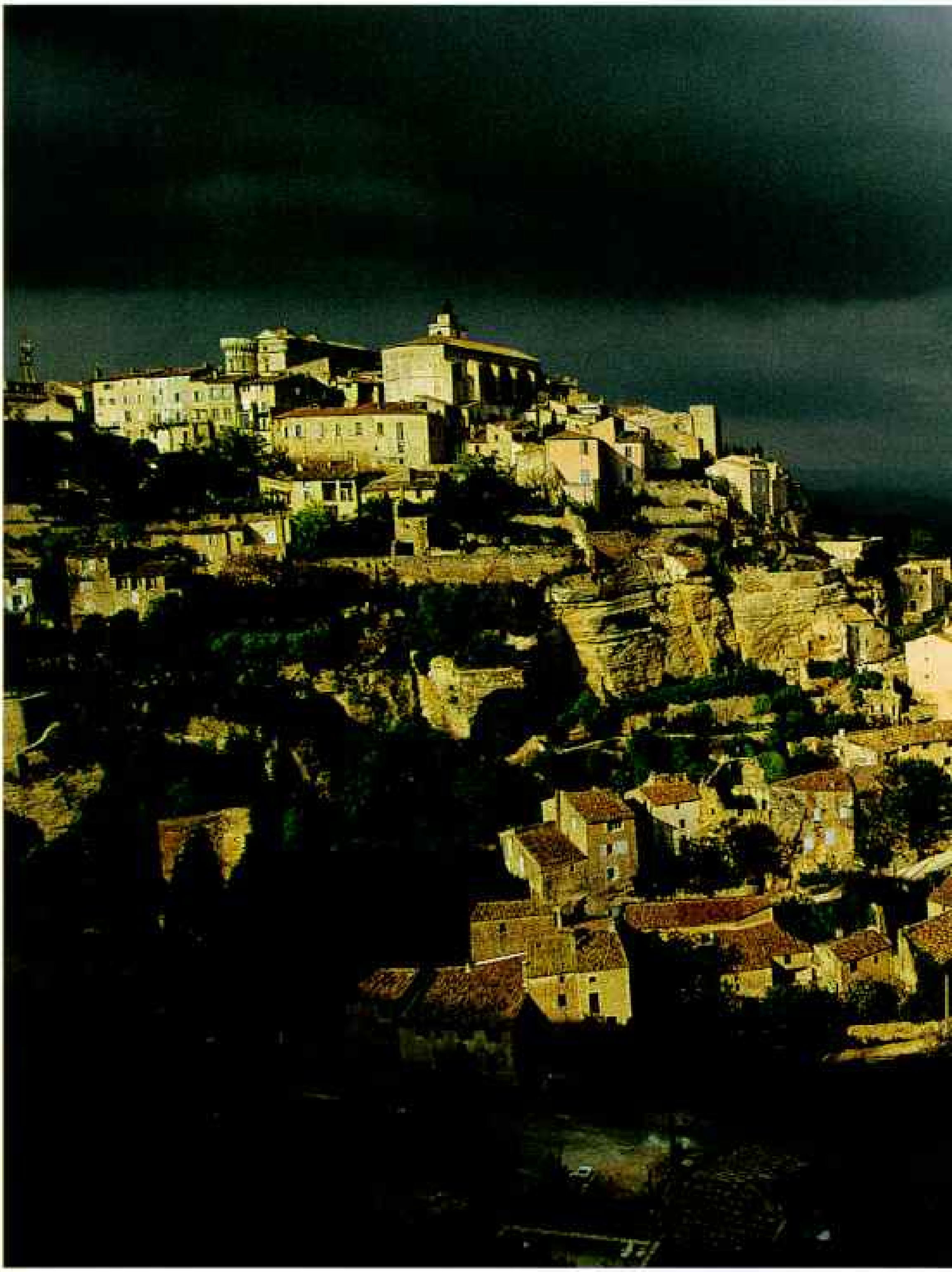
In the days ahead we excavated his discovery—a piece of the upper jaw with a tooth. We found several more teeth nearby. They are fragments, to be sure, but they are also clues. The search continues, and slowly we will accumulate enough of them to begin to understand our oldest ancestors. □

By BILL BRYSON
Photographs by WILLIAM ALBERT ALLARD

ESSENCE OF

PROVENCE

LIKE A PAINTING *stirred to life by summer wind, Provence is where the simplest of landscapes—poppies dancing in a field outside Roussillon—can turn suddenly sublime. No wonder artists are drawn to this corner of southern France, and why everyone from Roman emperors to movie stars has wanted to claim a piece of it. But as much as it gives up to those just passing through, Provence reserves its sweetest self for those who call it home.*



LIGHT EMBRACES LIMESTONE *in the Vaucluse village of Gordes, which may turn out to be too picturesque for its own good. In centuries past such walled hill towns protected the Provençaux from bands of roving brigands; today's*

invaders—vacationers brandishing credit cards—are harder to resist. Damaged by earthquake and Nazi bombs, Gordes's renovated medieval buildings are now fashionable homes, restaurants, and art galleries.

SOARING TO SAFETY, *a white-clad* razeteur *dodges the horns of a charging bull—and thrills spectators at a bullfight in St.-Rémy-de-Provence. Unarmed except for a small rakelike tool, razeteurs win glory by hooking a rosette from the horns.*

These small, half-wild Provençal bulls, revered in the Camargue region, aren't hurt during the contest, but the men who "fight" them pay dearly if they're slow to vault the bullring wall. "The nearer the horns," explains one fan, "the higher the leap."

IT HAPPENED EARLY on a Sunday morning while I was walking in the wooded Lubéron hills of southern France. From somewhere nearby there rose a strange, powerful, indeterminate noise, like a thundering waterfall or the roar of a furnace—the kind of noise you might expect to hear if a dam had broken and it was all coming your way.

Then the pine trees around me began to dance and bend, the dust from the track at my feet rose up in boisterous swirls, and my jacket took on a life of its own, leaping and flapping about me. The whole world seemed suddenly, crazily to be misbehaving, and I realized I was experiencing my first mistral.

You cannot spend much time in Provence without encountering this cold and feckless wind, which rises on the plateau of France's Massif Central and bowls southward out of the valley of the Rhône River to the Mediterranean, sometimes as a stiff breeze but often with a force that knocks you sideways. When it is blowing, as it can for a hundred days a year or more, people talk of little else. Most will tell you (wrongly, according to authorities) that each visitation lasts for a period reliably divisible by three—for three days, six days, nine days, and so on. For however long it blows, when it comes, you know it.

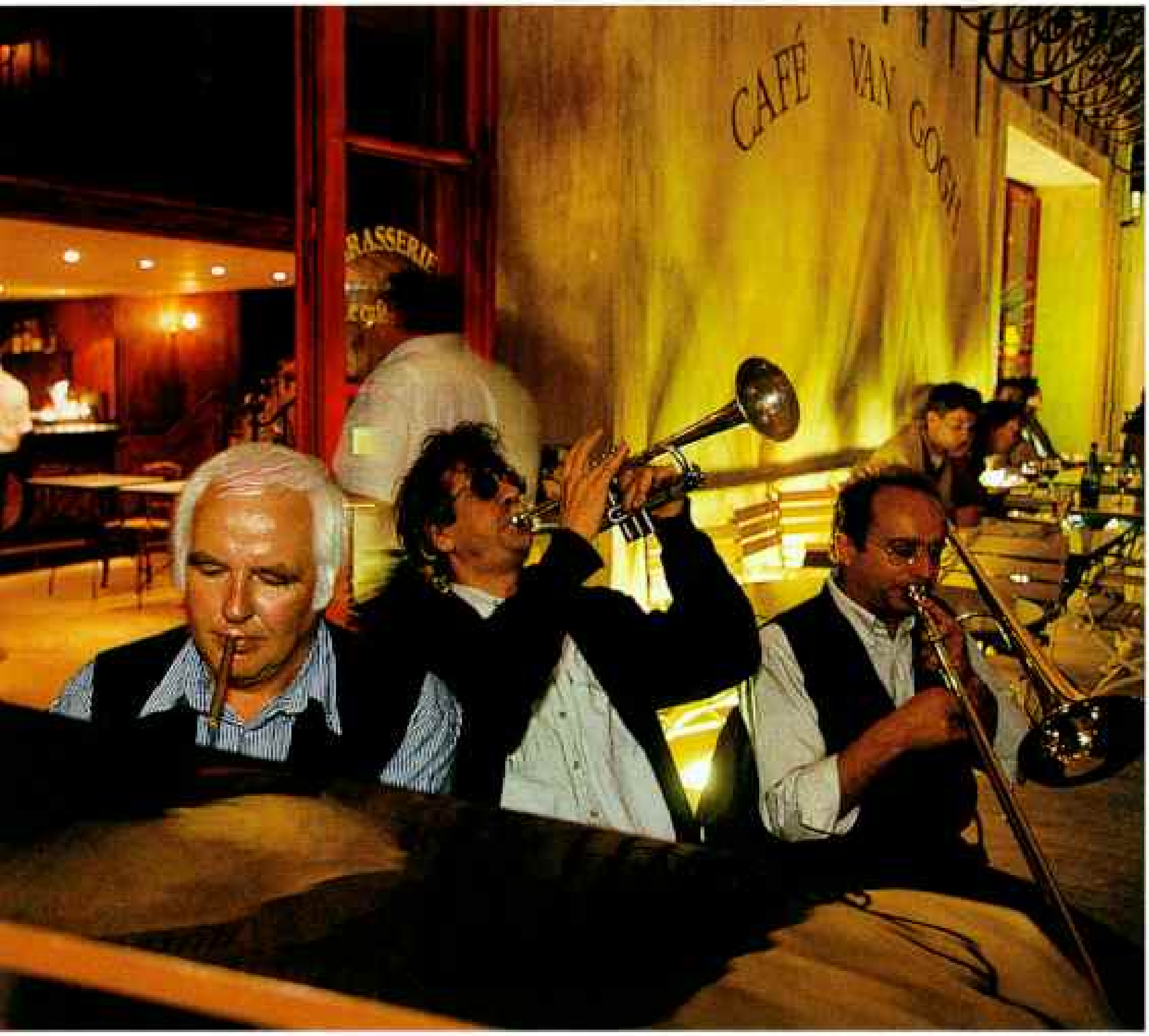
I am a biggish—one might charitably say well-ballasted—fellow, but even on a sheltered hillside with the wind at my back I found myself scooted along in a manner that was not altogether voluntary. Turning to face it, I found that you don't so much walk into the mistral as lie on it and push, as if shouldering a car up a steep hill.

And then, after several hours of noisy gust and tumult, the mistral abruptly moved on, like a passing train, and left me and the surrounding countryside tousled but at peace. Sunshine poured onto the hills, the sky turned a luminous blue, and the air, so wild and unruly a moment before, became still and balmy. It was the kind of instant transformation that astonishes the senses and makes you glad to be alive. It was perfect Provence.

Though the mistral does not always come and go so quickly, it invariably has the effect of seeming to scrub the world clean, of leaving behind a landscape in which colors are richer, scents more intoxicating, the air sharper and fresher than ever before. The view with which I was presented now—of green hills flecked with tightly clustered villages, of low stone farmhouses tucked among olive groves and cherry orchards, and of a huge, blue, perfectly

TRADING ON A NAME, *Arles's stylish Café van Gogh (right) lures both jazz lovers and those who visit the city to pay homage to the café's namesake. Vincent van Gogh lived in Arles for a year until, after an argument with fellow artist Paul Gauguin, he sliced off part of his own ear. He spent much of the next year in a mental hospital in nearby St.-Rémy, where he painted some of his most moving works, including "Irises" and "Starry Night," before his suicide in 1890.*

BILL BRYSON resisted the urge to buy a cottage in Provence, returning last spring to his native United States after 18 years in England. His new home is in New Hampshire. WILLIAM ALBERT ALLARD has photographed 24 stories for the GEOGRAPHIC, seven of which he also wrote. He lives near Charlottesville, Virginia.



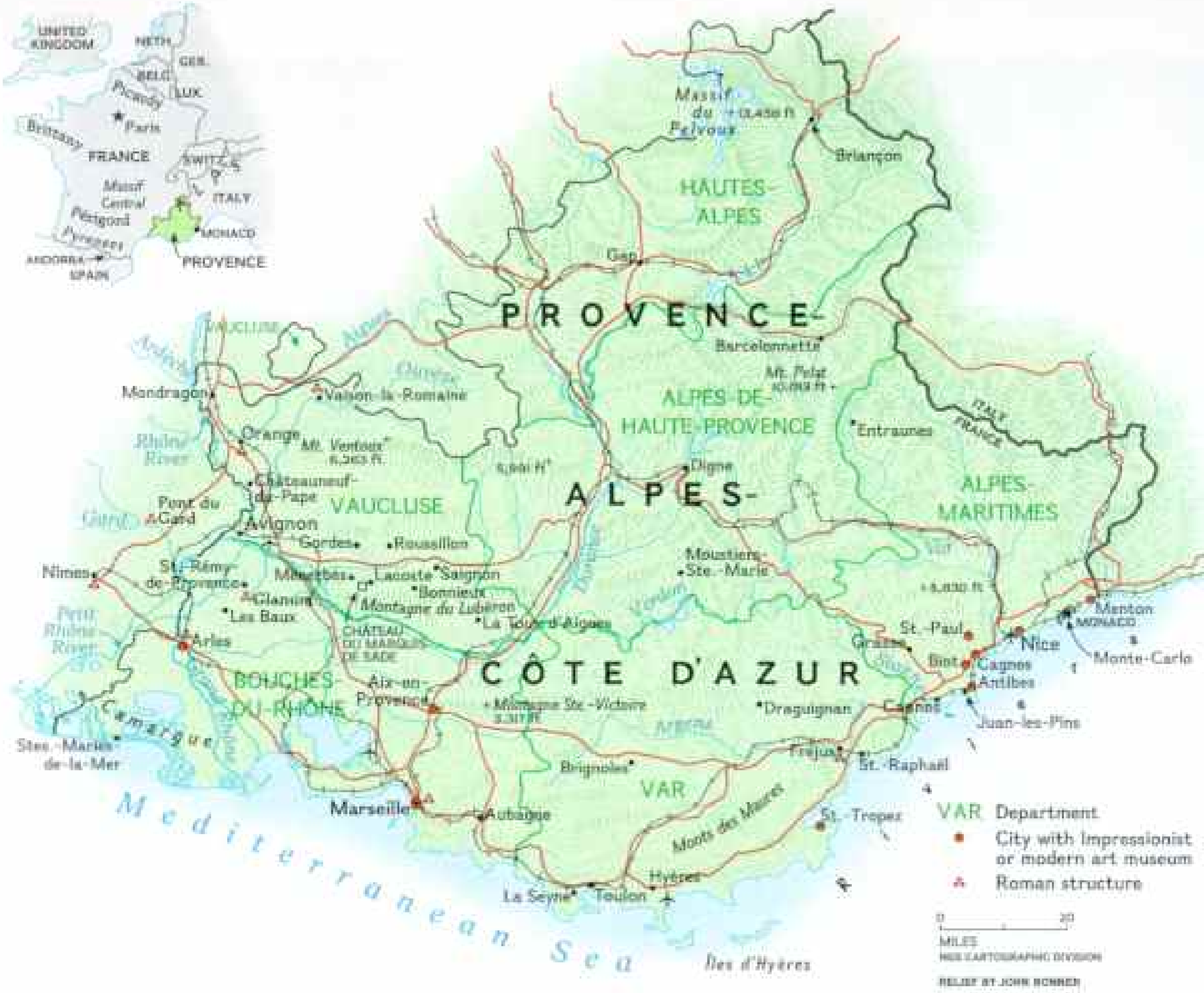
empty sky leading to a distant wall of snow-capped Alps—had a radiance that surpassed sumptuousness. The air was so clear that I felt as if I could almost reach out and ping it with a finger, as I might a polished wine glass.

No other place I know has the same capacity to dazzle the faculties and sharpen the senses as this unceasingly seductive corner of France. It is not only the most beguiling of French regions but also perhaps the most varied and contradictory, with a landscape that ranges from the verdant to the forbidding, a climate that can be alternately benign or fierce, and a topography that is often grand and always restless, as if trying to encompass in its brief sweep every possible manner of crag and undulation.

It contains vibrant cities like Marseille and Nice, university towns like Avignon and Aix-en-Provence, the glittering, traffic-plagued Mediterranean resorts of the Côte d'Azur, and tranquil medieval villages that seem somehow to have escaped the passage of centuries. Mixed into this geographic bouillabaisse are wild gorges, well-ordered farms, Roman ruins almost without number, hills both soft and savage, tangled forests where wild boars roam, the marshy flats of the Camargue where the Rhône splits to meet the sea.

All this variety is packed into an area just 160 miles or so across and perhaps 140 miles from north to south. I use rough figures because the limits of Provence are not just highly irregular but no less highly uncertain.

In pursuit of an answer to where this most ancient and well-named of provinces ends and the remaining, less favored part of the world begins, I took myself to Avignon, a compact



and handsome city dominated by the Palace of the Popes. This monumental edifice served as the seat of Roman Catholicism from 1309 to 1377 after the French-born Pope Clement V abandoned Rome during a period of church factionalism. On a leafy backstreet, in the even more ancient University of Avignon (founded 1303), I tracked down René Grosso, a droll and kindly emeritus professor of geography, and put my question to him.

"Please, I beg you, ask me anything but that," Professor Grosso said, throwing up his hands in mock horror. Then, assuming a more solemn air, he removed and neatly folded his jacket, pulled down a wall map of southern France, and cleared his throat in a manner that suggested this might take a little time.

"To begin with," he intoned, "you should know that Provence was the first Roman province outside Italy—hence its name. Originally it stretched across the whole of southern France from the Alps to the Pyrenees. But after the fall of Rome it was fought over by various forces—Franks, Saracens, and feudal lords—before being divided between the kingdom of France and the papacy. As a result of all this fighting, its shape was constantly changing.

"During the revolution, in the late 18th century, France was carved into scores of administrative units called *départements*. Provence was incorporated into five of these—and thus effectively ceased to exist, except in a sentimental sense. To complicate matters further, in the 1960s the départements were merged into 22 regions. Provence became part of the region known as Provence-Alpes-Côte d'Azur. The whole thing was done haphazardly, and there are many disagreements still. The people of Nice, for instance, have never been happy being part of a region whose capital is Marseille.

"The upshot is that although everyone speaks of Provence as if it were a discrete entity, it is not. Most people think of Nîmes as

A STATE OF MIND *more than a political entity, Provence was singled out as Rome's first province outside Italy in the second century* B.C. *In the 1960s the French government combined Provence with the regions of Alpes and Côte d'Azur.*

Citadel of stone, Les Baux (right) was home to the brutal Lords of Baux, who ruled from A.D. *1000 to 1400. Now two million visitors breach the fortress each year, more interested in Les Baux's feudal past than in its other boast: the mineral bauxite, discovered in 1821.*

part of Provence. In fact, it hasn't been in Provence since Roman times. On the other hand, few think of the Hautes-Alpes region as being in Provence, but it is. In short, Provence exists more up here"—Professor Grosso tapped his head—"than here"—he tapped the map again. "Confusing, no?"

Confusing, yes. But if centuries of turmoil have given Provence a confused outline, they have at least endowed it with a rich sense of its past. Almost nowhere will you find a place where past and present are more agreeably fused. At Orange you can watch opera in an amphitheater, perched on stone seats that were numbing Roman buttocks before the birth of Christ (as they still very effectively do today). In Arles you can sit with a coffee or pastis at a café in the Place du Forum and luxuriate in a scene almost unchanged since van Gogh painted it a century ago, or stroll through dark-lit, flagstone lanes to an evening concert at an arena where gladiators did battle nearly 2,000 years ago, when Arles was a leading city of the Roman Empire.

PERHAPS the most dramatic reminders of the region's often bloody past are the exquisitely picturesque hill villages like Les Baux, Gordes, Bonnieux, Roussillon, Ménerbes, and Moustiers-Ste.-Marie that command the steep-sided hills and mountains of central and northern Provence. Built for safety during the Middle Ages when local lords waged wars across southern France, these *villages perchés* huddle tightly together, often on the edge of giddy precipices on the most precarious of footholds, forever determined to keep the outside world at bay.

For centuries they succeeded. But since the 1960s they have been increasingly overrun by a new type of invader, less brutal but more relentless: the tourist.

"Often in the summer you go into a shop wanting to make some small purchase," a

FAITH RENEWED, *old friends greet each other outside Nôtre Dame de Romégas church in La Tour-d'Aigues. Provence has long been Catholic country. For much of the 14th century the city of Avignon was home to the pope and was the center of Western Christendom.*

retired diplomat told me in his home in Gordes, "and you find you have to wait until a busload of tourists have each paid for their two or three postcards. It can be very tiresome."

Out of season, however, much of Provence sinks back into a gentle repose. "Oh, it's just *wonderful,*" Jane Eakin, an American artist who lives in Ménerbes, says of the peace that comes each September. "People talk in the streets. They reappear in the cafés. The village feels like a community again."

Then too the shimmery, stifling heat of summer vanishes, and the landscape takes on a soft golden hue. On such a day I spied Ismael Bernard, a farmer in the Lubéron for all his 73 years, plowing behind a horse. I stopped to ask him why he didn't use a tractor. He gave me a look as if I had asked him why he didn't swap his wife for a robot.

Those who ask why in Provence must get used to such looks. The Provençaux are a kind and patient people, but ask them what it is that binds them to this particular fragment of France and their eyes narrow. I asked Bernard now. "Because it is my home," he said, fixing me with a dubious gaze. "It is where I was born, the land I know." He shrugged. "Because it is Provence." And because, he might have added, everywhere else isn't.

FEW FARMERS plow with horses these days, but in other respects the old ways live on in Provence. In the shadow of a nearby hill village, Saignon, I found Pierre Roux, a genial giant of a man who had offered to let me join him in one of the more venerable and rewarding of off-season Provençal pursuits, one that had the dual merits of involving time spent in the open air and a reward for the stomach at the end of it. We were going hunting for truffles, the elusive fungi that grow underground on the roots of trees, especially oaks, and are so distinctive in flavor that people will pay a fortune for them.

A builder and handyman by trade, Roux hunts truffles as a hobby throughout the season, which runs from late autumn to early spring. It was early March when I met him outside his farmhouse, or *mas,* and he introduced me to Piou-Piou, a golden-haired mongrel of diminutive size but exceedingly friendly temperament.

We clambered into Roux's old Citroën van, Piou-Piou on my lap, and drove into the quiet hills along a track so rough that I was only intermittently in contact with my seat. Between licks from Piou-Piou, I remarked to Pierre that I had always understood that truffles were hunted with pigs.

He laughed. "They sometimes use pigs in Périgord," he answered in a tone that left open the possibility that mild derangement and

residence in Périgord were not necessarily unconnected. "The trouble with pigs is that they find the flavor of truffles irresistible. You need three men to restrain a pig that has found a truffle. Much easier to work with Piou-Piou."

We stopped in a scrubby clearing above Saignon. The view to the distant summit of Mont Ventoux was very fine, but to my untutored eye the stony soil around us seemed unlikely to be productive of anything. Certainly there were no oaks to be seen.

"No, no, this is a very good spot," Pierre assured me as he set Piou-Piou down. The dog made straight for an area of "burned ground," as Pierre called it—an irregular circle about ten feet across, wholly barren but for a few patches of weedy grass.

"Where's the oak?" I asked. With a foot, Pierre nudged aside some grass to expose a frail-looking plant eight inches high. Three tremulous leaves revealed it to be a white oak, source of some of the best Provençal truffles.

"Often the sickliest-looking oaks provide the best truffles," Pierre said with a shrug, disowning responsibility for the complex and bewildering etiology of mycorrhizal fungi, as truffles are formally known. "The truffle is *très mystérieuse*," he went on, but abruptly broke off. Piou-Piou was scrabbling excitedly at the earth with her paws. Pierre gently

WHO WILL BE THE NEWEST QUEEN OF ARLES? *Wrapped in heirloom lace, contestants await word of the winner, who is judged on mastery of local tradition. One contest prerequisite: knowledge of Provençal, a*

regional tongue closer to Latin than to modern French. "Our language is alive," said native poet Frédéric Mistral, who won a Nobel Prize in 1905. He used the award money to preserve and promote Provençal culture.

pushed the dog aside and plunged a hand into the loose sandy soil. He smelled a fistful of it, then plunged his hand in again, felt around carefully, and after a moment came up with a nubby lump of earth about the size of a golf ball.

"*Voilà!*" He grinned and passed me the truffle to examine. To my surprise it was not light and spongy like a mushroom but hard and dense. The smell was pungent: musty, almost acrid, but with just a hint of sweetness. Though I handled the truffle for only a moment, the scent lingered on my hand for hours. It was not frankly a smell that I would have associated with a delightful eating experience, yet there is almost no edible organism for which people will pay more.

At the time of my visit a hunter could get 3,000 francs (about $500) for a kilo of truffles. By the time they had passed through a succession of middlemen and found their way to the markets of Paris, they would be worth 8,000 francs a kilo—$1,350 for 2.2 pounds.

HAVING DEVOTED a morning to hunting for truffles, it was clearly imperative that I eat some. To that end I repaired shortly afterward to La Beaugravière, a disarmingly plain-looking restaurant along an anonymous stretch of back highway in the no less anonymous village of Mondragon. Were you to drive past it, you wouldn't give the premises of La Beaugravière a second glance, except perhaps to wonder why the parking lot of a restaurant in such an obscure spot was so full of BMWs and Mercedes-Benzes. The drivers of these expensive cars are there for one thing: Guy Jullien's famous truffles.

Jullien has been specializing in truffle dishes for 18 years. "Truffles are fickle things," he told me as he conducted me through the controlled chaos that was his kitchen and into a back office. "They need just the right conditions to prosper—at least one good soaking rain between July and August and an autumn that is wet, but not too wet, and cool, but not too cool. In consequence it is easy to have bad years. Eighty-five was a disaster: There were no truffles at all after February 1. But in 1988 the truffles went on till May. That was a wonderful year." He paused for a moment, lost in a happy reverie.

And this year? He waggled a hand and made a stoical grimace. "Not so good."

LITTLE ROME *on the Rhône, the city of Arles (right) has gone about its business since the sixth century B.C. In the first century A.D. the Romans built a 25,000-seat amphitheater at the town's hub as a showcase for gladiators. Today men still do battle there—with bulls.*

The Pont du Gard aqueduct (below), built by the Romans, now funnels francs into the town of Nîmes as one of France's most popular tourist attractions.

Fortunately for Jullien, demand is not so variable. He hefted two large bags of truffles, six kilograms altogether, onto the table. It looked to me like enough truffles to last a lifetime, but Jullien smiled. "I will go through these in a weekend."

In 1976, his first year at La Beaugravière, Jullien prepared just ten kilos of truffles. Now he goes through up to 300 kilos in a season, which works out to 900,000 francs, or $150,000. That's a lot of fungus.

I asked his advice on ordering truffles. "Truffles go well with almost anything but fish," he said. "The main thing is never to regard truffles as a condiment. Never. The truffle is the main thing, the *raison d'être* of a dish. With truffles," he concluded with just a hint of Gallic grandness, "all else is condiments."

Thanking him, I retired to the restaurant,

FE DI BIOU—the faith of the bull—inspires Provençal cowboys, whose lives are devoted to the animals. What drives the bull is more pointed: a trident-tipped pole called a ficheroun. *As bullfight season nears, the* gardians *round up the bulls, which spend the off-season roaming the plains.*

where I studied the outsize menu. One page was given over entirely to truffle dishes: *les oeufs brouillés aux truffes* (which sounds a trifle less flamboyant when translated into English as scrambled eggs), truffles in pastry, truffle and foie gras turnover, truffle salad, truffles with cheese, even truffle ice cream. A quick calculation revealed that a four-course lunch from the truffle menu could set me back $130. That was before I had even thought about wine or coffee.

I decided not to push the boat out quite that far and settled for a small steak with truffles. It was the first time I have ever regarded a filet mignon as a condiment. The steak was plump, tender, and simply cooked, and all but hidden by a heap of finely diced truffles, small and black and shiny. They were crunchy and vaguely nutty flavored, and the pungent smell had been considerably subdued in the cooking. I had been told that for many people eating truffles is an intense experience not far removed from genuine ecstasy. My own pleasure receptors, alas, appeared largely immune. Possibly they were in shock from the price of this single dish: almost $50.

THE PEOPLE of Provence have always had a knack for generating pleasure and prosperity from remarkably little. Put a farmer from Brittany or Picardy down on the arid, wind-scoured soil of Provence and he would, I suspect, die of a broken heart. But hand the same land to the hardy Provençaux and they will give you an Eden of produce: piles of aromatic truffles, luscious red cherries, juicy melons, plump olives in varieties beyond counting, rich and fruity wines, a galaxy of goat cheeses, crisp vegetables, glossy faience pottery, intoxicating perfumes.

It is the perfumes that perhaps best capture the Provençal gift for making maximum use of what nature gives. For more than 400 years the French fragrance industry has been centered on the small, busy city of Grasse, in the hazy hills a few miles inland from the Mediterranean resorts of Antibes, Juan-les-Pins, and Cannes. Though Grasse has long been associated with the creation of high-class perfumes, much of the real money today lies in the production of aromas and flavors for more mundane products. Aromas are added to just about everything we buy—soaps, shoe polish, window cleaner, you name it.

"Even tobacco is flavored, often with chocolate of all things," Henri-Joseph Roca, marketing director of Robertet, an old Grasse firm, told me as he showed me around the company's factory. Raw materials of almost every conceivable type enter the factory in bulk and, after being subjected to a succession of steamy processes, leave in drums or bottles

as agreeable smells. Though many of the raw materials were what I would have expected to find at a perfume plant—rose petals, jasmine, lavender—many others surprised me, not least oak moss, seaweed, and sawdust.

Oak moss, Roca shouted to me over the industrial noise around us, is used as a preservative. Sawdust gives the pine smell in cleaners.

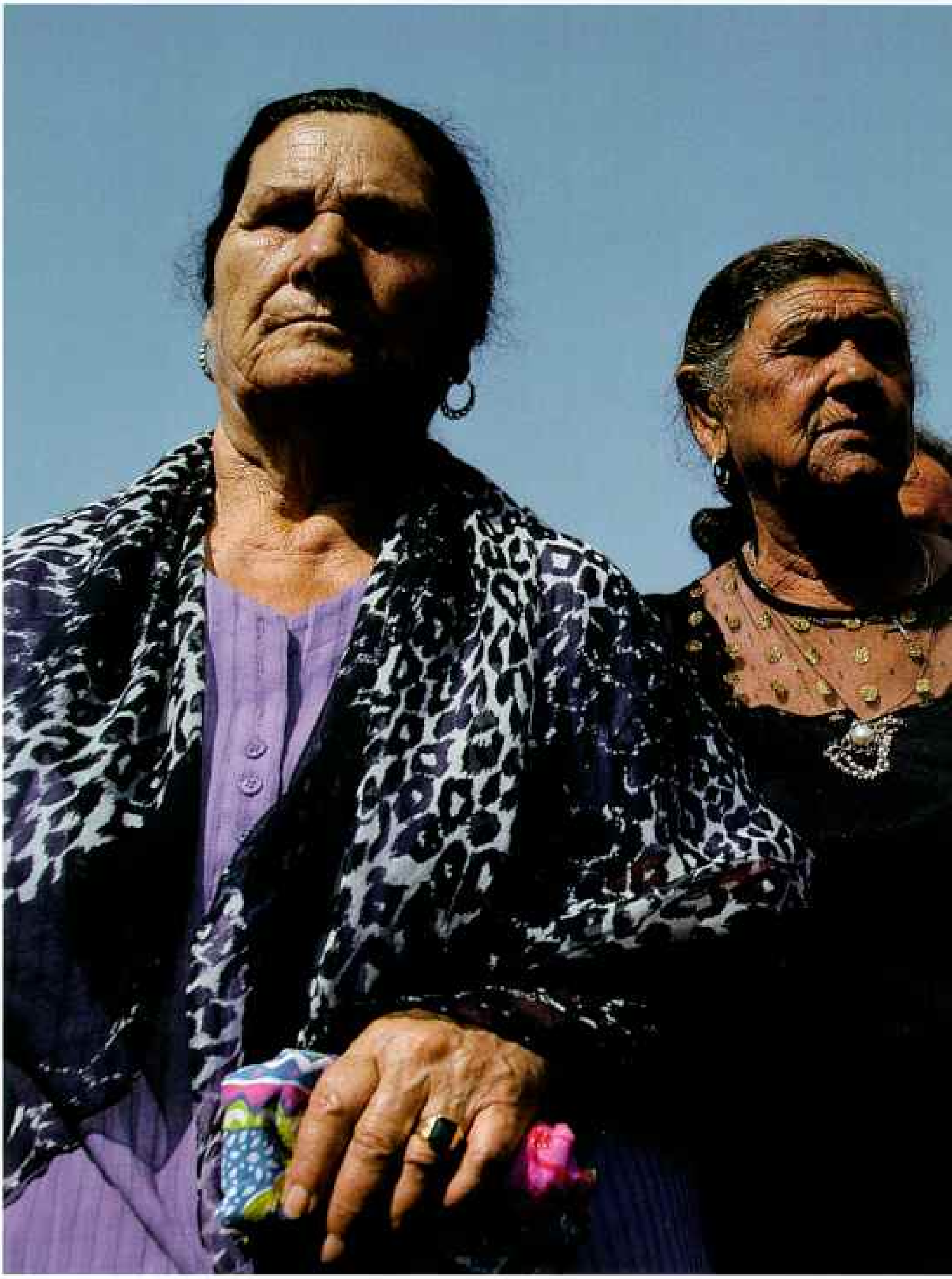
And seaweed? I asked.

Roca smiled. "You know when you buy a deodorant with a name like Ocean Breeze or Sea Spray or something like that?" I nodded. He nodded too—voilà!—and strolled on.

The heart of the operation was a building where a dozen or so perfumers—noses, as they are known in the trade—sat with bottles, vials, and strips of blotting paper creating aromas that could end up in anything from *eau de toilette* to trash bags.

A good nose can identify more than 700 smells. Most of the rest of us are lucky to recognize 50. "And," Roca went on, "noses must be able to recognize smells in minute concentrations, sometimes as little as two parts per million, and they must be able to remember them for weeks, months, even years. That is what makes a great nose."

A few miles outside Grasse, in a roomy white villa high on a sunny hill with long views down the steep valley of the Siagne River,



TWO SAINTS NAMED MARY, *their likenesses held aloft, are honored by a procession of Gypsy worshipers in the Camargue city that bears their names—Stes.-Maries-de-la-Mer. Each May thousands of Gypsies gather*

to pay homage to the Marys and their servant, Sarah, whose boat, it is said, blew here without sails when the women fled Palestine after the death of Christ. Many Gypsies regard Sarah as their patron saint.

I met the man who is widely agreed to be the greatest nose of them all. Now 90, Edmond Roudnitska suffers from failing hearing and sight, but his nose and spirit are indomitable.

To call Roudnitska a perfectionist would be to engage in reckless understatement. In nearly seven decades of work he has created just 17 perfumes that he thought worthy enough to share with the world, but they include some of the most successful perfumes of the century, among them Femme, Diorissimo, Eau Sauvage, and his own favorite, Diorella.

"Anyone can make a nice smell," he says of modern perfumers. "The trick is to create a fragrance that has soul. It isn't a matter of mixing up potions like some kind of alchemist. Most of my time is taken up with reflection and writing—trying to *imagine* the perfume. Often I go months without smelling a formula."

"You cannot overestimate the importance of simplicity," he says suddenly at one point. "Let me show you something." With startling agility he rises from his desk and leaves the room. A moment later he returns bearing a long blotter—a kind of paper wand—which he wafts very briefly in front of my nose, so briefly that at first I smell nothing. A moment later a most wonderful and delicate hint of violet brushes my nostrils. "Just five ingredients," Roudnitska tells me and beams with boyish, unabashed pride.

The smell lingers faintly. It really is quite intoxicating. I ask if we can expect to see it in the stores soon. "Oh, goodness no," Roudnitska laughs. "This is my first attempt at this perfume. I have a very long way to go."

As we part, I ask Roudnitska if the natural fragrances of Provence have been an inspiration to him. I have heard many times that the lush background aromas of the countryside—the long, orderly ranks of lavender, the groves of rich mimosa, the soft scent of cherry blossoms—account for the vitality of the perfume industry in the region. But Roudnitska just grins. "Let me tell you, I created Femme in 1943 in Paris during the worst days of the war in a building that had a rubbish dump on one side and a paint factory on the other."

A SYMPHONY *of earth tones, the old ocher quarry at Roussillon was once mined for 17 different tints of the mineral, which artists worldwide used to color paints and pottery. When ocher was made obsolete by cheaper, synthetic pigments, the quarry suffered losses and finally closed in 1958. Eroded and fragile, it has been declared a historical preserve; today tourist trails wind past walls of the chalk-soft rock.*

IF THE NATURAL BOUNTY of Provence has not notably inspired its greatest perfumer, it has unquestionably provided inspiration for countless artists—Matisse, Renoir, Picasso, Bonnard, and Chagall among them. Paul Cézanne, the region's one great native artist, grew up and lived much of his life in Aix, working from an airy second-floor studio on a hillside just outside town (now marooned in a neighborhood of high-rise apartment houses). A painted advertisement for his father's hat shop can still be seen on the wall above a café at No. 55 Cours Mirabeau in Aix, another passing reminder of the lingering quality of history in the region.

But it is an artist who was not native to the region, or indeed even French, who towers above all others in connection with Provençal art. I refer, of course, to the Dutchman Vincent van Gogh. So prolific and dazzling was van Gogh's output that we tend to forget that he painted for just ten years and that most of his greatest work was done in the disturbed and frantically productive two years he spent in Provence, from early 1888 to the spring of

1890, first in Arles and then in a sanatorium in a former monastery near the ancient town of St.-Rémy-de-Provence. The 150 or so pictures van Gogh painted here include the famous swirling landscapes like "Road With Cypress and Star" and "Olive Trees With Yellow Sky and Sun," whose eerily restless patterns capture both his mental turmoil and the sense of a merciless wind. Two months after leaving the hospital, van Gogh took his own life. He was just 37.

Van Gogh was fascinated by the color and light of Provence—and, rather surprisingly, by the mistral. In 1888, in a letter to a friend, he explained how he had painted "Summer Evening" in a furious mistral. "One rams the legs of the easel into the ground, and then one drives in an iron peg 20 inches long beside them. Then one ties the whole thing together with rope. In this way you can work with the wind blowing."

A short stroll from the sanatorium, on ground over which van Gogh roamed with easel and brushes, stands one of the most remarkable sights in Provence. Tucked into a steep-sided valley are the ruins of a small Greco-Roman city complete with temples, baths, a forum, a basilica, and all the other accoutrements of a place of substance. This is Glanum, once one of the principal communities along the Via Aurelia, the main road in Roman times between Spain and Italy, and today the most important Roman archaeological site in France.

Van Gogh never painted Glanum, and for very good reason. Until 31 years after his death no one knew of its existence. Walking through its ghostly, worn stone lanes and past

SPICY WARES *attract a crowd at the Saturday morning market along Boulevard des Lices in Arles. The famous* herbes de Provence—*basil, fennel, thyme, savory, and lavender—flourish in the rich, dry soil of the region and lend a distinctively aromatic, south-of-France flavor to foods cooked all over the world.*

the still grand remnants of its edifices, it is hard to believe that a community so imposing and noble could have completely disappeared from the human record for 1,600 years, but Glanum managed it. The explanation lies in the peculiar geography of the site.

"Because Glanum was built in a steep defile between hills, it was quickly covered—quickly in historical terms—by alluvium from rains after the Romans abandoned it in the third century A.D.," said Nicole Lambert, Glanum's chief archaeologist when I visited.

By 1921, when a geologist named Pierre DeBrun discovered Glanum, parts of it lay buried under 30 feet of earth and stone. A farmhouse stood on the site of the forum.

"Even now, after 70 years of excavation, many questions are unresolved," Lambert went on. "Glanum was clearly an important town, with an unusually rich collection of temples and other public buildings, and yet there is not a single mention of it in the written record. There is also the question of why it is here at all, what its purpose was."

The presumption is that it functioned as a resting-place and trading post for travelers on the long trek between Spain and Italy. But the wealth of elaborate buildings suggests to Lambert that Glanum was more than just a refueling center. Perhaps the site was held sacred.

More might be known except that, for no good reason, work at Glanum was all but suspended from 1970 until 1980, when Lambert took over. Using Roman building methods, her stonemasons re-created a towering column and part of the facade of the forum, giving visitors an instant indication of the grandeur and quality of the originals. Above all, thanks to Lambert's perseverance, archaeological work is again proceeding.

ELSEWHERE, however, preservation and restoration work have sometimes been left to chance to the most extraordinary degree. A striking example of this is the grand and lofty Château du Marquis de Sade, a shadowy romantic ruin standing high on an outcrop of rock above

PETAL BY PETAL, *Italian workers gather the makings of perfume—jasmine blossoms—on the Mul plantation near Grasse. Hired for their delicate touch, the women each gather more than 15 pounds a day. Mul grows roses too, for Chanel, which uses mainly Provençal flowers to make its famous fragrance No. 5.*

Lacoste. Until he sold it in 1796 to pay his debts, the castle was the home and family seat of Donatien-Alphonse-François, Comte de Sade (1740-1814), better known to history as the Marquis de Sade—libertine, writer, and inspiration for the term "sadism."

For much of this century the château was in the unlikely safekeeping of André Bouër, a retired teacher of high school English who dedicated some 60 years to its purchase and restoration before his recent death at 76. It is a remarkable story of obsession.

"When I was a boy in the 1920s, my grandfather often brought me here," Bouër told me. "There wasn't much of it left by then. The château had fallen into ruins after the French Revolution and for generations had been plundered by locals for building materials." But Bouër found himself drawn to it. "I took pity on this old castle," he confided with a fleeting smile.

In 1932 he began a long and seemingly insane quest to make the castle and surrounding estate his. He spent ten years poring through records dating back to the 13th century to trace the owners. "The castle belonged to more than 40 people, many of whom had no idea they were part owners of a historic château," Bouër said. "I had to persuade them to sell to me—and to do it cheaply. I was just a poor schoolteacher, you see."

Some were more helpful than others. One of the heirs sold him the north wing for ten francs—a couple of dollars. "I paid her in cash, but I didn't have quite enough on me. I still owe her 25 centimes. She is dead now, I'm sorry to relate, but I always carry 25 centimes with me just in case I meet her again."

Even after six decades of work, the château was still largely a ruin. But progress had been made. The 20-foot-deep moat had been cleared of rubble, the cellars excavated, an 18-foot-high defensive wall and a large external staircase rebuilt. "We proceed little by little," Bouër said simply.

He employed three workers year-round and had a workforce of 90 volunteers for three months every summer. He received "a little

GILDED MEADOWS *meet domes of rock outside Aix, near the home of artist Paul Cézanne. After a slow start in Paris, Cézanne returned to Aix to paint and finally found his inspiration. "When one was born down there," he wrote of Provence, "nothing else seems to mean anything."*

money" from the government. The rest came from admission charges and the income from a small conference center on the grounds.

I asked if he didn't think such an important project ought to be in the hands of the French state. "Yes, of course," he answered. "But the state didn't want it. No one wanted this château but me."

Together we stood for a moment at a window in the shell of the main hall and took in the view—a glorious panorama encompassing in its mighty sweep the hill villages of Lacoste, Gordes, and Roussillon, the great pyramid of Mont Ventoux, and the rolling, darkly wooded Lubéron hills.

IT WAS EASY TO SEE how people from the dull gray cities of northern Europe could become so captivated that they would impulsively throw over everything and buy a home here. No one appears to know how many *étrangers*—"strangers," as all non-locals are known—own homes in Provence, but it is certainly in the many thousands.

"You see it happen again and again," I was told by a longtime resident, British architect Andrew Corpe. "A couple on vacation see a house for sale. It looks wonderful in the summer sunshine, and it seems cheap compared with prices in Britain or Holland or especially Paris. So they buy the house and quit their jobs and move here. Then when winter comes, they discover their house isn't so cozy and appealing with the mistral raging. Very probably it faces north, into the wind, so it's cold and drafty and doesn't catch the winter sun. Almost without exception when you see a north-facing house here, it will be owned by an étranger who bought it in good weather."

We were standing on the terrace of a handsome, old—and resolutely south-facing—stone house in the Vaucluse when this information was imparted to me. It was late afternoon on one of those cool but sunny days that lie on the cusp between winter and spring. The sky was streaked with vivid pinks from the last wisps of sunset, and dusk was settling over the earth. Lights were beginning to come on in the scattered farmhouses silhouetted against the landscape before us, and an earthy smell of woodsmoke hung on the still air. The world, or at least this timeless piece of it, seemed a good and gentle place.

"Winters here can come as a severe shock to outsiders," Andrew said. "The mistral totally dominates everything in Provence—farm crops, the style and positioning of houses, the size of window openings, people's moods, everything. Even in a snug house it can drive you half crazy when it blows for days on end.

"On the other hand, when things are good—when you wake to brilliant sunshine,

or step outside on a warm summer evening to find a sky blanketed with stars, or when it's like this with the sun setting and a peaceful evening drawing in—well, life doesn't get any better than that."

I knew exactly what he meant. It is a literally intoxicating landscape, one that takes hold of you in a profound, even alarming, way.

I could happily have stayed on the terrace drinking in the view, but it was my last evening in Provence, and I had something to do. A few hundred yards down a neighboring lane, in a setting that might have been painted by Cézanne, stood a shuttered stone cottage half hidden in a field of flowering cherry trees against a backdrop of dark, angular hills. The cottage was awfully pretty. More than that, it was for sale.

For days I had been driving past it and, to my private surprise, had found myself gazing at it in an increasingly speculative fashion. I wasn't actually considering buying it, you understand—though it really was *awfully* pretty, and the price was very reasonable—but I had an unaccountable desire to gaze at it one last time before darkness set in.

Besides, for no reason that I could particularly put a finger on, I felt a quiet but pressing urge to see which direction it faced.

North. □

Trial and Tragedy a Mile Beneath Mexico

CAVE QUEST

Caught in raging runoff that fell as rain 2,500 feet above them, explorers struggle for balance within the Huautla Cave system. Despite dismal conditions and the death of a comrade, the team pushed on—farther than ever into one of the world's deepest caverns.

Article by WILLIAM C. STONE
Photographs by the author and WES SKILES

WES SKILES (RIGHT)

DEEP DOWN at the bottom of the cave a flickering light appeared in the black pool. Kenny Broad was coming back. The diver had gone looking for his partner, Ian Rolland, who had failed to return from a descent into a flooded U-shaped tunnel called a sump almost 4,000 feet below ground in southern Mexico. For 17 years this sump had blocked exploration of the Huautla Cave system, then the second deepest known cave in the Western Hemisphere.

Breaking the surface, Kenny reached for me, and I helped him out of the water. Because of the roar from a nearby waterfall, I couldn't hear what Kenny said as he pulled off his mask, but I saw "Ian" and "drowned" form unmistakably on his lips.

My heart plunged.

The date was March 28, 1994. Though I'd steeled myself for bad news, it still floored me when it came. I thought of Ian's wife, Erica, and their three children back in Scotland.

For the past two months Ian had been a part of our 44-member team pursuing an arduous quest: to get past the sump to explore the deep, mysterious core of the Huautla Plateau—perhaps the most remote place beneath the planet's surface. Over the eons, subterranean rivers have carved miles of interconnected passages within the plateau, a massive limestone-capped buttress standing 7,000 feet above the Gulf coastal plain in the state of Oaxaca.

Our plan, once we got past the sump, was to follow an underground river, the Río San Agustín, through the heart of the plateau until it gushed back to the surface in the Santo Domingo canyon six miles away. Dye trace experiments in 1988 had pinpointed the spot where the river emerges at a spring 5,492 feet below the highest cave entrance, at Nita Nanta. If we found a route connecting the two ends of the river, it would establish Huautla as the world's deepest cave, surpassing the 5,256-foot-deep Jean Bernard Cave in France.

We had been preparing for this expedition for a decade. To carry it out, we hauled 60-pound packs down 60 vertical shafts—some as tall as 36-story buildings—scrambled around subterranean waterfalls and along horizontal passages, spent weeks in dark, underground camps, and slept in damp, moldy clothing.

Ian's death nearly tore the project apart. One person left to accompany Ian's body back to Scotland. Other members pointed angry fingers at me, saying I'd pushed too hard as leader, that I was obsessed with the cave. Relations were strained. But after a group meeting in the village of San Agustín Zaragoza,

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A structural engineer and inventor, BILL STONE works for the National Institute of Standards and Technology in Gaithersburg, Maryland. He founded the U. S. Deep Caving Team in 1980. Florida-based WES SKILES specializes in cave and underwater photography.

Adios to the sun: Noel Sloan descends into a natural funnel (right), one entry to the Huautla Cave system. Nearly a mile below and some six miles distant, daylight marks the end of the cave, where an underground river rises at a spring and joins the Río Santo Domingo (above). The author's ultimate goal is to traverse the labyrinth from summit to riverside.

all those remaining agreed to stay, if only to help photographer Wes Skiles document the known part of the cave. We'd decide later whether to continue exploration beyond the sump.

Time, however, was running out. In late May the rainy season would begin. Then rivulets would trickle between rows of corn on the hillsides, flowing together to form streams, which would rush headlong into the cave system. Passages deep inside would echo with the roar of water, and escape would be impossible for anyone trapped at the bottom.

KENNY BROAD had made an important discovery just before Ian met his death. More than a quarter mile into the sump—farther underwater than anyone I'd heard of ever going in a cave so deep—Kenny had surfaced in an air-filled chamber. Had he cracked the San Agustín sump at last? Ian had gone to take a look but had never come back.

When I first heard that Ian was missing, I thought of his diabetes. He had been determined not to let this condition keep him out of the cave system, and, considering his long commitment to the project, I had agreed not to stand in his way. But after the accident I agonized that we both had made the wrong choice.

When I dived to recover Ian's body, I found him beneath the air-filled chamber, lying on his side at a depth of nine feet. His mouthpiece was out, but his gear was still functioning. He had apparently blacked out while returning from a dive, a result, I learned later, of insulin shock brought on by exertion and low blood sugar.

It took us six days to haul Ian's body to the surface in a litter—emotionally the most difficult thing any of us had ever done. When we emerged from the cave, we were met by 200 people from the village, many holding roses and burning incense. We carried Ian up the steep hill to the church, where, on the Saturday before Easter, a priest conducted a memorial service in Mazatec, the language of the Huautla Plateau.

We said good-bye to our friend. He was 29.

A week later, hoping to jump-start the expedition, I made a solo dive into the sump to pick up where Ian and Kenny had left off. Though I too felt the pain of Ian's loss, I did not believe he would have wanted us to give up. With a backup team poised at our staging camp, I swam back to the air-filled chamber, which we named the Rolland Airbell in Ian's honor. Submerging again, I found a large passage leading to the south. Fifty yards. A hundred. Where was it going? After 186 yards I saw a mirrored image above me and surfaced. I was in a cavern as long as four football fields with a 40-foot ceiling.

It took a moment to hit me: This was it! The continuation of the main river passage beyond the sump. This was what we'd spent so many years trying to reach. But I couldn't explore what lay beyond by myself. I needed a partner to back me up on climbs, help me measure distances, take compass bearings, and figure slope angles while I recorded data and sketched a map. I returned to Camp 5.

Noel Sloan, our expedition physician, was the logical choice for the final push beyond the sump. Since 1982 Noel and I had been on many difficult expeditions together. As a teenager Noel had gotten his kicks "yo-yoing," or rappelling and ascending, abandoned gold-mine shafts in Colorado. But the stress of this project had taken its toll.

"I'm having second thoughts," he told me the night before our dive. "I don't think I can do this."

My *(Continued on page 90)*

WES SKILES (RIGHT)

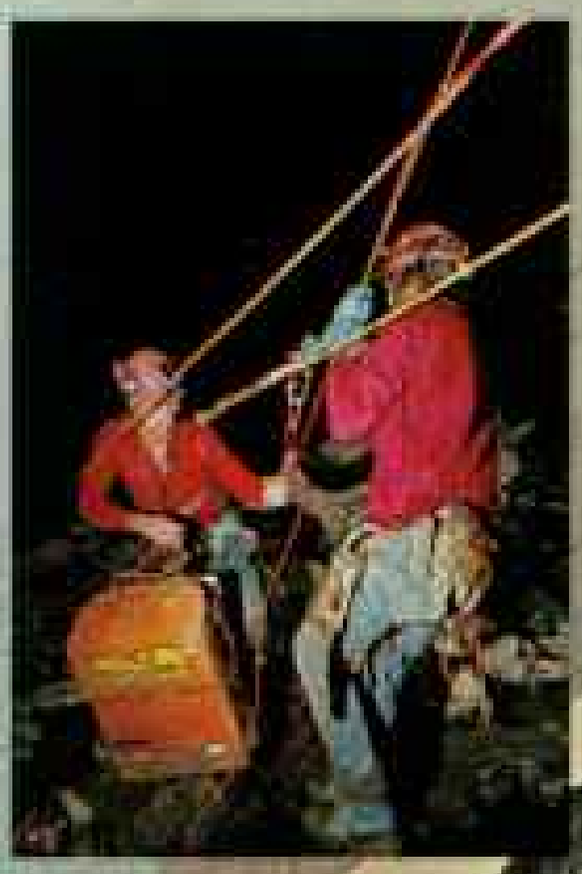
For the first few days, vertical descents (right) had to be made, using ropes anchored by stainless-steel rock bolts. All seemed well. But later, in a flooded tunnel, or sump, caver Ian Rolland died of insulin shock. It took six days to lift his body to the surface, where locals (above) helped manage the final quarter mile to town.

To plumb the deepest puzzle

Nightmare for logistical supply, technically difficult, perhaps even impassable, Huautla may be the world's deepest cave system. To test that proposition, experimenters in 1988 poured dye into a stream at an entrance atop the Huautla Plateau. Tinted water emerged from an opening 5,492 feet below. Yet records are established by human effort, so despite submerged corridors that have for 17 years foiled cavers trying to plumb the system's depths, there is but one way to verify what the dye suggested. Start at the beginning and go to the end, in person.

Since the system was discovered in 1966, 18 expeditions have entered its mouth. Besides natural obstacles and limits of gear, luck, and persistence, many faced resistance from the Mazatec Indians, who consider caves sacred. Resentment grew in the late 1960s, when adherents of the U. S. counterculture tramped in to search for Huautla's psychedelic psilocybin mushrooms. In 1969 a Mazatec cut the rope of one caver, who fell onto a ledge uninjured; in 1970 boulders were rolled down a shaft where cavers were exploring. During the author's 1994 expedition a fiber-optic cable for sending television images from inside the cave was cut twice. Even so, the team of 44 pressed on.

ILLUSTRATION BY DAVID WELTZER



The team spent three weeks lowering 1,500 pounds of equipment and supplies to the depot in the Lower Gorge, 2,756 feet down. It took ten days to remove the gear.

After a 22-hour final push, Stone and am Ende shared oatmeal rations, then grabbed some sleep. The pair were dependent on rebreathers for a safe return.

Entering at a sinkhole, the team descended numerous vertical shafts before reaching the area of new exploration. Depths are measured from the highest cave entrance, at Nita Nanta, roughly two miles from the San Agustín entrance.

The Río Iglesia pours 40 feet from a gaping hole in a cave wall. Four hundred feet downstream, the river joins the San Agustín.

Day by day

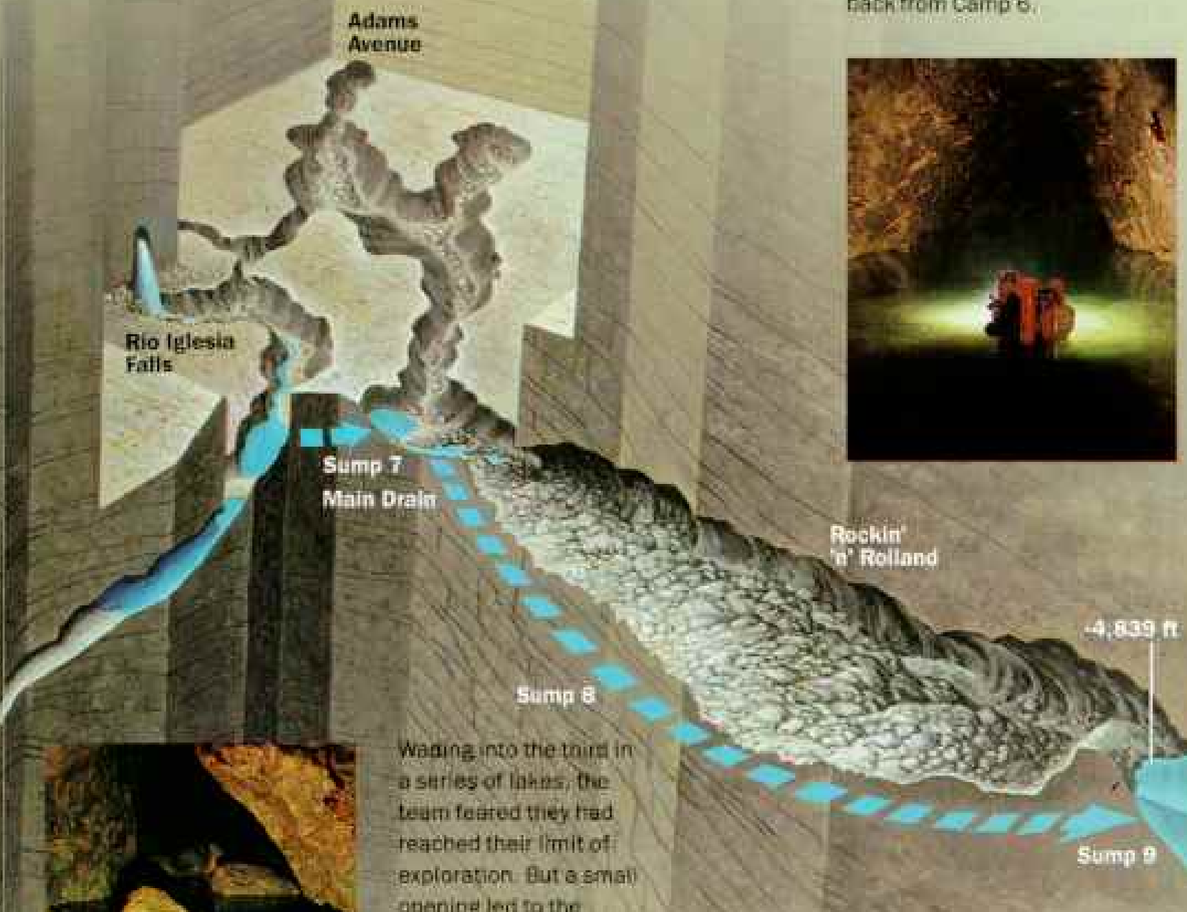
From Camp 5 on May 1, Bill Stone and Barbara am Ende began a journey into uncharted corridors.

DAY 1: Passing through the Rolland Airbell—where Ian Rolland's body was found—the two dive through Sump 2 and set up Camp 6. They explore a dead-end tunnel that am Ende names the Silent Borehole.

DAY 2: A dry bypass enables the team to avoid two sumps, but the discovery of Four Corners—four channels leading from a single pool—is discouraging. One arm leads them to a huge room they name Perseverance Hall.

DAY 3: Surveying of Perseverance Hall continues.

DAY 4: After passing three long lakes, Stone and am Ende discover the Main Drain, where the Iglesia and San Agustín Rivers converge. Beyond a rock-strewn room they call Rockin' 'n' Rolland, the pair encounter a deep sump—to end their season more than two miles beyond the former limit of exploration.



Her green "buddy lights" confirming that her diving gear was working perfectly, am Ende took one last look before heading back from Camp 6.

Wading into the tight in a series of lakes, the team feared they had reached their limit of exploration. But a small opening led to the cave's Main Drain.

Thrusting 7,000 feet upward from the lowlands of Mexico's eastern coast, the Huautla Plateau is honeycombed by a maze of limestone caves. Scores of streams atop the plateau disappear down sinkholes—some 1,000 feet deep—and flow underground, following structural folds and faults in the rock.

Radical breathing gear

The task ahead led Bill Stone to design his MK4 diving rebreather with one goal in mind: To go from one end of the Huautla Cave system to the other without resupply—a job no ordinary scuba apparatus could do.

Pushing into the cave back in 1981, Stone and a team explored dry-land marvels like Anthodite Hall (following pages), large enough to encompass nine football fields. But his 1984 expedition was defeated by the cave's water-filled sumps and the need to haul conventional diving equipment—which allows only a short period underwater per tank—through mile upon mile of cave passageways.

What's more, no one knew how long divers would need to stay submerged upon entering a flooded passage.

Stone headed home to Maryland and began designing a rebreathing system that would enable divers to safely recycle their exhaled breath. Similar systems already existed, but they lacked sufficient internal backups in case of failure. In a flooded cave, a diver cannot float to the surface or take refuge in a diving bell if equipment breaks down.

After ten years' work, Stone perfected a closed-circuit design (right). Air exhaled by a diver (A) has its carbon dioxide removed in a chemical reaction with alkaline hydroxide (B). Divers cannot breathe pure oxygen; it becomes toxic at 25 feet. So helium and oxygen are added in precise mixtures (C), depending on diving depth, to the treated exhaled air. This process is regulated by three onboard computers with built-in backup systems. The fully renewed air is then rebreathed (D).

By the time Stone organized the 1994 expedition, he had a rebreather that could sustain a diver for as long as 16 hours. Easily broken down into modular parts and weighing 97 pounds, it was readily transportable to the deepest reaches of the cave.

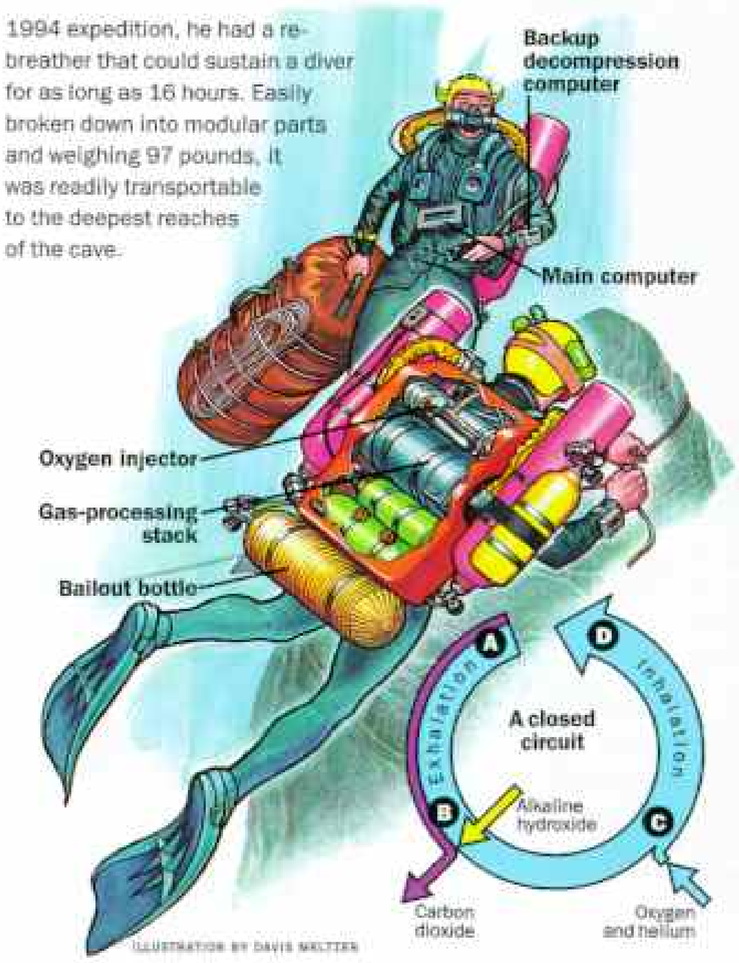
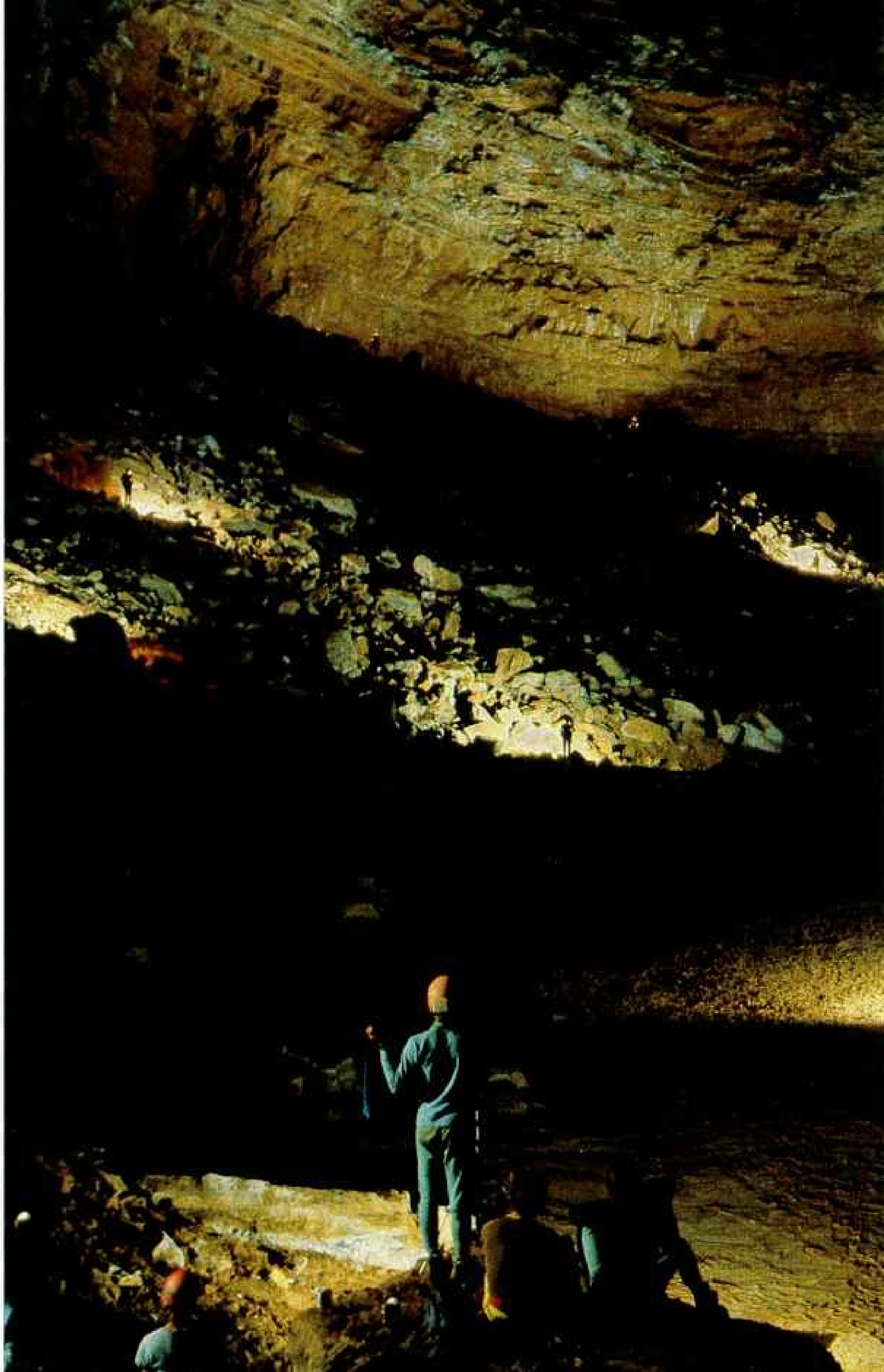


ILLUSTRATION BY DAVIS MEITZEN



(Continued from page 82)
options were running out. Aside from Noel, only nine team members had been trained on our high-tech rebreathing gear (diagram, page 87). Five left after Ian died, and two wanted no part of anything beyond the sump. That left Barbara am Ende, a graduate student in geology at the University of North Carolina at Chapel Hill. If Barbara bailed out, the project was over. Three and a half months of work for nothing. No new data. No new passages charted. Though she was a qualified cave diver, Barbara had far less experience than others on the team. On top of everything, she had also been putting up with grumbling about the fact that she and I were a couple.

"You wouldn't even be here if you weren't Bill's girlfriend," one person told her.

Such comments infuriated Barb. They overlooked her 20 years of caving experience.

"I've trained for this all my life," she declared. "I know I can do it."

WE SET OUT on May 1 from Camp 5, a 4-by-12-foot nylon deck suspended above the sump. Barb and I were taking food for seven days: oatmeal, instant potatoes, and freeze-dried beef stroganoff, each ground into a fine powder and compressed into plastic bottles. We would drink cave water treated with iodine. Noel helped us suit up and ease into the sump. He would wait for us at Camp 3.

"See you in a few days," I said.

"Just come back alive," he replied.

Barb gave Noel's hand a squeeze, then sank into the pool. I followed, pulling our heavy bag of gear. Minerals suspended in the water dispersed the beam from my helmet lamp as fog scatters car lights. A few feet ahead, Barb faded in and out of the haze. After 35 minutes of swimming, I followed her up a bank of sand and surfaced in the Rolland Airbell.

"How's it going?" I said.

"Extremely well," she replied. "Oxygen level was on the money the entire way."

We submerged again and swam through the second sump. Stepping out of the water on the other side, we pulled off our fins and hauled the diving gear up to a flat gravel area, where we set up Camp 6. We would leave the gear here. We couldn't risk damaging it, or we might not get back. From now on, we would explore without it.

As Barb took off her helmet, however, her lamp tumbled off, bouncing into a crack between the rocks. Pointing a backup flashlight down the hole, I saw her lamp, well out of reach. With only one spare lamp, we couldn't risk going deeper into the cave. So I went fishing. After an hour I caught the reflector with a cord and gingerly pulled it up. We were indescribably relieved.

The next morning we followed the Río San Agustín down a sloping limestone chasm to a walled-in pool. Had we reached a dead end so soon? Spotting an alcove near the ceiling, I climbed 30 feet up the wall and found a new tunnel. After hiking a hundred yards, I saw a drop—a bypass around this new sump. I went back to lower a rope for Barb, then dropped a line at the other end of the bypass.

We came to another sump, and climbed yet another bypass, before reaching a green pool with a towering pinnacle of bedrock at its center. The water rippled away through caverns in four directions.

"This does not look good," said Barb. I turned completely around, searching the darkness, hoping for a way out.

"I guess we're going to have to swim," I said. But in which direction? The water was chilling as I set off in my thin jumpsuit and caving boots. The first branch was a bust. The second also dead-ended. The third doubled back to the previous sump. That left the southwest branch—the longest, deepest looking passage. I splashed along for 30 yards, then felt my feet hitting the bottom. This was no sump at all but the beginning of a large cavern. I left the water and sprinted down a hundred yards of dry gravel to where the cave expanded into utter blackness.

"Whoooooop!" I yelled. The echo was carried off into the void. Only later would we learn just how vast an open space we were entering, with walls separated at one point by a span of 200 yards and a ceiling arching up out of sight—all a mile underground. We called it Perseverance Hall.

Beyond the hall we found three long lakes. The last one looked like a dead end. Cold and tired, we declared our exploration finished for the day. We'd come almost a mile since morning and needed to document what we'd found: Three sumps with back doors, a giant cavern, and three narrow lakes, all heading south toward the Santo Domingo canyon.

Ten hours later we were back at Camp 6, celebrating with stroganoff mush.

TWO DAYS LATER, after surveying down to the hall, we returned to the three lakes, the last of which had a small opening where the ceiling met the water. Barb swam out to investigate, her caving helmet disappearing beneath the roof with just enough room for her head. Ten minutes passed. Then twenty. I was about to jump in when she reappeared.

WES SKILES

Torrent from a freak April storm erupts into the Upper Gorge, below which seven team members had camped. Getting his grip with rubberized gloves, Noel Sloan fights thundering white water six feet above normal. When high water strikes a caver, the author says, "You just find high ground and break out the playing cards."

"Want the good news or the bad?"

"Give me the good," I said.

"Well, the low air space lasts for only a few yards. Then the roof rises up again. Beyond the lake, a huge river comes in from the left. It must have four times the flow of this one."

I was stunned and elated—it had to be the Río Iglesia. A Canadian expedition in 1967 had followed the Iglesia into a cavern a half mile from the San Agustín cave entrance, before the stream vanished into a boulder-strewn floor 822 feet below ground. Geologists assumed that it merged with the Río San Agustín somewhere beneath the Huautla Plateau to form what we called the Main Drain.

We had found the juncture.

"OK, what's the bad news?"

"Just beyond the Iglesia, the cavern sumps out," she said. "There's no way around it."

Our progress downriver halted for now, we went to where the Iglesia gallery joined the passage we'd been following and hiked upstream. We heard a rumbling ahead and felt mist on our cheeks. Then suddenly we were face-to-face with a deafening, 40-foot-high waterfall—the largest I'd ever seen underground.

But we weren't finished yet. On our way back to the San Agustín tunnel, I climbed into a fissure hidden in a wall. It led us to a new passage. Pushing up through a maze of boulders, Barb broke out into a great chamber that smelled of rich, damp earth. The next thing I knew, she was racing down a long slope of dirt—soil eroded from hundreds of years of Mazatec farming. At the bottom we spent an hour searching for a way out. Then I heard the faint rush of water.

As we followed the sound, we popped out into an even larger cavern, whose floor was clean-washed stones from wall to wall. We saw the river flowing over the rocks, and in the dim light of our lamps we made out a great pile of stones rising into the darkness.

"It gets really big over the next rise," Barb said.

"You don't call this big?" I replied, waving my hands at the vast passage.

"You don't understand. I mean it gets HU-MON-GOUS!"

Sure enough, when I crested the rock pile, I saw an immense funnel going down. At the bottom was a darkness so deep it defied my most powerful flashlight. It was a lake 150 feet across. And as we dipped our hands into the water, we realized that the funnel continued straight down into the water.

Until this moment we had resisted thinking about how

utterly remote this place was. But ripple marks in the sandy floor reminded us that when the rains came, the river would form a gigantic whirlpool where we stood. I imagined the roaring vortex, like a watery black hole sucking everything down.

More than anything I can describe, I wanted to keep pushing beyond this giant sump. But the only way to do that was to return to Camp 6 for the rebreathers. The rainy season was too close. We turned and headed back. By the time we got back to Camp 6, we had been exploring for 22 hours straight. We had discovered more than two miles of new passages with eight sumps, a new portion of the Río Iglesia, a giant waterfall, the Main Drain, Perseverance Hall, and a massive cavern.

WE RESTED the next day, finished our logbooks, and packed up to leave the following morning—our sixth beyond the first sump. An hour after strapping on our diving gear, we resurfaced at Camp 5.

"We made it!" I said, fumbling to give Barb a hug—not so easy in bulky diving gear.

We spent the afternoon breaking down the gear for transport. By the time we climbed to Camp 3, it was 8:30 p.m. When I saw lights ahead, I gave a shout. Noel hurried down. I extended my hand, but he gave me a hug.

"I cannot tell you how relieved I am to see you two," he said. Everyone was smiling.

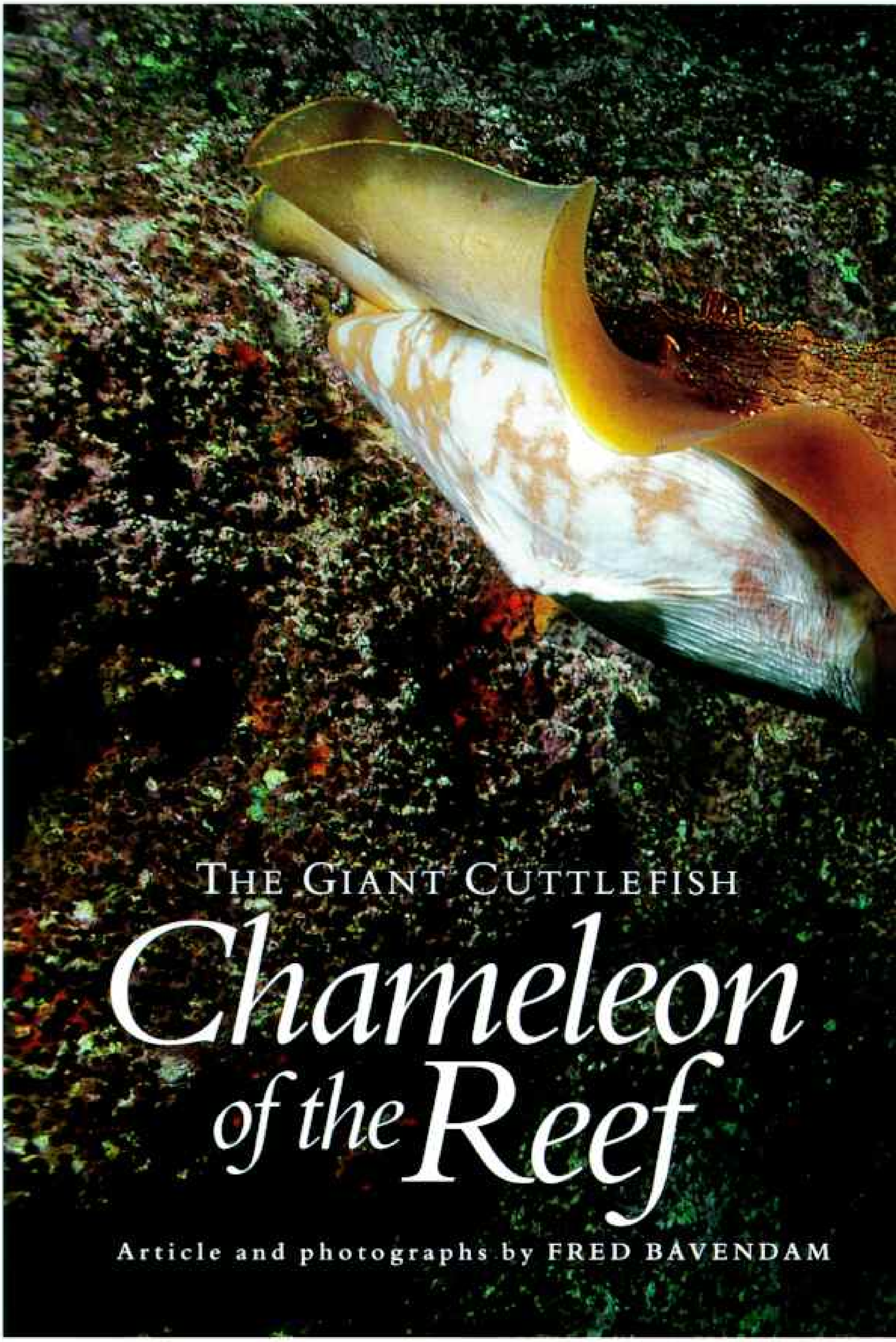
It was another week before we saw sunlight. For ten backbreaking hours a day, a group of us—Don Broussard, Bev Shade, Jim Brown, Sergio Zambrano, Angel Soto, Noel, Barb, and I—pulled our heavy equipment bags across the long traverses and up the endless shafts.

In the end I had to admit that our goal of following Río San Agustín all the way to the canyon had been unrealistic this time. I had underestimated the difficulty of hauling so much gear over so many obstacles to the bottom. And we had all been shaken by the loss of a friend.

But when we calculated the survey data for the most distant sump, the deepest spot in the cave, we were stunned. The new number, minus 4,839 feet, pushed Huautla from the twelfth deepest to the fifth deepest cave in the world.

At 10:57 p.m. on May 14, 18 days after going underground, Noel, Barb, and I stepped out of the cave as the season's clock finally ran out. The air was heavy with the scent of ferns and rain. We heard the rumble of thunder and the patter of drops falling around us. □

Hanging in limbo: For weeks the team's last outpost was Camp 5 (opposite), a platform of nylon tarps and aluminum poles suspended over a sump. The team slept in hammocks. In the final push (above), the author followed Barbara am Ende through mineral-laced waters, "as close to being in outer space as I can imagine."


THE GIANT CUTTLEFISH
Chameleon
of the Reef
Article and photographs by FRED BAVENDAM

Faster than an octopus, able to change colors in the blink of an eye, a 30-inch giant cuttle-fish patrols its home waters off southern Australia.

A MUTUAL admiration society exists between divers and the giant cuttlefish. Shy and solitary by nature, *Sepia apama* are often attracted to bright colors; they sidle right up to divers wearing today's fashionable hot pink and green wet suits. Maybe it is because of the yellow tank I sometimes carry, or maybe it is simple curiosity, but giant cuttlefish have come so close that I can pet them on the back.

Just as cuttlefish will follow me for up to 15 minutes at a time, I can't help ogling them back. They change colors as fluidly as a neon sign, showing reactions like aggression, fear, or sexual excitement.

Divers encounter *S. apama* only in southern Australia's coastal waters. Reaching four feet in length, they are the largest of the hundred or so species of cuttlefish, all characterized by the thick, chalky internal shell called a cuttlebone.

Cuttlefish belong to a class of mollusks called Cephalopoda, which includes octopuses and squid. Like their kin, cuttlefish have highly developed brains for invertebrates; I sense their intelligence whenever I meet the stare of their large eyes. Someone is obviously home.

Like the octopus and the squid, the cuttlefish has sucker-lined appendages growing from its head; the cuttlefish has ten in all, including two hidden tentacles. When it goes for speed, it shoots its eight arms out to streamline its form. When it hovers, using skirtlike fins to stabilize itself, the arms droop down and sway like kelp fronds.

A cuttlefish communicates as vividly with its arms as with its skin colors. Brushing past a diver 30 feet down in Jervis Bay, south of Sydney, a large adult, probably a male, showcases its long outer arms (right), flattened and angled downward like bent swords—a posture assumed when confronting other males.

In the same area, near a bright patch of ascidians, or sea tulips, I startled a smaller adult rounding a corner. Its skin flashing the colors of its surroundings, the animal threw up its arms (below), in what I took to be a back-off gesture. Cuttlefish will bite pushy divers, snipping through wet suits with sharp, parrot-like beaks. Heeding the message, I gave way.

FROM ITS WIDE PALETTE of disguises a giant cuttlefish chooses shades of green and brown to mimic the rock ledge where it keeps a den. Like most cephalopods, cuttlefish are camouflage artists, displaying a remarkably vivid and expressive range of colors. Under the skin of the cuttlefish is arrayed a dense layer of elastic pigment sacs called chromatophores. They come mainly in yellow, red, black, and brown. At a signal from the brain, the cells expand and flood the skin with the appropriate shade. By a combination of expanding and contracting the cells, the animal also can create a complex zebra-like striping.

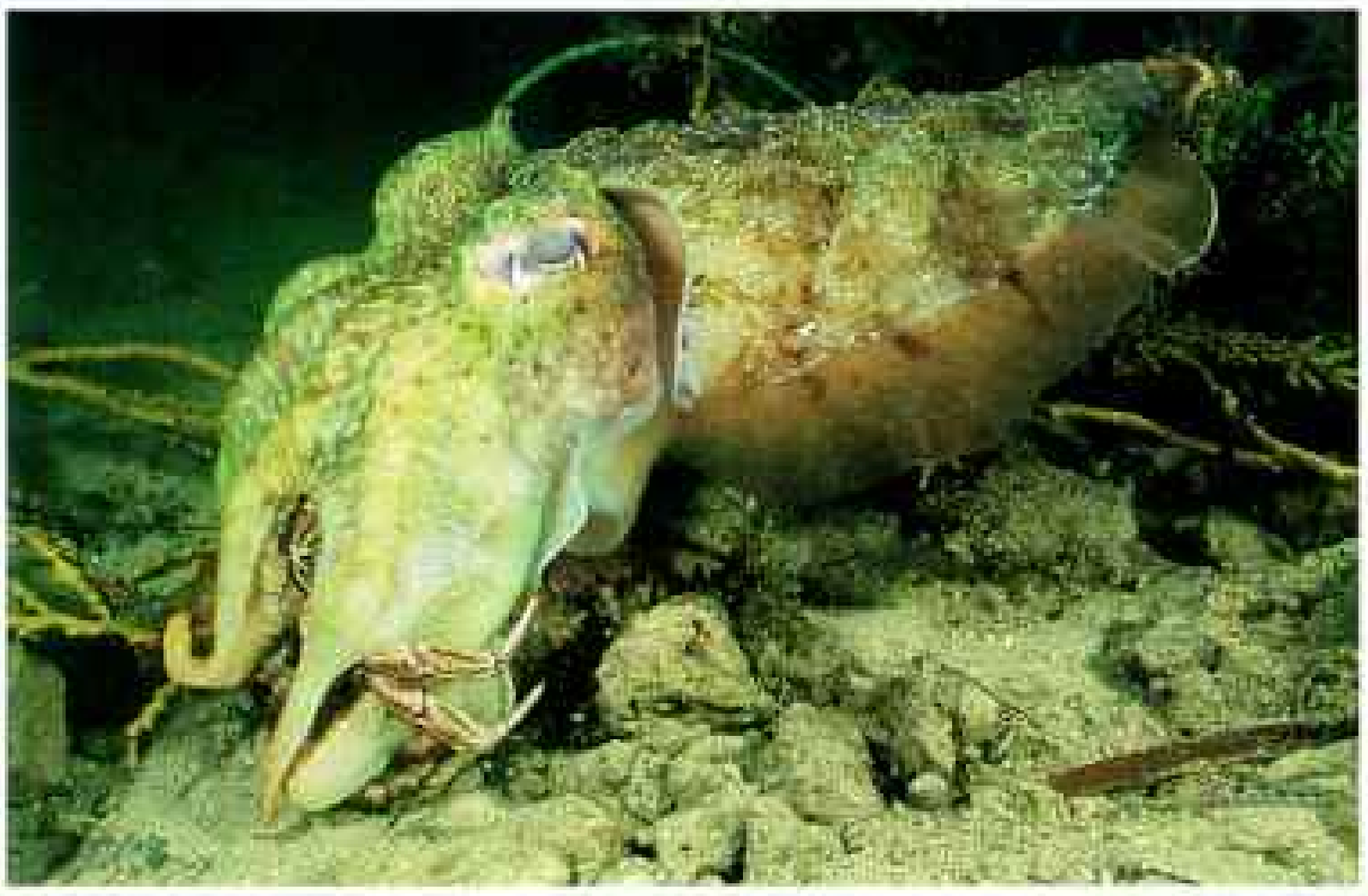
Off Yorke Peninsula, near Adelaide, I came upon an individual that had matched himself to the sandy floor of his hideout (right). When he saw me, he turned bright yellow (far right). Did my strobe excite him? Or did he change colors simply to see what *I* would do?

CLAWS RAISED in vain, a crab doesn't stand a chance in the face of a giant cuttlefish attack. In a flash the cuttlefish unleashed its two whiplike tentacles, kept coiled in pouches beneath its arms, and snatched up the crab.

Engulfing its prey, the cuttlefish started to eat (below). Either it will tear the crab to bits with its beak or neatly puncture the shell and rasp out the meat with its tongue.

The giant cuttlefish also nabs shrimp and fish. In turn it is caught by sharks and dolphins, and the occasional fishermen who prefer its taste to squid.

S. apama hunts with acute vision. Each of its complex eyes contains a lens similar to that in the human eye. To focus, it changes the shape of the entire eyeball, moving the lens closer or farther from the retina. The contours of the eyelid (above) control the amount of entering light. Oddly enough, cuttlefish are thought by some scientists to be color-blind. If so, they must see an incredible range of tones for them to match their skin to the environment.



During mating season, rival males go to dramatic lengths to challenge one another for dominance and the right to take over a good den site. In a typical duel (left) an intruder, foreground, has stretched himself out to look as imposing as possible. The resident retaliates by creating menacing rippies of color on its body. For three or four minutes they glide past each other until the challenger breaks away, its bluff called.

Most cuttlefish confrontations take this form of ritual combat, in which no direct attacks are made. The winner is usually the larger animal, though an aggressive, showy cuttlefish can sometimes intimidate a bigger one.

In one instance a smaller cuttlefish seemed to taunt a larger one in its den, flashing colors and extending his arms. Finally the elder cut short the nonsense and clamped two arms around the pretender's head (bottom left). It wasn't a death grip, as the smaller one shook loose and jetted away, presumably having learned his lesson.

Not all face-offs end benignly. I saw a male with three arms chomped off (bottom right). Cephalopods are known to regenerate their arms, but since giant cuttlefish live only two to three years, and usually die after a mating season, I would guess that this adult's days were numbered anyway.

BODY LANGUAGE makes intentions clear in the combative world of *S. apama.* When squaring off with another male, a large adult ripples his gangly outer arms (top right), thereby emphasizing his size. Another male, cruising limestone overhangs for a female to mate with, elongates himself to look intimidating (above).

I expected some kind of confrontational response from the various males in their individual crevices, but they held tight, waving their long arms as if to lightly brush off the challenger.

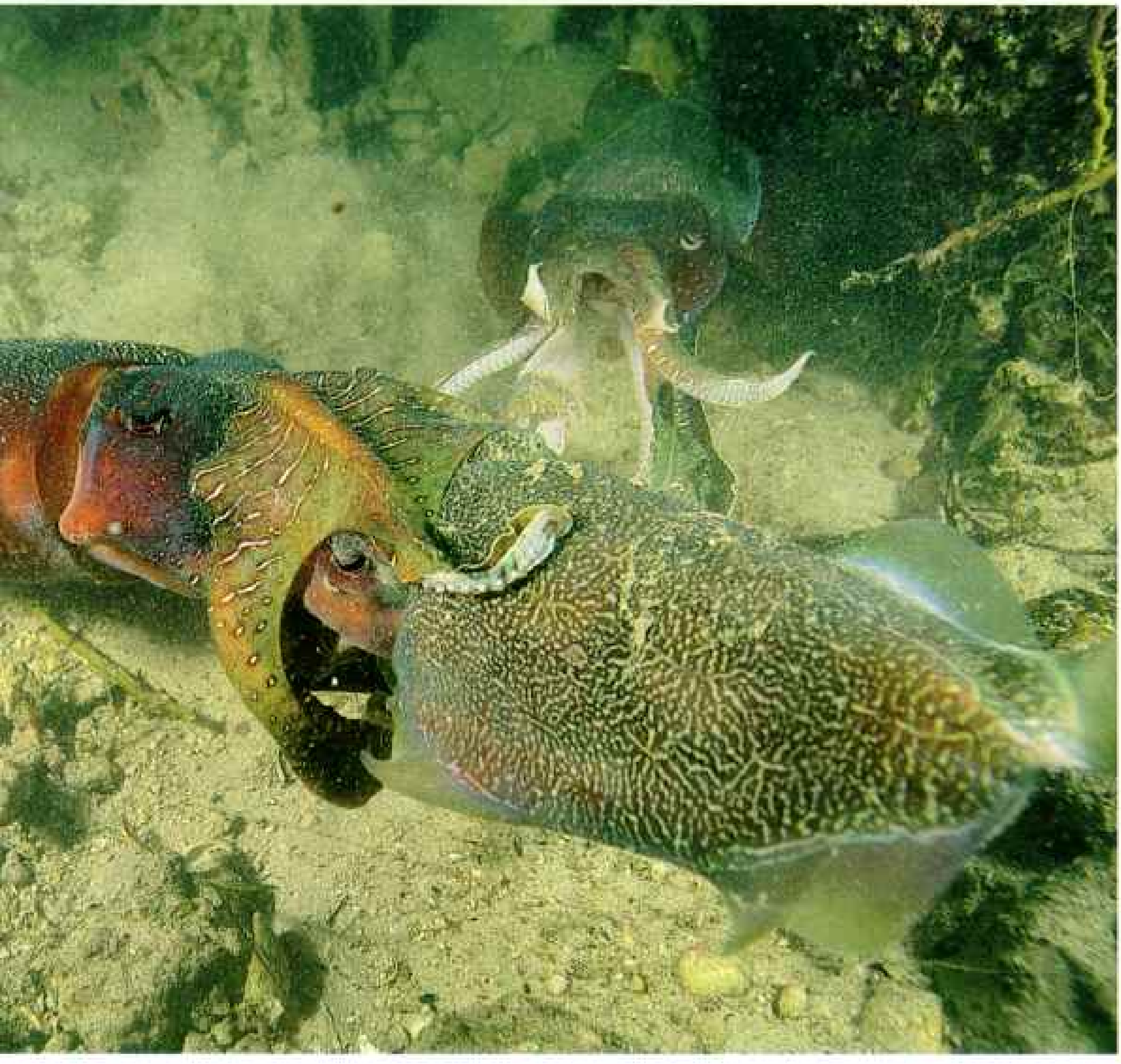
Then out of the darkness swam a female, which may have been scouting the ledge for an egg-laying site. Attracted by the displays of the suitor, she proceeded to mate (right), even as one of the spurned males spread his arms and bared his beak in an empty threat.

The mating proceeded quickly. The male, at left, used one of his arms to deposit sperm capsules into a pouch beneath the female's mouth. The capsules burst open, spreading sperm

into her mantle and fertilizing the eggs. The coupling completed, the female swam back into the cave to lay her new eggs.

Females, which look quite similar to males, typically do not extend their arms as dramatically as their exhibitionist mates. A common female posture is to fold up the arms like a blossom (bottom left).

What shows clearly is her siphon. By expelling water through the funnel-like tube, a fleeing cuttlefish can propel itself backward in a surprising burst of speed.



AFTER FOUR MONTHS of living inside an egg, an inch-long cuttlefish breaks free for its natal swim. The embryo breaks the egg casing with a small brushlike patch on its tail, a feature that disappears shortly after hatching. The cuttlebone is visible as the dark spot on the newborn's mantle. Lined with gas-filled chambers, the shell provides the cuttlefish with neutral buoyancy, allowing it to float as though weightless.

In the adjacent egg, an embryo feeds on the yolk. Within hours it too will hatch.

Both giant cuttlefish were born in my home aquarium. To document the embryonic development of *S. apama*, I had removed several dozen eggs from a cave (bottom left) off Yorke Peninsula. Eggs hung as thick as stalactites. The large number indicated that several females had used the space to lay eggs. Unlike octopuses, however, female cuttlefish do not guard their clutch. They deposit eggs as deep as possible inside a cave, probably to discourage predators like the leatherjacket (bottom right).

One of the first instincts of a newborn is to hide—under rocks, in kelp beds, under the sand. The predation rate is extreme. Survivors, though, grow into one of the ocean's most fascinating and inquisitive creatures, one that might even slip an arm around you. □

Maimed by war, fisherman Berti de Jesús Castro lost his legs to a land mine in 1985 during El Salvador's 12-year civil war. He's learned to adapt—relying on daily rides from his wife, Antonia, who carries him to their lakeside home as the children handle his gear. He credits "willpower and survival spirit"—vital qualities in this wounded land.

EL SALVADOR

By MIKE EDWARDS
ASSISTANT EDITOR

Learns To Live With Peace

Photographs by TOMASZ TOMASZEWSKI

Changing the countryside, tiny farm plots called *minifundios* checker the expanse below San Vicente Volcano. The property, once owned by the government and a few families, was parceled out to landless

campesinos. Land reform was a key issue in the war, in which a U. S.-backed government fought communist-supported guerrillas. A 1992 peace agreement ended the hostilities, which took some 75,000 lives.

Shooting at targets instead of each other, former government soldiers and guerrillas train together for the civilian-controlled national police. An FBI agent from Puerto Rico leads practice. In wartime the military ran the police, widely viewed as murderous enforcers.

Land. "My whole family farmed, but we didn't own land," Simón Amaya said. "We rented a little piece to grow our corn. But to get any money, we had to migrate to pick coffee or cotton."

Land. "I was born learning to work land—that's all I know," said Serafín Chávez, Simón's *compañero*, his buddy.

In El Salvador the inequity of landownership was one of the main causes of the civil war that flared in 1980 and lasted a dozen years. A yawning economic fault allotted great estates to a handful of landlords while tens of thousands of *campesino* families had not a clod.

So there is unaccustomed pride of possession today in parts of El Salvador, such as the sandy plain that delivers the Río Lempa to the Pacific Ocean. Guerrillas once, Simón and Serafín are landowners there, with about five acres apiece. Not a lot, but many campesinos survive on less. "Anybody who suffered through 12 years of war would be happy with anything," said Simón, a guerrilla at 17.

The smallest and most densely packed nation on the New World mainland—Massachusetts-size and nearly as populous, burgeoning with 5.9 million souls—El Salvador, the land of the Savior, is more familiar with suffering than salvation. Besides periodic social upheavals—the recent war and a land-related rebellion in 1932 that resulted in the slaughter of thousands of Indians—it endures a geologic curse. Volcano-studded, it trembles often, sometimes devastatingly. This explains why the capital, San Salvador, is a modern, mostly low-slung city, its Spanish-era architecture having toppled long ago.

But no event has been as potentially earth-shaking as that of January 1992, when the Farabundo Martí National Liberation Front (FMLN) and the government signed a peace pact with far-reaching accords. Both sides were weary and found their allies also flagging. After spending an estimated six billion dollars to bolster the government and the army, the United States wanted out; at the same time, the communist regimes that nourished the guerrillas were collapsing.

The UN brokered the peace negotiations and sent human rights lawyers, police, and other observers to monitor implementation of the accords. These halved the army to 30,000 men and, if faithfully observed, will end

A frequent GEOGRAPHIC contributor, photographer TOMASZ TOMASZEWSKI lives in Warsaw, Poland.

decades of military meddling in politics. A new national police force is on the streets, replacing forces that reeked of corruption and brutality. It is still weak, to be sure, as is the judiciary system, only partly housecleaned so far. Several thousand former soldiers and guerrillas are receiving vocational training to restart their lives. And about 39,000 ex-combatants and campesinos have been given land, most of it purchased by the U. S. government.

Simón and Serafín are among 1,600 ex-guerrillas who received parcels by the Río Lempa, where large estates once produced cotton and cattle.

To work his land will be difficult for Serafín. From the shade of a thatched roof, he regarded me with a misshapen countenance. A land mine exploded in front of him in 1988, and although a German doctor working with the guerrillas tried to save his sight, as he said, "I'm missing a big part of me."

Serafín could see my form, "but I can't tell who you are." Corn is an impossible crop. "To put seeds in a row—I can't do that. But I can work with bananas because they are big." No doubt Serafín's four children will help. And he may get work in a cashew cooperative being organized among the community's ex-guerrillas, most of whom were members of a Marxist branch of the FMLN.

There are many Serafíns bearing scars, for this was a vicious struggle, claiming some

REPUBLIC OF EL SALVADOR

Conquered in the 1520s by the Spanish, who named it the Savior, the nation won independence in 1821. With 726 persons per square mile, El Salvador is the American mainland's smallest and most densely populated nation.

AREA: 8,124 sq mi. **POPULATION:** 5.9 million. **CAPITAL:** San Salvador. **RELIGION:** Roman Catholic. **LANGUAGE:** Spanish. **ADULT LITERACY:** 72%. **ECONOMY:** Coffee, cotton, sugar, livestock, corn.

CORTESY INFORMATION: FUNDACIÓN SALVADOREÑA PARA INVESTIGACIONES DEL CAFÉ, NUEVA SAN SALVADOR

75,000 lives. Death squads of the right, and to a lesser extent terrorists of the left, preyed upon civilians. Bridges were blown up, city halls burned. Dozens of people from the hundred or so families of the wealthy elite, once called the Fourteen Families, were kidnapped for prisoner exchange or for ransom, swelling the FMLN war chest by tens of millions.

So it is not easy for Salvadorans to put aside hatred and suspicion in this time they call *La Transición*. On my first visit to witness the return of peace, early in 1994, many were still wary and combative. On San Salvador's crowded streets former FMLN *comandantes* strode proudly, having descended from their mountain strongholds to become public figures. But they strode with bodyguards, as did, also, nearly everyone of importance on the right. During the 1994 election campaign—which resulted in a big victory for the conservative Nationalist Republican Alliance (ARENA) over the FMLN—ARENA bodyguards drew pistols when hecklers harassed a rally.

When I visited again a few months later it seemed to me that tensions had subsided somewhat and that now and then people of extreme and obdurate mind-sets were beginning to try to reach across the chasm.

Yet among the capital's 1.5 million inhabitants the extremes of wealth and poverty were as great as ever. And in the rich neighborhoods of Escalón and San Francisco the fear of kidnapping was as palpable as the bougainvillea spilling over walls in joyous scarlet.

Today the kidnappers are likely to be apolitical—just gangs toting U. S. M16 rifles or Soviet AK-47s, the murderous flotsam of the war. They occasionally rob buses, and they have tossed grenades at the new police officers. Hence, many of the rich continue to dwell behind walls and barbed wire.

Right beside these posh fortresses lie alleys spiked with community water spigots. In such a neighborhood Alma Andrade runs a beauty shop in a corner of her home, a tin-roofed shed.

Alma's mother lives in San Francisco, California, one of perhaps a million Salvadorans who, fleeing war and poverty, dwell legally or

Gentle slopes of Santa Ana Volcano yield a robust brew of high-quality coffee. El Salvador's chief export accounts for 30 percent of the nation's agricultural earnings. Cross-hatched rows of trees shield coffee bushes from wind damage.

illegally in the U. S. "She sent me $75 to start this business," Alma said. "I bought the mirror, the scissors, the hair dryer. My mother sends money to my brothers too, so they can go to the university." Alma wept, thinking of her hardworking mother, who holds two jobs. And then she lectured me. "People don't go to the States because they want to leave us. They go to earn money for their families. You should tell people that."

Cash from stateside relatives flows to El Salvador at the rate of more than two million dollars a day, a great sustainer in a nation where 45 percent are jobless or underemployed and a hundred dollars will feed a family for a month.

THE KINSHIP between El Salvador and the U. S. is visible everywhere. Burger King and Wendy's are present in such numbers that the *hamburguesa* seems likely to topple the national dish, *pupusas*, corn pancakes enfolding cheese, beans, or meat.

It is a formidably traditional cuisine that is under attack. As archaeologists discovered at Joya de Cerén, where a village was preserved in volcanic ash, the fare of Indians 1,400 years ago was also corn and beans, plus chilies, tomatoes, squashes, and chocolate.

This New World Pompeii, found when a bulldozer's blade struck a buried building, is less than an hour's drive from the capital.

Removing ash 17 feet deep, a team led by Payson Sheets of the University of Colorado has bared 17 adobe structures. Nowhere else has such a detailed picture emerged of village life in pre-Hispanic America.

Dr. Sheets is not yet sure who these Indians were. Possibly they were Lenca, one of the several Central American groups.

What is certain: They departed in a rush after a volcanic eruption. Hot ash covered the things they left behind, including food, seeds, and dishes. Dr. Sheets discovered that the Indians grew flowers and kept ducks and dogs. They had no grills for making pupusas, but they did steam tamales. "The variety of food is amazing," he said. "We had no idea how good life was for common people."

Wolfing down a discarded orange, Ernesto Morales, 13, and one-year-old Blanca Asucena live on the edge of the Mariona dump outside San Salvador, the nation's capital. Hundreds subsist here by

foraging and collecting recyclable materials, driven to desperate measures in a country where 45 percent are jobless or underemployed. A trash avalanche at another dump in 1992 killed 18 people.

MAKING LIFE GOOD AGAIN in this nation just starting over includes the challenge of rescuing the environment.

The land of the Savior is a denuded land; only 3 percent still grows natural forest. In this hemisphere only Haiti has less. More than half of all the energy expended in the country—more than from petroleum and hydroelectric power combined—derives from wood, which is used for everything from grilling pupusas to baking bricks.

No city has a working sewage-treatment plant. The main stem of San Salvador's sewer system is the Río Acelhuate, running gray-brown and gravid through the capital.

Salvadorans, however, are beginning to care about what's left of nature. For example, there's a major effort to save a mountainous enclave aptly named El Imposible, near the Guatemalan border. At 20 square miles—smaller than Manhattan—El Imposible is the largest Salvadoran preserve. It still harbors plants and animals found nowhere else in the country, such as the *pajuil,* or great curassow, a large bird that, unfortunately for its future, is also tasty. The park service has entrusted the protection of El Imposible to SalvaNatura, a new citizens environmental group.

Néstor Herrera and Alicia Díaz are of a rare species themselves—aspiring field biologists in a nation that has offered scant opportunity for that work.

They were my hosts one sunup in a mangrove swamp. In a motorboat we chugged to a small island where parrots screeched—sweet music to Néstor and Alicia. Not far away, Pacific surf pounded a strip of sand that held a fishing village named Barra de Santiago.

For their theses at the National University, Néstor and Alicia considered studying parakeets near the capital. "But the war was still going on, and the army and guerrillas were all around," Néstor said. "It wasn't smart to be out with binoculars."

The swamp was safe, for the war never reached the region of Barra de Santiago, in far western El Salvador. And the mangroves were home to the country's remnant colonies of the yellow-naped parrot and the white-fronted parrot. Poached for the pet trade, the yellow-naped parrot was down to 50 birds here. Both species also had declined because many of the high trees they prefer for nesting had toppled during a hurricane in 1982.

Néstor and Alicia reasoned that, with a little money, they could save these birds. "We wrote about 50 letters," Néstor said. "To the States, Europe, even Australia." Presently $1,300 arrived from New York from the Wildlife Conservation Society. Néstor is still amazed—"They didn't even know me."

A $15,000 grant soon followed, helping to pay for a guard during the nesting season, "the time the birds are most threatened by poachers," Alicia pointed out, and for hollowed log nests that have been hung in the remaining tall trees. Parrots have moved into 17 of them.

I slept that night in a hammock by the beach; then I went to the clouds. It's only a three-hour drive—north and up, up—from Barra de Santiago to Montecristo. This is El Salvador's lushest park, only 7.7 miles square. I bathed in a cold stream and bedded down in an old hacienda while cicadas rang in concert.

Next morning I hiked a trail so densely canopied that the sky vanished. It wasn't just the huge oaks that blotted out blue; it was the

Sickly mix of exhaust fumes and smoke hangs over San Salvador, where pollution controls are virtually nonexistent. Brisk evening winds usually clear the air—temporarily. Earthquakes have obliterated colonial Spanish architecture in this low-rise city. In the nearby farming center of Cojutepeque shoppers stroll the main market (bottom). In wartime "vendors waited until the gunfire stopped, then reopened," says a native. "Here, life is lived on the street."


FERRETERIA
"CENTRAL"
ALMACEN
"EL MILAGRO"
SE HACEN
LLAVES
DELTA

trees growing on those oaks, and the myriad bromeliads and luxuriant philodendrons. Finally, at almost 8,000 feet, I emerged on a windswept clearing where El Salvador meets Guatemala and Honduras. These neighbors have pledged to save their cloud forest too, creating an international biosphere reserve. But only in El Salvador does the land have government protection.

To be sure, other green vistas please the eye. Northwest from the capital, the Pan American Highway coils among volcanoes rising to more than 6,000 feet, upon whose slopes dark foliage marches with drill-team precision.

These groves yield brown gold. At a *beneficio*, a coffee-drying plant, Arturo Velasco brewed a sample and filled three glasses with dark brown liquid. He spooned from each glass and with quick slurps drew liquid into the back of his mouth. "Strictly high grown," he pronounced. Thus this sample, from a shipment bound for Germany, had been graded first class, as coffee grown at an altitude of at least 1,200 meters (3,937 feet). The higher the elevation, the greater the quality—and the better the price.

In a cool grove above Arturo's tasting room, 240 pickers labored. Roberto Sánchez and his wife, Blanca, were helped by two of their children, 12 and 8.

Coffee picking, Roberto proclaimed, pays better than a factory job "because in a factory I would be the only one working. Our last pay was 1,200 colones [$140 U. S.] for 15 days. And each year is going to be better because my kids are growing bigger." School vacation coincides with the picking season, beginning in October, and child field labor is legal.

The good life is savored by architect José Roberto Suárez, foreground, watching a soccer match with friends. For the 83 percent of Salvadorans who earn less than $4,000 a year, his hot tub and affluent lifestyle are light-years away. An even more elite group of about a hundred families still commands most of the nation's wealth. But prosperity is dangerous. In January, Rodrigo José Fernández, at right, was shot to death in a carjacking at a San Salvador stoplight.

Before the war Roberto and other locals had to fight migrating pickers for jobs. No more; out of fear, people stopped migrating during the hostilities. And many pickers no longer work, a foreman complained, "because of the money they get from the States." Others have taken jobs in garment factories in San Salvador—low-wage enterprises geared to the U. S. market. All this has growers worried, for the picking machine hasn't been invented that can travel El Salvador's steep slopes.

Coffee is (besides people) El Salvador's chief export, yielding 245 million dollars last year. And it was extraordinarily good to the oligarchs of the 19th and early 20th centuries.

Much of the high ground ideal for coffee was held in common ownership by the Pipil, the major Indian group, related to the Toltec of Mexico. In the 1880s, driven by the profit potential of coffee, the government abolished communal holdings. Planters moved in.

This was one more blow to the Indians, who had been in decline since the conquistadores arrived in 1524, burdened by the Spaniards' labor demands and felled by their diseases.

Coffee *fincas* ran to 3,000 acres; profits spawned banks and businesses. Many small farmers became mere tenants or squatters.

When coffee prices collapsed in the Great Depression, even the campesino's meager wage from picking vanished. The president had promised land reform—which he could not deliver, even if he had intended to, because he was ousted by the military. Campesino hopes were frustrated yet again when many local elections were aborted.

So, in January 1932, came rebellion. Prominent in that uprising was a dark-skinned communist known as El Negro. This was Augustín Farabundo Martí, for whom the FMLN would be named. His followers included many of El Salvador's remaining Indians. Some besieged towns with machetes, destroying property and killing 100 people, including a few landlords. Vengeance was terrible. In an orgy with racial overtones, soldiers slaughtered anyone who looked Indian. *La Matanza*, it is called: the massacre. Historians place the dead at 10,000 to 30,000. El Negro died too—executed.

Indianness became an identity to be hidden under a Spanish veneer. Rarely today can you find a speaker of Nahua, the principal language at the time of the conquest.

Military dictators ran the country after 1932, in alliance with the wealthy. They gave scant heed to land reform (although one U. S.-backed program was attempted). Meanwhile, the social dynamite accumulated; the population was nearly doubling every 20 years, and 40 percent of the rural people were landless.

THE NARROW ASPHALT RIBBON climbing into the Departamento de Morazán, a province in El Salvador's northeast, was pocked with circular holes. Not long before I traveled that route, a Belgian company hired by the UN had removed the contents of those holes—land mines.

Stitched with forbidding ridges, Morazán came to serve as an ideal guerrilla fortress, with the town of Perquín its nerve center. Not much more than a church and a spray of bougainvillea, Perquín seems about to slide off its mountainside.

Many people here joined the FMLN, some to fight, some to survive. A woman named Victorina told me she had simply wandered into a guerrilla camp. "There was no choice," she said. The army, applying scorched-earth tactics, had burned her family's village. For seven years Victorina and her mother dwelled in the mountains—"finding the nicest tree to live under." Victorina is 27 but looks 45.

When peace came, they moved into a house vacated by a family who had fled to Honduras. "But now the owners have come back, and we have nowhere to go," Victorina said. "We own the little piece of land where our own house was, but somebody else is there now." People are all atumble in Morazán, disputing who owns what. "We never knew it was going to be so hard *after* the war," Victorina said.

The FMLN was organized in 1980, uniting five leftist groups. This followed a decade of escalating violence, during which death squads killed dissidents—including even Roman Catholic Archbishop Oscar Romero—and the army stole elections. Leftists staged demonstrations and strikes and kidnapped the rich. Would-be guerrillas streamed into the mountain fastness of Morazán, from which they descended to fight the army and sabotage the economy.

To Perquín still come the revolution's leaders, as if on pilgrimage. I spoke there with a woman of gentle countenance who looked, altogether, like a sociable neighbor who'd invite you over for spaghetti. In truth Ana Guadalupe Martínez was an important comandante. Another who returns is Joaquín Villalobos, boyish-faced though 43, a tactician once at the top of the army's most wanted list.

In the 1970s both were students at the National University, a hotbed of revolution. Joaquín was moved by the help-the-oppressed liberation theology that swept the Catholic Church in Latin America beginning in the 1960s. Many if not most guerrillas, particularly

Risky business: Minimarts in San Salvador post armed guards, as do most businesses that deal in cash. Robbery is pervasive, with the new police not yet providing adequate protection. Some crime is blamed on former guerrillas and renegade former policemen who served the war-era government.

On streets jammed by a postwar auto boom (below), traffic cops are nowhere to be found. Drivers routinely jump from their vehicles to unsnarl gridlock.

in the faction known as the Popular Liberation Forces (FPL), espoused Marxism.

Ana and Joaquín joined the less ideologically extreme People's Revolutionary Army (ERP). "It was not ideology that made me a revolutionary," Ana said. "It was the injustice, poverty, and human rights violations I saw every day."

Though the FMLN had a large following in the war, it fared poorly among conflict-weary voters in its first political contest, last year's elections. ARENA—pro-business, well-organized—won by a landslide.

To Joaquín the message was clear: The leftist revolutionary image had to be discarded if the ex-guerrillas expected to succeed in politics. "The only way we can win against ARENA is to create a new, more centrist party," he told me. Anyway, he added, "We were always uncomfortable with the FPL people. There were many communist ideas we didn't believe in." A few months after the elections he led his ERP faction (about 30 percent of the FMLN's strength) out of the organization. It is now called the Democratic Party, and its leader espouses private enterprise.

Thus the FMLN, which fought the Salvadoran Army to a virtual standstill, spawning fears of a communist takeover in Central America, has been shattered, done in by peace.

At Perquín's edge stands a small museum displaying an arsenal—everything from

Years of toil show in the face of a young sugarcane cutter near San Miguel. He earns about $2.75 for a day's work, which starts as early as 4 a.m. to allow for a siesta during midday heat. Many farmers and

migrant workers put children to work at age five. Lifeblood of the economy, agriculture suffered during the war, when fields were neglected and sometimes burned for tactical advantage.

homemade mines to U. S. mortars. As I looked, several men talked at once. "We used those captured radios to follow the enemy and interfere with their communications. . . . We took that machine gun from a battalion in Corinto." The pride was so thick you could have shot holes through it.

I wanted to hear Rufina Amaya's story. So my assistant Cecil Mata, a young woman who had braved gunfire to escort journalists during the war, went to a crude shack in Perquín to find her.

Rufina and one boy apparently were the only survivors of the El Mozote massacre. In December 1981 soldiers swept through El Mozote and surrounding hamlets; assuming that the people supported the guerrillas, they killed everyone who could be found. UN investigators said more than 500 died; Rufina and others in Morazán say 1,200.

We bounced over a dirt road, coming at last to a few walls, all that remain of El Mozote. Rufina showed me where her husband was shot. And where children—including her own four—had been pushed into a house and shot. Through tears, she said: "I could hear them begging, 'Please don't kill us!' I recognized the voices of my kids." The soldiers burned the village before withdrawing. During all this Rufina had hidden in dense undergrowth—surviving to testify about the worst massacre of the war.

A UN Truth Commission that reported on this and other atrocities cited the FMLN for a small percentage of the crimes, while blaming by far the greatest number on government security forces, which were abetted by civil authorities and by "some of the richest landowners and businessmen." Only a few of the more than 40 officers named in the report have been tried; a hastily passed amnesty law makes it unlikely that others will be.

A rare stand of rain forest shades the mountainous Cerro Verde Tourist Resort, a national preserve west of the capital. Harvesting for firewood and timber and clearing land for agriculture have shrunk El Salvador's natural forest cover to 3 percent, causing erosion and depleting wildlife populations.

After scavenging for firewood (bottom) a family heads into the town of Suchitoto, where bundles fetch about 30 cents apiece.

PRESIDENT ARMANDO CALDERÓN SOL, a rotund lawyer with an open, friendly face, does not dispute that human rights, and almost everything else, must improve. "I don't defend the society we had. I'm sure it was corrupt in everything." This he blames on years of leftist subversion; others say lawlessness was simply endemic.

In El Salvador's quest for lasting peace, much will depend on whether Mr. Calderón Sol is able to manage the country for the benefit of all rather than for a wealthy few.

He began his five-year term in June 1994 espousing the healing process begun by his predecessor, Alfredo Cristiani, who persevered in peace negotiations with the FMLN despite death threats from furious rightists. All the same, Calderón Sol lives with a ghost; he was an early protégé of Roberto D'Aubuisson, a charismatic former major, who died in 1992 from cancer. D'Aubuisson is widely held to have run death squads in the 1970s. As the president spoke to me in the headquarters of the ARENA Party a portrait of D'Aubuisson looked down from a wall. The party's founder, he has not been disavowed.

Calderón Sol's administration is benefiting from U. S. largesse. Though El Salvador is no longer the hemisphere's largest recipient of U. S. aid (it's now fourth), 266 million dollars has been provided, including 60 million dollars to buy land for the Serafins and Simóns. The new police force is down for 26 million dollars. There's a 20-million-dollar program


TIRE

Survivor of savagery, María Sánchez, center, fled to Honduras after her brother, suspected of being a guerrilla, was killed by police in 1981. "He was coming back from cutting wood," she says. "They

tortured him, burned him alive." In all, she lost 13 family members. Sánchez later returned to El Salvador and opened a store in this empty house in Morazán. She and her five children were recently evicted.

to rescue the environment. Ex-guerrillas applaud the continuing U. S. presence, and not only for the cash; they also want the U. S. to press the government to keep its promises.

In El Salvador's rebirth, perhaps the most difficult task is to wipe the slate clean of animus and distrust. "You cannot forgive a person who murdered or kidnapped a friend or a relative," said Enrique Altamirano. A courtly man of 63, he is the publisher of *El Diario de Hoy*, long one of the most strident voices thundering against the left.

In a book-lined study—a serene sanctum within his newspaper's heavily guarded compound—he reminded me that a friend of his was one of the first kidnap victims. He himself had a narrow escape, he added, when guerrillas planted explosives by his house. Like many wealthy Salvadorans, he fled to Miami.

I asked if his is the prevailing attitude toward the left among businessmen today. "There are people who say, 'Oh, I'm willing to forget,' " he answered, "but nobody invites them to dinner." Nor has *El Diario* invited any to become employees—"There aren't any people from the left with the qualifications to work in an orderly business."

Federico Batlle also was affected by a kidnapping; his family paid $500,000 for the return of his uncle, who had been kept in a dark box—in which he could not stand up—for nine months. But Batlle, who manages a bottling company, has a viewpoint voiced only recently among Salvadoran capitalists. "The war was a lesson for everybody," he said. "You learned to open your mind to other ideas." What ideas? "The owners of capital were selfish. They were just thinking about making

Zeroing in for a shot on goal, a member of the El Salvador National Amputees Football Team plants himself during a practice match in San Salvador. Three times in the late 1980s the war-maimed army veterans won the Boeing World Cup soccer championship for amputees in Seattle.

El Salvador—poor in natural resources, accustomed to violence, and lacking a stable democratic tradition—will need similar determination to overcome its other wounds of war.

money. The war could have been prevented if they had understood that the people needed help." Batlle has hired leftists.

And then there is Jaime Hill (the Salvadoran elite is sprinkled with English and German names). Coffee, banking, and insurance enriched Jaime's family, which made its members prime kidnap targets. Jaime was seized in 1979 and kept in a small room for more than four months, until a three-million-dollar ransom was paid.

"There was no sense carrying a grudge here in my stomach," he told me. So after peace came, he decided to assist his captors—Joaquín Villalobos's ERP. The comandante wanted to meet businessmen; he needed help starting a construction company to put his compañeros to work. Hill found him a business manager and an accountant.

LEONEL GÓMEZ reasoned that talk would help heal the Salvadoran wounds. Several times I visited a conference hall where Leonel, a political activist with lively brown eyes, presided over discussions of such subjects as justice and economic recovery.

The 60 participants were a diverse lot: politicians to professors, priests to killers. One was a general. Another, tall and bearded, answered when I asked his profession: "ex-guerrilla." He had left the National University to join the FMLN, abandoning his dream of becoming a nuclear physicist.

"You must have been good at math," I said.

"Yes. I used that in the war."

"How?"

"Artillery," he answered.

For four months these men and women had been meeting three times a week, talking five hours at a session.

Leonel organized this program, known as Centro Demos. The U. S. government pays the bills here too but stands clear; it is a Salvadoran catharsis. "I just want people to listen to one another," Leonel said. "What we're doing is just common sense. Decency."

Leonel had essayed decency before. He once accused government officials of a 40-million-dollar fraud—then had to flee the country. In 1989 he was the chief investigator for a U. S. commission that blamed the murders of six Jesuit priests and their housekeeper and her daughter on a coterie of army officers. Most of the suspected conspirators went free. But this time, decency in El Salvador just may succeed.

One night several conferees heaped criticism on the military. "They killed the Jesuits," exclaimed a priest. A union leader: "When we see soldiers on our streets at night, we're still afraid we're going to die."

Finally a beleaguered colonel responded. "I don't think everything is the army's fault. Anyway, we know what happened in the past. We should talk about what the army should become from now on."

A self-serving position perhaps, but it found agreement in an ex-guerrilla. Yes, he said, we should be looking ahead, "looking for what's best for El Salvador." And, he added, acknowledging guerrilla atrocities, "We made some mistakes too."

At the end of one session I saw an ex-general and an ex-comandante chatting like old buddies. Blessed are the peacemakers. □

ROSCOE W. PERKINS

■ FROM THE ARCHIVES

Warm Memories of Hawaii

Tourists have always sought novel souvenirs to impress friends back home. Early visitors to Kilauea volcano actually dipped postcards into red-hot cracks of active lava flows. Toasting postcards is prohibited at Kilauea today—too dangerous. This photograph, although never published in the magazine, was among several by Roscoe W. Perkins acquired by GEOGRAPHIC Editor and Society President Gilbert H. Grosvenor for his article "The Hawaiian Islands," in the February 1924 issue. Grosvenor traveled the world in search of compelling stories and often purchased the work of local photographers.

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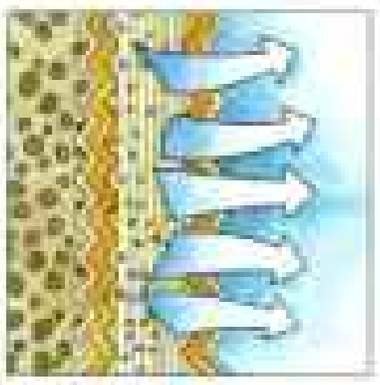

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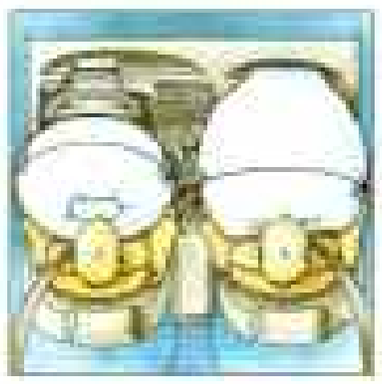

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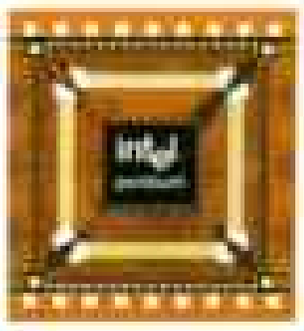

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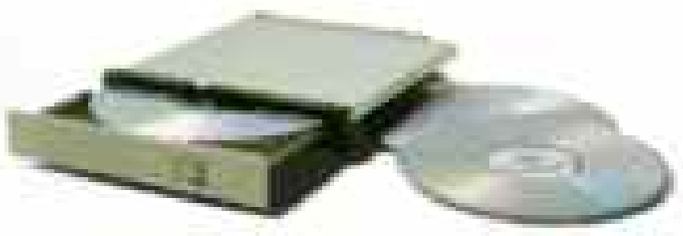

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NATIONAL GEOGRAPHIC

SEPTEMBER 1995

The Cover

Flaunting feathers once sought for the capes of Hawaiian royalty, an 'i'iwi clings to an existence made precarious by an army of imported predators. Photograph by Chris Johns

Getting published has never been easy.

Just ask any third or fourth grader in Mrs. Graham's writing class. They've experienced the challenge firsthand. It was part of an assignment in which she had her students create articles that actually ran in a local magazine.

First came assigning individual responsibilities to the class. Each student was given a position just like you'd find at any magazine. Positions like editor, operations director, art director, photographer and journalist. Then with unheralded enthusiasm the class began the hard work of getting their story to print. They handled everything – research, layout, design, proofing, even production – all in time to make their deadline.

It's a lesson she says the class loved. Not only did they discover some of the rigors of journalism, they also learned how articles come to life.

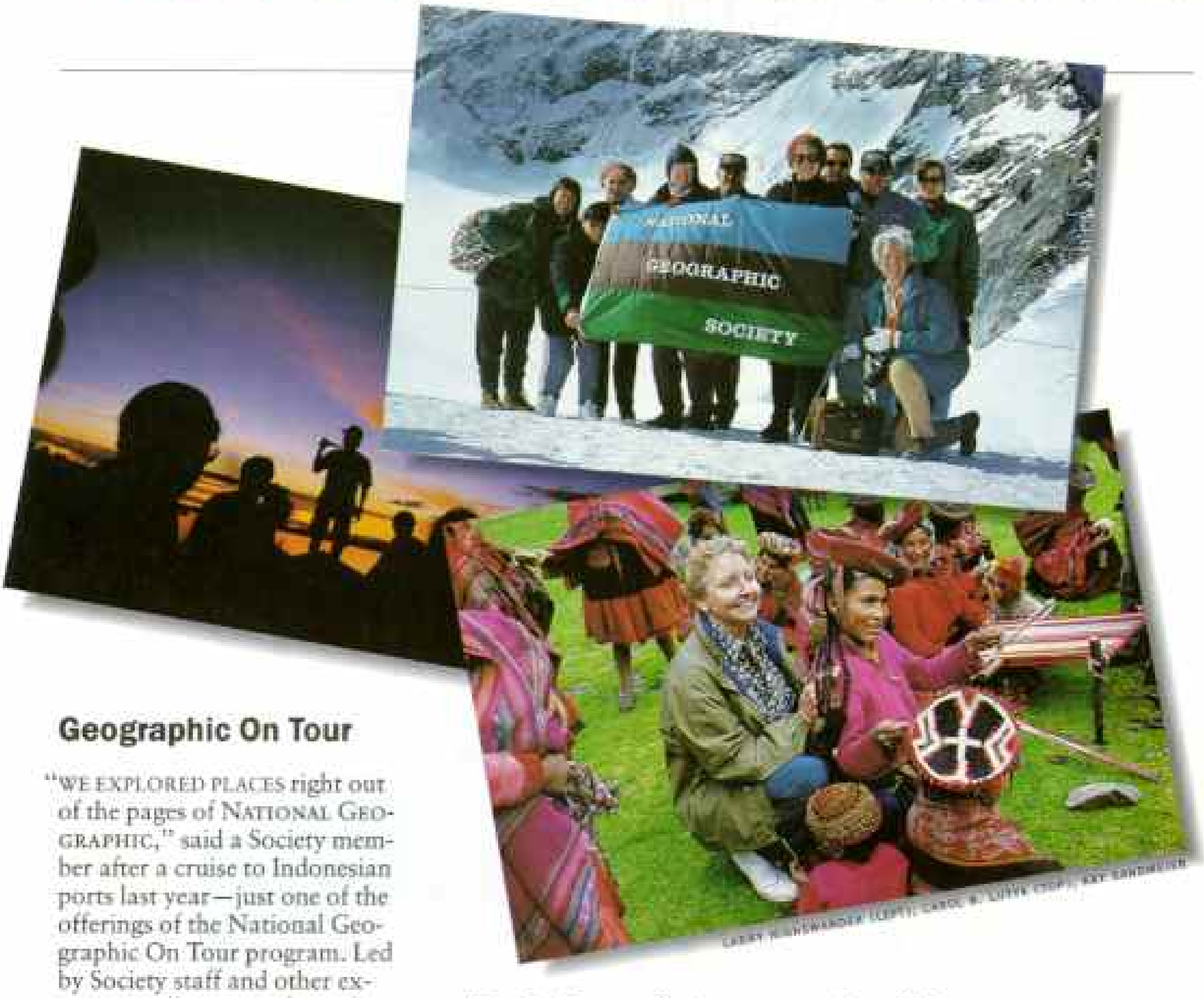
But most importantly they got to see their efforts actually printed in a real magazine.

For her creative and outgoing teaching efforts, State Farm is pleased to honor Mrs. Graham with the Good Neighbor Award and donate $5,000 in her name to Ashland Elementary in St. Louis, Missouri.

The Good Neighbor Award was developed in cooperation with the National Council of Teachers of English.
"Ashland Talks" is reprinted with the permission of *Take Five Magazine*.

NATIONAL GEOGRAPHIC

Behind the Scenes



Geographic On Tour

"WE EXPLORED PLACES right out of the pages of NATIONAL GEOGRAPHIC," said a Society member after a cruise to Indonesian ports last year—just one of the offerings of the National Geographic On Tour program. Led by Society staff and other experts, small groups of travelers have experienced the wildlife parks of Kenya (below), bird-watching along the Amazon (above left), and weaving demonstrations in Peru (above right). Europe's highest railway took members of the Alpine villages tour up Switzerland's 11,333-foot Jungfraujoch (top).

The On Tour staff tries to accommodate special requests. But when one Bering Sea cruise passenger asked to be wakened half an hour before whales appeared, Senior Assistant Editor Bob Booth and colleagues had to explain that these marine mammals just don't keep a schedule.

When he joined a Masai dance in Kenya, retired associate editor Tom Smith was approached by a woman who jokingly offered to marry him if he fulfilled a few Masai requirements, starting with killing a lion single-handedly.

Future On Tour destinations include Provence, Prague and Budapest, and the Maya ruins of Guatemala and Belize.

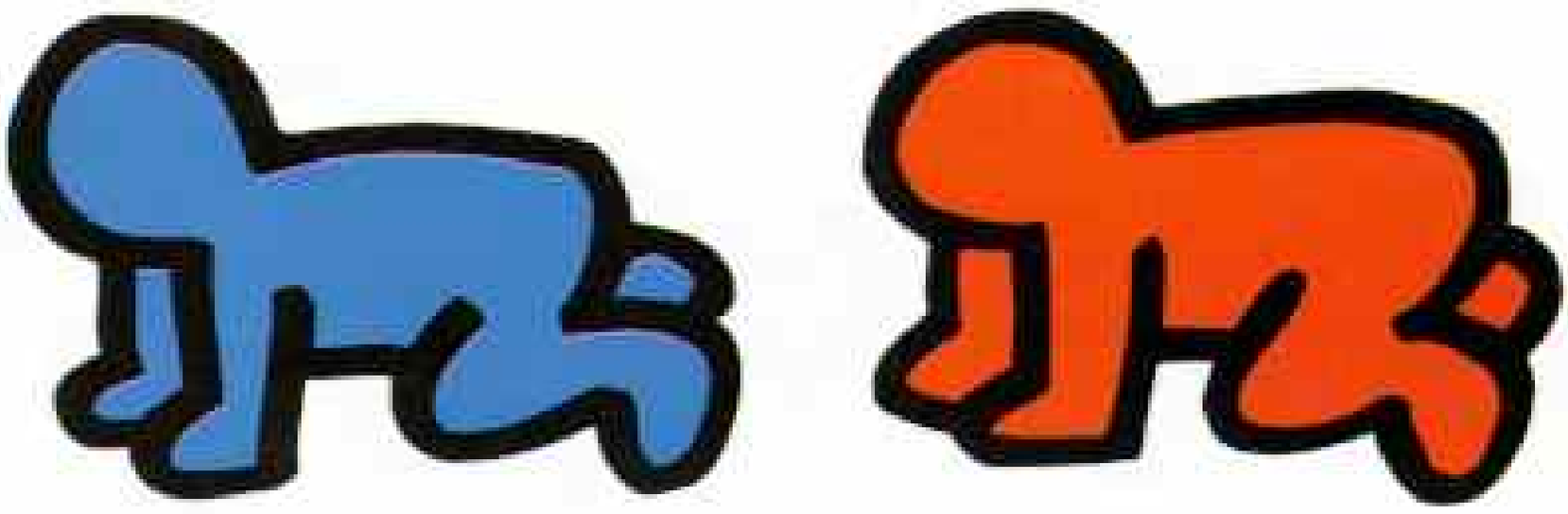
Don't Jump

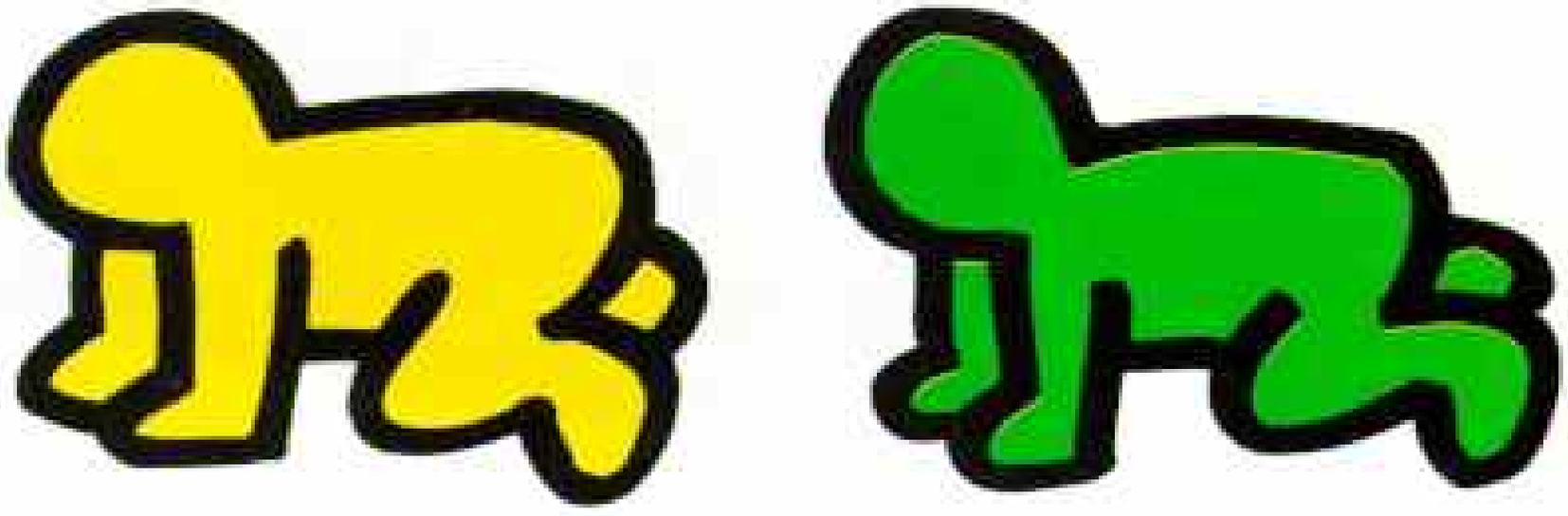
ON A COLD WINDY DAY during his Connecticut coverage (February 1994), photographer Joel Sartore leaned out from a New London bridge for an hour to record a submarine surfacing upriver. Suddenly police, fire, and other emergency vehicles roared up. Seems someone had reported him as a "jumper."

Hats Off

THE THIEF WHO STOLE tripods and clothing from a rental car parked by photographer Chris Johns in Rochester, New York, was apprehended within an hour. He was wearing Chris's NGS cap.

Ladies and gentlemen, start your families.





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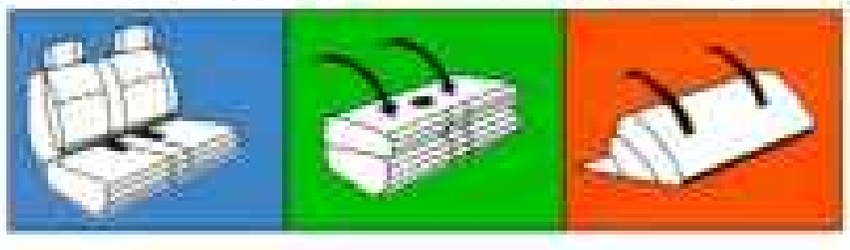

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MICHAEL NICHOLS; MARK THIESSEN (BELOW)

Pant-Hoot Is a Hit

NATIONAL GEOGRAPHIC's most prestigious honor, the Hubbard Medal, was presented to Jane Goodall last April for groundbreaking work with chimpanzees. Her 35-year research program at Gombe in Tanzania is the longest field study ever conducted on an animal. The energetic primatologist (above, reading to an orphan at a Brazzaville, Congo, sanctuary) was in for a wilder tribute from a former Gombe colleague. Following a banquet at Society headquarters, Harvard professor Richard Wrangham taught attendees a chimpanzee cheer called the pant-hoot to honor Jane. "Wah-wah, wah-ooh, waaaaaah!" aped the 250 assembled dinner guests.

"Nobody really knows what the pant-hoot means," said Wrangham. "Maybe 'What a lovely bunch of bananas,' or 'Let's go hunting.' Maybe it means 'Hi, Jane!' "

JUDY BRIESKRICK

It's a Small World

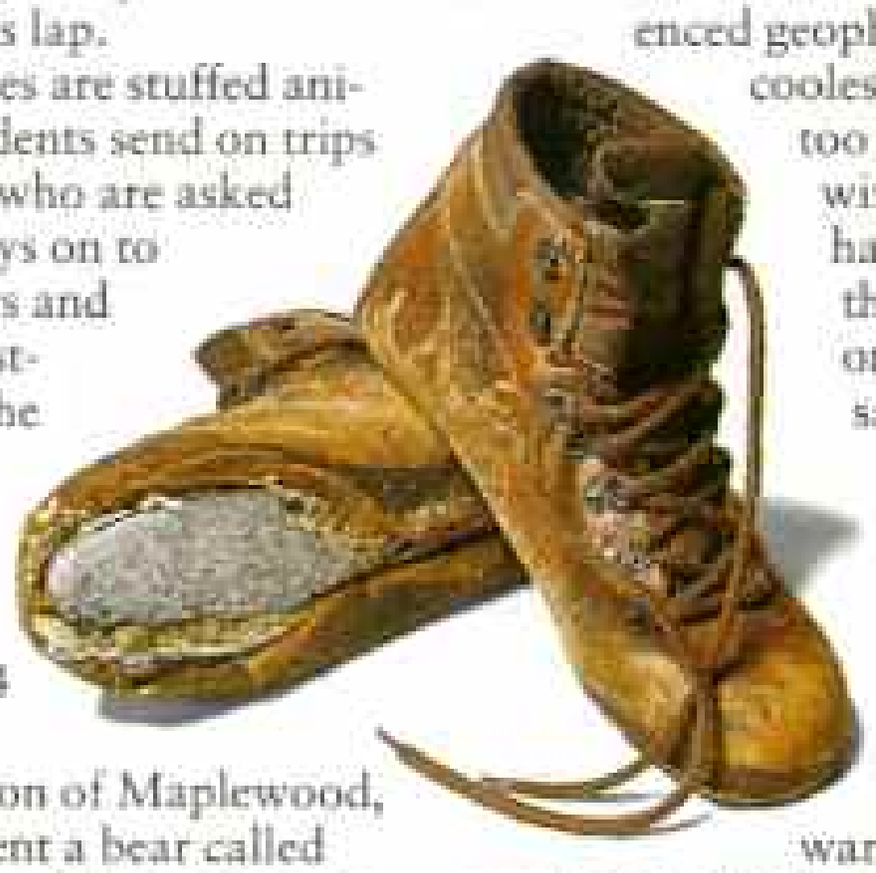
NOT OFTEN DOES a Society-inspired geography-education project land literally in the Society President's lap.

Travel-mates are stuffed animals that students send on trips with friends, who are asked to pass the toys on to other travelers and mail back postcards about the progress of the huggable hitchhikers. In October 1994 third grader Craig Anderson of Maplewood, Minnesota, sent a bear called Bully to Seattle with his grandparents. Five months and 27 cities later, on a flight from Tokyo to Washington, D. C., Bully was handed by chance to Gilbert Grosvenor. Delighted, he wrote about his flight's polar route in Bully's travel diary and personally returned the bear to Craig (bottom).

The travel-mates project was created by middle-school teacher Judy Dollard of Kansas City, Kansas. The idea spread around the country after she presented it at the 1991 National Geographic Summer Geography Institute.

Hawaiian Hotfoot

THESE BOOTS were not made for walking—over hot lava. While working on the Hawaii map supplement in this issue, Jennifer Iscol, a researcher with our Cartographic Division, hiked Kilauea in Hawaii Volcanoes National Park with an experienced geophysicist. "The coolest ground was too hot to touch with your bare hand for more than a second," she said. Toward the end of the four-hour evening trek, Jennifer's feet felt far too warm. The volcano's heat had melted the glue holding her hiking boots together; she had lost her soles to Kilauea.



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Eurasian Otter *(Lutra lutra)* **Size:** Head and body length, 60–80 cm; tail, 30–45 cm **Weight:** 6–12 kg **Habitat:** Rivers, lakes, marshes, and along seacoasts in Europe, Asia and North Africa **Surviving number:** Unknown; now rare or absent in many countries, but recovering in some areas Photographed by Gerard Lacz

WILDLIFE AS CANON SEES IT

Elusive, largely nocturnal, and often living in inaccessible places, the Eurasian otter is rarely seen across most of its vast range. A mother otter raises 1–3 cubs alone, and for nearly a year helps hone their fishing skills, which will become their mainstay for survival. Habitat loss, pollution, and the disappearance of fish and other food sources have all contributed to the decline of this endearing otter. 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.

"YOU TAKE CARE OF THE THINGS YOU CARE ABOUT."

It's up to all of us to take care of the Earth, as well as the things that live here. I work for Georgia-Pacific, a forest products company, and they

believe the same thing. When we learned that the Coho salmon and Steelhead trout were struggling to survive, we came up with a plan to help. We're putting large boulders and logs in the rivers to create calm pools where the small fish can grow and survive until they head out to the ocean. It was something that needed to be done to help the fish. And it feels good to know that my company is doing it." *Dick Patton, Resource Manager*

habitat

Georgia-Pacific

Forum

Vimy Flies Again

It is interesting that three significant long-distance flights were completed shortly after World War I: the Ross Smith flight from England to Australia (highlighted in the May 1995 issue); the first non-stop crossing of the Atlantic, from Newfoundland to Ireland, by Alcock and Brown; and the first flight between England and South Africa, made by van Ryneveld and Brand. In all these instances, the aircraft used was a Vickers Vimy.

DWIGHT S. WILDER
Newmarket, New Hampshire

The article is a true adventure story in which both man and machine have come out on top. What is surprising is the risk taken by the crew at Agra, India, where they decided to fill up with that "mystery juice," perhaps suitable for scooter engines. When such a thing can happen in 1994 with good communication and logistics, the pioneers who won the first race from London to Australia deserve great applause in overcoming problems.

D.B.N. MURTHY
College Station, Texas

Having a collection of GEOGRAPHICs back to 1910, I was able to read the article about the Vimy in both the May 1995 and the March 1921 issues. Sir Ross Smith continually expressed concern about engine failure, but his Rolls-Royce Eagle VIII engines performed flawlessly compared with the modern engines on the replica.

GILBERT A. ROBERTSON
Gretna, Nebraska

The replica was built in Browns Plains, Australia, by Wayne Daley and his staff at Aircraft Engineering. It was only put together in San Francisco so that it would pass the air tests and meet standards worldwide.

F. J. CARRICK
Greenbank, Queensland

The photographs of landscapes and the narration made me feel the breeze and enjoy a trip around the world. What a nice adventure!

RAFAEL G. BLANCO
Mexico City, Mexico

NGS Maps in World War II

As a high school teacher of contemporary history, I have used your "Germany and Its Approaches" map from July 1944 for years. I inherited it (and Geographic membership) from my father. I had it plastered on wood, and it has been used year in, year out to show my students Nazi Germany's aggressive politics in the 1930s and a touch of history itself. It's a delight to see students review its cracks and marks with a sense of awe at seeing a relic from that bygone era.

FRANCISCO AMPARAN
Torreón, Coahuila, Mexico

I love the GEOGRAPHIC and its maps. However, it was the hundreds of thousands of accurate ground maps, naval approach and bombardment charts, aeronautical charts, town plans, and more created by U. S. Army topographic engineers and their sister units, including the British Survey Directorate, that paved the way to Allied success in World War II.

LEONARD EVERETT FISHER
Westport, Connecticut

Our 16-year-old son took his sports posters off his wall and replaced them with NATIONAL GEOGRAPHIC maps. He said, "These are so cool." Our collection dates from 1979.

ELLEN AND TIM BOOTH
Coppell, Texas

The multiple signpost shown on page 70 is not on Saipan but on the island of Leyte in the Philippines. The top sign points to Tacloban, the provincial capital. The next two signs give alternate routes to White Beach, where Gen. Douglas MacArthur waded ashore. The fourth sign points to Palo, whose cathedral was converted into a wartime hospital. The seventh sign directs one to a tavern selling tuba, the local drink made of fermented coconut sap.

Why do I know all this? I was born in Tacloban and lived in the area during World War II. Your mistake put a big grin on my face.

ARCADIO F. ORTIZ, JR.
Woodstock, Illinois

But not on ours. We did not catch the error until after the page was on press.

The Cherokee

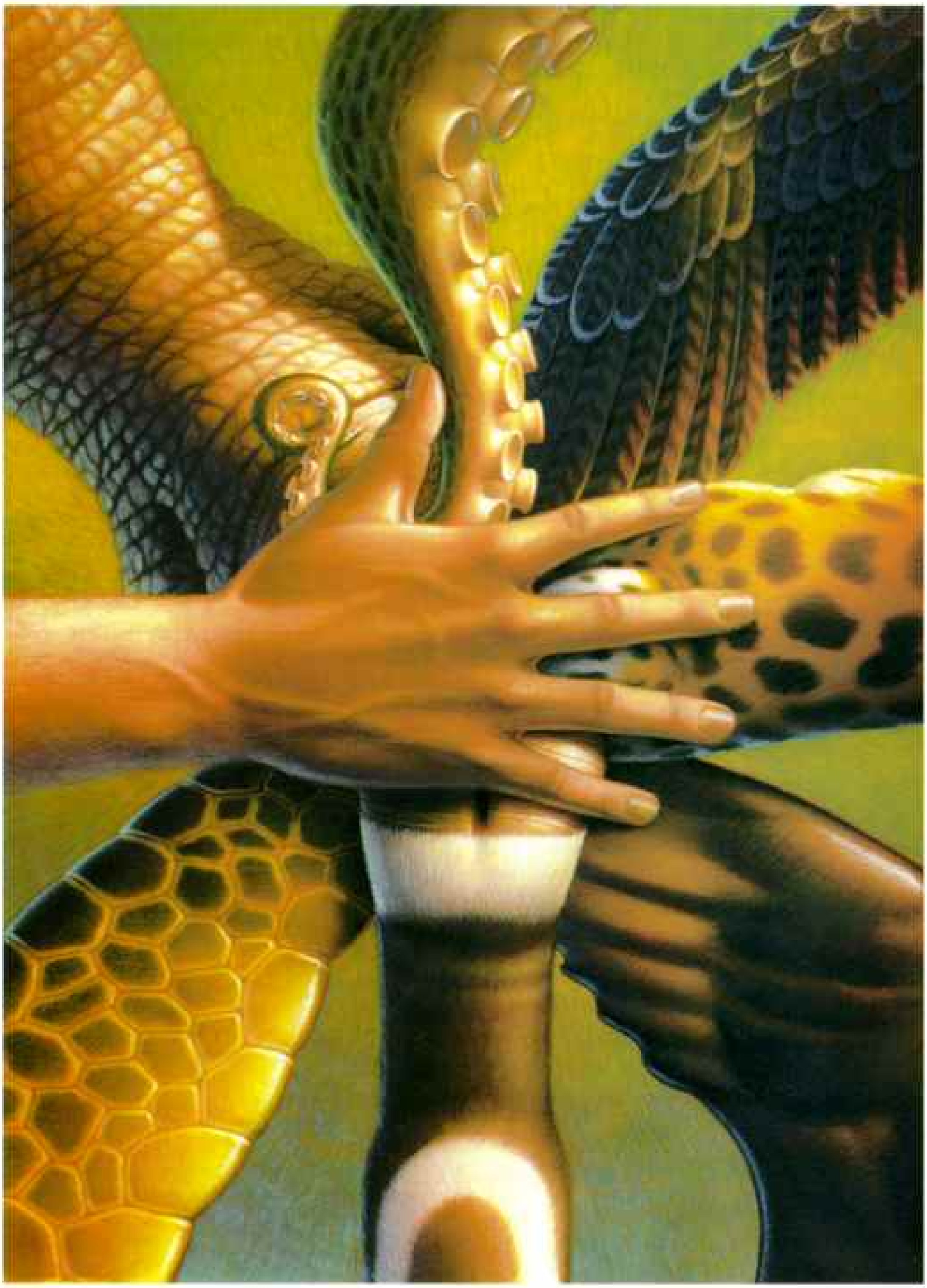
As a scientist and a Cherokee, I note that your article only mentions in passing the great intellectual achievement of Sequoyah. The unschooled Sequoyah, observing that whites had the power to communicate through space and time with marks on special leaves, designed an efficient syllabary to fit an existing spoken language. The syllabary was so applicable that within ten years the Cherokee had achieved a remarkably high literacy rate. He enriched his people in the most human of characteristics, language, and he started from scratch. That's the reason his achievement was so extraordinary.

JACK HOHENSTEIN
Shawnee, Oklahoma

The Cherokee story of resilience and success is quintessentially American in the finest sense. Highest accolades for sharing it.

TIMOTHY S. SHEAR
Columbus, Ohio

Henry Lambert describes one of his occupations as "chiefing," or dressing in culturally inaccurate dress for tourists. Some may justify this type of



IF WE'RE GOING TO SAVE THE PLANET, WE ALL NEED TO LEND A HAND, PAW, FIN, HOOF, AND WING.

These days, everyone is becoming more environmentally conscious. From recycling at home to driving more fuel-efficient cars, we're all doing our part to clean up the planet. But we still have a long way to go. And together, we can make a big difference in the lives of all creatures, great and small.

At Chrysler Corporation, we're doing our part by recycling. Every year we recycle thousands of tons of wooden pallets, cardboard, and paper. Even our cars are 75 percent recyclable.

Our engineers are also working to reduce emissions and improve air quality. Even though today's gas engines burn cleaner and more efficiently than ever, we're looking at alternative fuels like methanol-gasoline mixtures, natural gas, and electricity to power our vehicles in the future.

But you don't have to wait for technology to have a "green" machine. Keep your air and fuel filters clean for better mileage, performance, and a cleaner exhaust. Maintain recommended tire pressures to increase fuel efficiency. And combine errands, since short trips use more gas per mile than a long trip.

As you can see, there's a lot we can do. So let's all lend a hand to save our planet. After all, it's the only one we have.

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entertainment as giving people what they want or expect. Yet how is the public to gain understanding of native traditions if individuals do not put forward an accurate depiction of their people? Perpetuating stereotypes and then implying that those people who take them at face value are ignorant is damaging to the Cherokee and misleading to us all.

ELIZABETH McJANET
Ottawa, Ontario

Another Cherokee hero was Tsali, who is honored in street and restaurant names in Cherokee, North Carolina. During the forced march to Oklahoma, according to one version of the story, a soldier prodded Tsali's wife with a rifle, and Tsali killed him. The family escaped to the Great Smoky Mountains. In exchange for a guarantee that a thousand Cherokee could remain in their homeland, Tsali surrendered. Before he was executed by a firing squad, his son heard his final words, "Love this land and never leave it."

JOE McELWEE
Drexel Hill, Pennsylvania

As a Royal Air Force cadet pilot in 1945, I was posted for flight training to northeastern Oklahoma, about 60 miles north of Tahlequah. Thus the history of the Cherokee, their struggle with federal government, and the uneasy relationship between the government and the Supreme Court were all of absorbing interest. At that time all this was unknown to me, a 19-year-old cadet at this improbable flying school. I am sorry it has taken me 50 years to learn about the story of the Cherokee Nation, but reading it now brought back in a most dramatic way the countryside, culture, people, open skies, and vast expanse of the Lake O' The Cherokees.

REV. DAVID ANTHONY HAGGAN
Reigate, Surrey

Oman

As a frequent traveler in Oman and an admirer of its prudent, hospitable people, I cannot quite agree with the rather pessimistic undertones concerning the nation's future. Developing a country at top speed toward Western living standards and at the same time keeping the people's identity and the land intact is a herculean feat and a great credit to the sultan and his government. Mistakes and friction are inevitable. We Westerners tend to measure everyone else by our standards of democracy, forgetting that it took centuries for us to arrive where we are today.

FERDINAND MEIER
Winterthur, Switzerland

I visited the sultanate twice in 1994, and I too was distressed by the resistance to freedom of speech. I was invited to give a paper at Sultan Qaboos University and submitted it before receiving my airplane ticket from the university. Before I was to speak, the conference chairman asked to see the paper and began to circle material he wanted omitted, information concerning American reaction to a 1915 rebellion against the sultan.

Still there are many signs of progress. Although all the women in James L. Stanfield's beautiful photographs covered their faces, no woman studying at the university wore a veil, nor did most of the women strolling Muscat's modern shopping centers. Today young Omani women drive cars and enter the workforce.

MIRIAM JOYCE
Department of History and Political Science
Purdue University Calumet
Hammond, Indiana

Your article acknowledges the severe atmosphere of political repression in the country today but doesn't mention the rebellion based in Dhofar Province, which began in 1965 and steadily grew until the Shah of Iran sent in troops in 1973 to help suppress it. In 1979 the Popular Front for the Liberation of Oman predicted that oil revenue would temporarily stabilize the regime of Sultan Qaboos. For now the opposition is underground, but there is little doubt that it will resurface when conditions change.

STEVE GOLDFIELD
El Cerrito, California

The practice of using children under the age of 12 as jockeys is inhuman and despicable and needs to be condemned. Sometimes such children are bought from their parents in India, Bangladesh, and Pakistan by rich Arabs. The parents agree because of poverty.

SHARAD SAWANT
Monroe, Louisiana

Poison-Dart Frogs

These wonderful and terrible little frogs look like Cartier jewels.

MARIE LA ROCHE
Montreal, Quebec

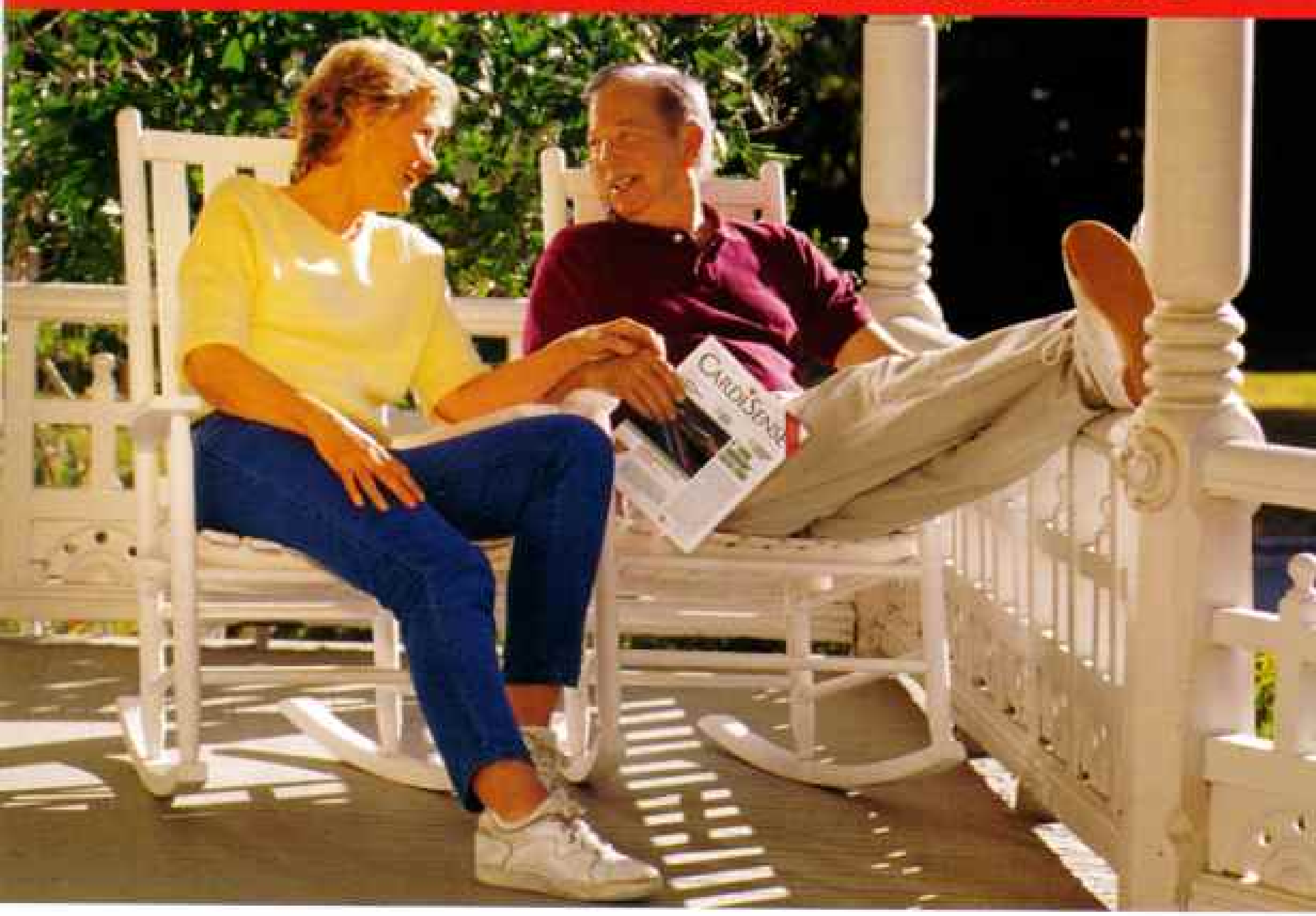
Geographica

In your report on Aharon Bilu's carvings of Polish wooden synagogues you conveyed in just three paragraphs what Aharon has been trying to impart these past 50 years. Its timely appearance when the world has been remembering the end of World War II and the subsequent revelation of the Holocaust has not gone unnoticed here. Your column has made an old man very, very happy.

ARNOLD LAVENSKI
Kibbutz Kfar Blum, Israel

Letters for FORUM *should be sent to National Geographic Magazine, Box 37448, Washington, D. C. 20013-7448, or by fax to 202-828-5460, or via the America Online computer network to ngsforum@aol.com. Include full name, address, and daytime telephone. Letters selected may be edited for clarity and space.*

ATTENTION PEOPLE WHO HAVE HIGH BLOOD PRESSURE OR ANGINA



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See important additional information on adjacent page.

0803E3

Brief Summary of
Prescribing Information as of April 1993

CARDIZEM® CD
(diltiazem HCl)
Capsules

CONTRAINDICATIONS
CARDIZEM is contraindicated in (1) patients with sick sinus syndrome except in the presence of a functioning ventricular pacemaker, (2) patients with second- or third-degree AV block except in the presence of a functioning ventricular pacemaker, (3) patients with hypotension (less than 90 mm Hg systolic), (4) patients who have demonstrated hypersensitivity to the drug, and (5) patients with acute myocardial infarction and pulmonary congestion documented by x-ray on admission.

WARNINGS
1. **Cardiac Conduction**. CARDIZEM prolongs AV node refractory periods without significantly prolonging sinus node recovery time, except in patients with sick sinus syndrome. This effect may rarely result in abnormally slow heart rates (particularly in patients with sick sinus syndrome) or second- or third-degree AV block (13 of 3290 patients or 0.40%). Concomitant use of diltiazem with beta-blockers or digitalis may result in additive effects on cardiac conduction. A patient with Prinzmetal's angina developed periods of asystole (2 to 5 seconds) after a single dose of 60 mg of diltiazem.
2. **Congestive Heart Failure**. Although diltiazem has a negative inotropic effect in isolated animal tissue preparations, hemodynamic studies in humans with normal ventricular function have not shown a reduction in cardiac index nor consistent negative effects on contractility (dp/dt). An acute study of oral diltiazem in patients with impaired ventricular function (ejection fraction 24% ± 6%) showed improvement in indices of ventricular function without significant decrease in contractile function (dp/dt). Worsening of congestive heart failure has been reported in patients with preexisting impairment of ventricular function. Experience with the use of CARDIZEM (diltiazem hydrochloride) in combination with beta-blockers in patients with impaired ventricular function is limited. Caution should be exercised when using this combination.
3. **Hypotension**. Decreases in blood pressure associated with CARDIZEM therapy may occasionally result in symptomatic hypotension.
4. **Acute Hepatic Injury**. Mild elevations of transaminases with and without concomitant elevation in alkaline phosphatase and bilirubin have been observed in clinical studies. Such elevations were usually transient and frequently resolved even with continued diltiazem treatment. In rare instances, significant elevations in enzymes such as alkaline phosphatase, LDH, SGOT, SGPT, and other phenomena consistent with acute hepatic injury have been noted. These reactions tended to occur early after therapy initiation (1 to 8 weeks) and have been reversible upon discontinuation of drug therapy. The relationship to CARDIZEM is uncertain in some cases, but probable in some. (See PRECAUTIONS.)

PRECAUTIONS
General
CARDIZEM (diltiazem hydrochloride) is extensively metabolized by the liver and excreted by the kidneys and in bile. As with any drug given over prolonged periods, laboratory parameters of renal and hepatic function should be monitored at regular intervals. The drug should be used with caution in patients with impaired renal or hepatic function. In subacute and chronic dog and rat studies designed to produce toxicity, high doses of diltiazem were associated with hepatic damage. In special subacute hepatic studies, oral doses of 125 mg/kg and higher in rats were associated with histological changes in the liver which were reversible when the drug was discontinued. In dogs, doses of 20 mg/kg were also associated with hepatic changes; however, these changes were reversible with continued dosing.
Dermatological events (see ADVERSE REACTIONS section) may be transient and may disappear despite continued use of CARDIZEM. However, skin eruptions progressing to erythema multiforme and/or exfoliative dermatitis have also been infrequently reported. Should a dermatologic reaction persist, the drug should be discontinued.

Drug Interactions
Due to the potential for additive effects, caution and careful titration are warranted in patients receiving CARDIZEM concomitantly with other agents known to affect cardiac contractility and/or conduction. (See WARNINGS.) Pharmacologic studies indicate that there may be additive effects in prolonging AV conduction when using beta-blockers or digitalis concomitantly with CARDIZEM. (See WARNINGS.)
As with all drugs, care should be exercised when treating patients with multiple medications. CARDIZEM undergoes biotransformation by cytochrome P-450 mixed function oxidase. Coadministration of CARDIZEM with other agents which follow the same route of biotransformation may result in the competitive inhibition of metabolism. Especially in patients with renal and/or hepatic impairment, dosages of similarly metabolized drugs, particularly those of low therapeutic ratio, may require adjustment when starting or stopping concomitantly administered diltiazem to maintain optimum therapeutic blood levels.
Beta-blockers. Controlled and uncontrolled domestic studies suggest that concomitant use of CARDIZEM and beta-blockers is usually well tolerated, but available data are not sufficient to predict the effects of concomitant treatment in patients with left ventricular dysfunction or cardiac conduction abnormalities.
Administration of CARDIZEM (diltiazem hydrochloride) concomitantly with propranolol in five normal volunteers resulted in increased propranolol levels in all subjects and bioavailability of propranolol was increased approximately 50%. In vitro, propranolol appears to be displaced from its binding sites by diltiazem. If combination therapy is initiated or withdrawn in conjunction with propranolol, an adjustment in the propranolol dose may be warranted. (See WARNINGS.)
Cimetidine. A study in six healthy volunteers has shown a significant increase in peak diltiazem plasma levels (58%) and area-under-the-curve (53%) after a 1-week course of cimetidine at 1200 mg per day and a single dose of diltiazem 60 mg. Ranitidine produced smaller, nonsignificant increases. The effect may be mediated by cimetidine's known inhibition of hepatic cytochrome P-450, the enzyme system responsible for the first-pass metabolism of diltiazem. Patients currently receiving diltiazem therapy should be carefully monitored for a change in pharmacological effect when initiating and discontinuing therapy with cimetidine. An adjustment in the diltiazem dose may be warranted.
Digitalis. Administration of CARDIZEM with digoxin in 24 healthy male subjects increased plasma digoxin concentrations approximately 20%. Another investigator found no increase in digoxin levels in 12 patients with coronary artery disease. Since there have been conflicting results regarding the effect of digoxin levels, it is recommended that digoxin levels be monitored when initiating, adjusting, and discontinuing CARDIZEM therapy to avoid possible over- or under-digitalization. (See WARNINGS.)
Anesthetics. The depression of cardiac contractility, conductivity, and automaticity as well as the vascular dilation associated with anesthetics may be potentiated by calcium channel blockers. When used concomitantly, anesthetics and calcium blockers should be titrated carefully.
Cyclosporine. A pharmacokinetic interaction between diltiazem and cyclosporine has been observed during studies involving renal and cardiac transplant patients. In renal and cardiac transplant recipients, a reduction of cyclosporine dose ranging from 15% to 48% was necessary to maintain cyclosporine trough concentrations similar to those seen prior to the addition of diltiazem. If these agents are to be administered concurrently, cyclosporine concentrations should be monitored, especially when diltiazem therapy is initiated, adjusted, or discontinued.
The effect of cyclosporine on diltiazem plasma concentrations has not been evaluated.
Carbamazepine. Concomitant administration of diltiazem with carbamazepine has been reported to result in elevated serum levels of carbamazepine (40% to 72% increase), resulting in toxicity in some cases. Patients receiving these drugs concurrently should be monitored for a potential drug interaction.

Carcinogenesis, Mutagenesis, Impairment of Fertility
A 24-month study in rats at oral dosage levels of up to 100 mg/kg/day and a 21-month study in mice at oral dosage levels of up to 30 mg/kg/day showed no evidence of carcinogenicity. There was also no mutagenic response in vitro or in vivo in mammalian cell assays or in vitro in bacteria. No evidence of impaired fertility was observed in a study performed in male and female rats at oral dosages of up to 100 mg/kg/day.

Pregnancy
Category C. Reproduction studies have been conducted in mice, rats, and rabbits. Administration of doses ranging from five to ten times greater (on a mg/kg basis) than the daily recommended therapeutic dose has resulted in embryo and fetal lethality. These doses, in some studies, have been reported to cause skeletal abnormalities. In the perinatal/postnatal studies, there was an increased incidence of stillbirths at doses of 20 times the human dose or greater.
There are no well-controlled studies in pregnant women; therefore, use CARDIZEM in pregnant women only if the potential benefit justifies the potential risk to the fetus.

Nursing Mothers
Diltiazem is excreted in human milk. One report suggests that concentrations in breast milk may approximate serum levels. If use of CARDIZEM is deemed essential, an alternative method of infant feeding should be instituted.

Pediatric Use
Safety and effectiveness in children have not been established.

ADVERSE REACTIONS
Serious adverse reactions have been rare in studies carried out to date, but it should be recognized that patients with impaired ventricular function and cardiac conduction abnormalities have usually been excluded from these studies.
The following table presents the most common adverse reactions reported in placebo-controlled angina and hypertension trials in patients receiving CARDIZEM CD up to 360 mg with rates in placebo patients shown for comparison.

CARDIZEM CD Capsule Placebo-Controlled Angina and Hypertension Trials Combined

Adverse Reactions	Cardizem CD (n=607)	Placebo (n=301)
Headache	5.4%	5.0%
Dizziness	3.0%	3.0%
Bradycardia	3.3%	1.3%
AV Block First Degree	3.3%	0.0%
Edema	2.6%	1.3%
ECG Abnormality	1.6%	2.3%
Asthenia	1.8%	1.7%

In clinical trials of CARDIZEM CD capsules, CARDIZEM tablets, and CARDIZEM SR capsules involving over 3200 patients, the most common events (ie, greater than 1%) were edema (4.6%), headache (4.6%), dizziness (3.5%), asthenia (2.6%), first-degree AV block (2.4%), bradycardia (1.7%), flushing (1.4%), nausea (1.4%), and rash (1.2%).
In addition, the following events were reported infrequently (less than 1%) in angina or hypertension trials:
Cardiovascular: Angina, arrhythmia, AV block (second- or third-degree), bundle branch block, congestive heart failure, ECG abnormalities, hypotension, palpitations, syncope, tachycardia, ventricular extrasystoles
Nervous System: Abnormal dreams, amnesia, depression, gait abnormality, hallucinations, insomnia, nervousness, paresthesia, personality change, somnolence, tinnitus, tremor
Gastrointestinal: Anorexia, constipation, diarrhea, dry mouth, dysgeusia, dyspepsia, mild elevations of SGOT, SGPT, LDH, and alkaline phosphatase (see hepatic warnings), thirst, vomiting, weight increase
Dermatological: Petechiae, photosensitivity, pruritus, urticaria
Other: Amblyopia, CPK increase, dyspnea, epistaxis, eye irritation, hyperglycemia, hyperuricemia, impotence, muscle cramps, nasal congestion, nocturia, osteoarticular pain, polyuria, sexual difficulties
The following postmarketing events have been reported infrequently in patients receiving CARDIZEM: alopecia, erythema multiforme, exfoliative dermatitis, extrapyramidal symptoms, gingival hyperplasia, hemolytic anemia, increased bleeding time, leukopenia, purpura, retinopathy, and thrombocytopenia. In addition, events such as myocardial infarction have been observed which are not readily distinguishable from the natural history of the disease in these patients. A number of well-documented cases of generalized rash, characterized as leukocytoclastic vasculitis, have been reported. However, a definitive cause and effect relationship between these events and CARDIZEM therapy is yet to be established.

Prescribing Information as of April 1993

Marion Merrell Dow Inc.
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NATIONAL GEOGRAPHIC
Geographica

WILLIAM W. FITZHUGH

Siberian Nomads Hew to Past, Eye Future

SOME 3,000 NENETS on the Yamal Peninsula in western Siberia still herd thousands of reindeer north onto the tundra in summer and south to the forest fringe each fall—a round-trip of 600 miles. Wooden sleds hauled by reindeer carry cargo and passengers. The Nenets camp in communal tents, wear reindeer-skin boots and embroidered clothing, and offer sacrifices of reindeer and fish. Unlike other Arctic peoples, they have not settled in villages; they use no power tools or snowmobiles. "I've never seen a people hold their traditions as deeply and closely," says William Fitzhugh, head of the Smithsonian Institution's Arctic Studies Center.

But the Yamal Peninsula contains one of the world's largest undeveloped reserves of natural gas. The Nenets hope its exploitation will avoid the environmental destruction caused by earlier projects. A U. S.-Siberian corporate partnership has flown Nenets leaders to the North American Arctic to convince them that development need not destroy their way of life.

Seeding the Future of Native Desert Crops

BROWN CORN grown by the Mayo and Yaqui of Mexico, red corn and orange lima beans cultivated by the Hopi, sunflowers planted at the bottom of the Grand Canyon by the Havasupai: Such crops have been grown for centuries by natives of the hot, dry lands of the southwestern U. S. and northwestern Mexico. But many species have vanished. Others hovered on the brink until Native Seeds/SEARCH of Tucson began to seek them out.

After 12 years it has collected 1,300 varieties and given seeds to members of 30 tribes to keep traditional crops—and ways of growing them—alive. "We have a palette of genetic material," says education director Kevin Dahl. "Take corn: Long-eared and short-eared, blue and white are being grown by different people for different purposes."

CHARLES MANN

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Phony Flowers—a Fungus Among Us

THEY LOOK LIKE FLOWERS. They have a sweet flowery smell. They even attract pollinating insects.

But the bright yellow blossoms are pseudoflowers: "They have no anthers, no pollen, no stigma, no seeds—all parts that

PUCCINIA MONOICA, BITTY ROY

define a flower," says Bitty Roy of the University of California, Davis, who spotted the fungus-caused mimicry in the Colorado Rockies. She says that even experienced botanists have mistaken the impostors for real flowers.

Its spores borne by the wind, the fungus—which Roy calls crucifer rust—invades mustard plants in late summer and causes them to change the way they look and grow. Healthy mustards are short and have only a few leaves at the base of their stems. Infected plants grow twice as tall; their elongated stems are crowned by dense, flowerlike clusters of bright yellow leaves covered with a sticky, sweet substance that lures butterflies, bees, and flies.

The insects pick up the fungal equivalent of pollen and carry it to other infected plants, fertilizing the fungus in the process. "The fungus is not being nice to the host," Roy notes. Infected plants grow too fast, lose water, and die early.

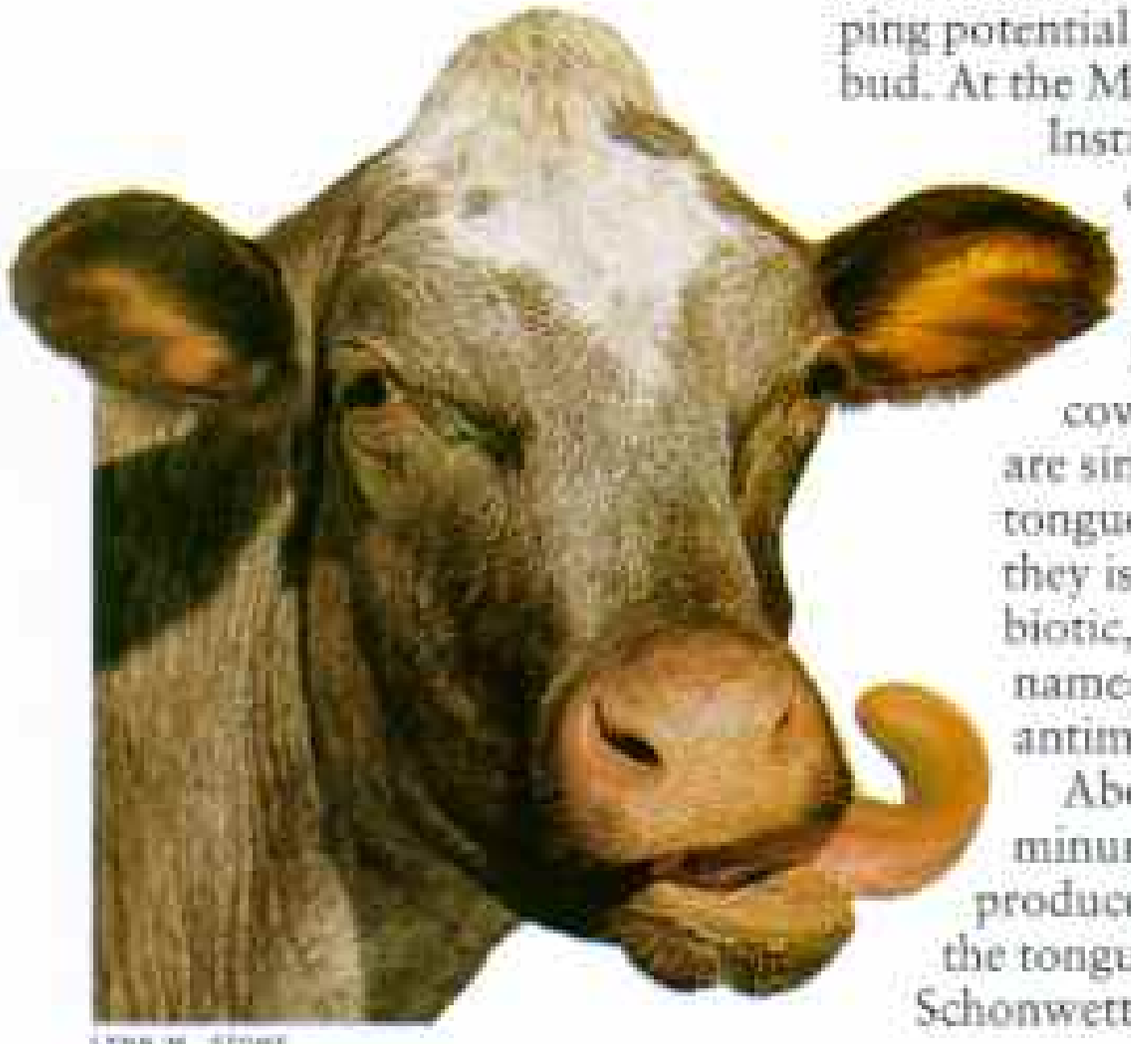
STEVEN PUMPHREY

It's Better Than Soap for Cleaning the Mouth

WHAT DIRTY MOUTHS we have! Disease-causing fungi, bacteria, and viruses live there. Microorganisms enter with every bite of food. Yet the tongue rarely gets infected, and when it does, it quickly heals.

There's a reason. The lining of the tongue secretes a peptide that acts as an antibiotic, nipping potential infection in the bud. At the Magainin Research Institute near Philadelphia, scientist Barry Schonwetter and his colleagues studied cow tongues, which are similar to human tongues. In the lining they isolated the antibiotic, which they named LAP, lingual antimicrobial peptide.

About as thick as aluminum foil, the lining produces more LAP when the tongue has a sore, says Schonwetter.



LYNN M. STONE

Science Seeks a Better Tortilla

FOR A HUMBLE SUBJECT Mexico's Tortilla Project has attracted a highfalutin staff—physicists, chemists, biologists, electronics specialists, and nutritionists. Their aim: to produce a tasty, nutritious tortilla in an efficient, nonpolluting manner. They say they've succeeded.

"We go from corn to tortilla in four minutes, instead of 12 hours the old way," boasts Jesús González Hernández, the project's manager. The traditional method starts with a lengthy soaking of corn in water and lime, washes and cooks away nutrients, produces contaminated water, and wastes energy.

The team studied every stage of the tortilla-making process to develop a machine that turns out 200 pounds of tortillas an hour. "Ours taste as good as the ones we eat now," González says. Good news for Mexicans, who consume nearly a pound of tortillas per person a day.

—BORIS WEINTRAUB

(*Francis Ford*)

Francis Ford Coppola's ranch, on a sweeping hillside in California's wine country, is a place that nurtures the wide-ranging interests of a creative mind. Not unlike the new IBM ThinkPad® 755CD in residence here. Although Mr. Coppola may retreat to the screening room or the research library or the bungalow to work, like many of us, he does his best thinking at the kitchen table. And now all the power of a true multimedia machine, with full-motion video and digital stereo sound, is available to him even there.

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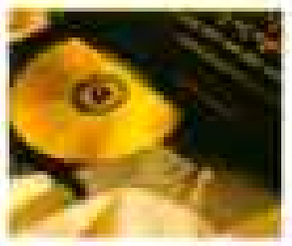

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On Television

BEN OSBORNE

■ REALLY WILD ANIMALS, CBS, SATURDAYS, 12:30 P.M. ET

Taking Kids Around the World on Saturday TV

A GENTOO PENGUIN warms the nest in the coldest place on earth—Antarctica (above). Now, nestled in their homes watching television, youngsters can learn about penguins and other creatures in National Geographic's first nationally telecast show for children. Airing on CBS-TV, *Really Wild Animals* will be shown in half-hour segments drawn from the Society's popular home-video series, a Parents' Choice Award winner.

One of the first programs is "Cold, Cold South," about life in the Antarctic freezer. Why are penguins such expert paddlers? What's on the menu for a whale the size of a school bus?

Young viewers meet Dion, Lief, and D. T. Poncet, whose mother enlists them in her work: counting penguins. They discover an old whaling boat, giving animated globe-on-the-go Spin (in the voice of Dudley Moore) a chance to encourage children to help whales and other endangered animals.

With Spin, *Really Wild Animals* transports young viewers to such destinations as Africa's Serengeti Plain, the depths of the oceans, and the green canopies of rain forests. With a fast pace of facts, maps, quips, music, and graphics, the series captures kids' attention while educating them about the world.

"We've always gone to every part of the globe with filmmakers and scientists," says Tim Kelly, senior vice president for television. "Now, with CBS as our partner and a Saturday time slot, we're taking our blend of entertainment and education to where the kids are."

■ PROGRAM GUIDE

National Geographic Specials
NBC. Wednesday, September 6
"The New Chimpanzees"
See local listings.

National Geographic EXPLORER
TBS. Sunday, 9 p.m. ET
September 3: "Vietnam Wild"; "Surfer Girls"
September 10: "The Swarm"; "A Glorious Way to Die"
September 17: "Space Odyssey"; "Rocketmen"
September 24: "Yellowstone: Realm of the Coyote"

Children's Programming
CBS. Beginning September 16, Saturdays at 12:30 p.m. ET
Really Wild Animals

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

PLYMOUTH GRAND VOYAGER. THE

In redesigning the Plymouth Grand Voyager, we literally reinvented the wheel. And the seats they're part of.

Our rear bench seats now glide on smooth, nylon wheels, making them a cinch to move. (We call them

Easy Out Roller Seats.™ You'll call them a dream.) Two levers release a seat and raise it up on wheels in a

Our new roll models.

single move. Then just roll it back, lift it out and roll it away. You won't find this capability in any other mini-

van, anywhere. But our seats don't sit down there. Depending on which seating package you choose,

both rear and middle bench seatbacks now fold flat,* allowing you to carry a 4' x 8' sheet of plywood with

the seats in and the liftgate closed. You won't find this capability on any other minivan, anywhere. (Beginning

to see a pattern here?) Up front is another exclusive: cup holders that adjust to accommodate

everything from a four-ounce baby bottle to a full one-liter jug. They even hold juice boxes and coffee

mugs. And speaking of exclusives (and it's hard not to when the subject is Plymouth Grand Voyager),

IT SIMPLY SLIDES, ROLLS, FOLDS, PRO

*Includes base models. Always wear your seat belt. Big Gulp® is a registered trademark of The Southland Corporation.

NEXT GENERATION OF THE MINIVAN.

getting to and from those seats is easier than ever, thanks to a second sliding door now available on the driver's side. It's the only one of its kind available today. Simply put, the new Grand Voyager is better in every way. Outside, it's aerodynamically streamlined to cheat the wind. While inside, volume has been increased, giving you 11 percent more passenger and 27 percent more cargo space, more than in any other minivan. Visibility has been expanded, too, with a 32 percent larger windshield. This turning circle was reduced by more than three feet.

Under the hood, Grand Voyager's available 3.3 liter engine is generous with cargo-hauling and load-pulling torque. And with its platinum-tipped spark plugs, it calls for its first scheduled tune-up at 100,000 miles. And, of course, we've maintained our position as safety role models with standard dual front air bags,* four-wheel ABS and available integrated child safety seats. Plymouth Grand Voyager is literally a minivan full of firsts, bests and exclusives.

Hey, the competition has to have somebody to look up to. For more information, see your local Chrysler and Plymouth dealer, or just call 1-800-PLYMOUTH.

Plymouth

TECTS, UNFOLDS AND DRIVES BETTER.

NATIONAL GEOGRAPHIC

EarthAlmanac

STUART FRANKLIN, MAGNUM

Whale of an Idea Foils Salmon-Stealing Seals

FISHERMAN CHARLES MARSHAM, a salmon farmer in Durness, Scotland, was losing nearly $1,500 a week to gray seals that attacked his net pens in the Atlantic and ate his fish. But he didn't want to kill the seals. What to do?

Marsham had seen a dramatic video of killer whales that routinely prey on sea lions off Patagonia in South America. Killer whales also range Scotland's waters. Would Marsham's thieving seals flee from such a presence? Marsham (above, second from right) and Marty Mackay, left, built a 16-foot fiberglass killer whale "scarecrow" and anchored it near Marsham's salmon pens in February 1994. "Salmon mortality quickly dropped to zero," Marsham reports. Since then his group has made about a dozen killer models for sale to other fishermen.

Could a dummy killer whale work in Seattle, where officials are considering shooting California sea lions that raid steelhead salmon (Earth Almanac, February 1995)? Unlikely, says Joe Scordino of the National Marine Fisheries Service. One reason: Since killer whales also feed on migrating steelhead, a model could scare the steelhead from their spawning grounds.

Ahhh-roma of Bakeries May Diminish

THE HEAVENLY SMELL of bread baking may be less aromatic in some urban neighborhoods if stricter regulations mandated by the Clean Air Act are followed. The problem: When flour, water, and yeast are heated to 170°F, one of the by-products released is gaseous ethanol, which is harmless itself but can help create ozone, a component of smog. States are required to find ways to reduce ground-level ozone by 15 percent by 1996.

Small mom-and-pop bakeries will be exempt. But operations that exceed acceptable emissions levels for their region may need to install catalytic oxidizers at as much as a half million dollars each to convert ethanol into carbon dioxide—and in the process dilute that olfactory delight.

DAVID CLARK

ADVERTISEMENT

Before You Take Advil or Tylenol Again, Get a Second Opinion

It's been about a year since a pain reliever called Aleve® was made available to consumers without a prescription, and its benefits are being discovered by more and more people each day.

In fact, clinical studies show that Aleve has key advantages over other brands. At the end of the day, a two-pill dose of Aleve provides stronger pain relief than a dose of Advil.®* It provides longer-lasting relief than Extra Strength Tylenol® and is gentler on the stomach lining than aspirin. So if you haven't been satisfied with your current pain reliever, you may want to try Aleve.

Aleve is the only non-prescription pain relief product that offers Americans in pain a completely different active ingredient — naproxen sodium†. It was developed from Naprosyn® (naproxen) and Anaprox® (naproxen sodium), two of the world's most widely used prescription pain relievers. That's probably why so many doctors have already recommended Aleve for their patients.

Here are some additional things you may want to think about when considering this new choice:

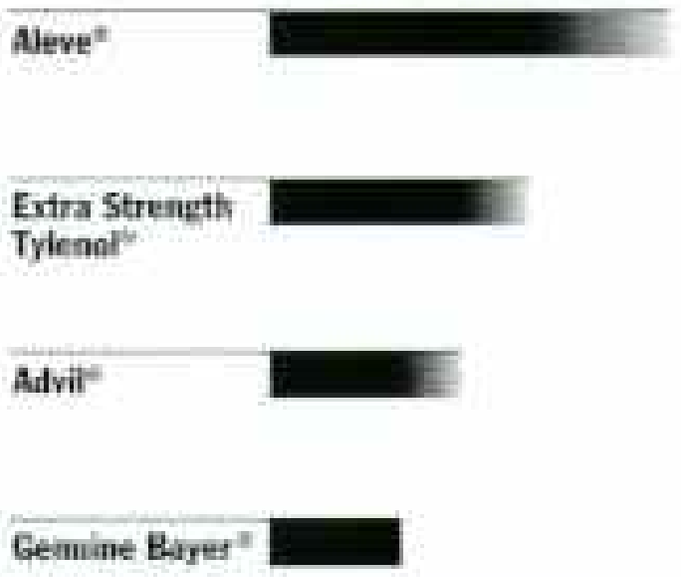
THE DOSING ADVANTAGE

Most pain relievers are labeled to be taken up to four or six times a day, which may not be convenient if you want to work all day or sleep through the night. However, in looking at the recommended dosing chart (above right), you will notice a basic difference with Aleve. Aleve is labeled to be dosed every 8 to 12 hours instead of every 6 to 8 hours like Extra Strength Tylenol, or 4 to 6 hours like Advil.

*Based on a single, 2-pill dose pain relief comparison at 11 and 12 hours.

†Do not take this product if you had either liver or a severe allergic reaction after taking any pain reliever.

RECOMMENDED DOSING



THE VALUE DIFFERENCE

How often you have to take a pain reliever also affects your wallet.

These days, it's important to get the most for your money. The table below shows that the price on the bottle is not the best guide to value. The cost for the number of pills you have to take for the maximum daily dose varies greatly. The cost for Aleve shows it may be an excellent choice for value-conscious consumers.

THE SAFETY STORY

Finally, even though you can buy them almost everywhere, remember OTC pain relievers are serious medicine. It's important to read the product's label and directions carefully.

COST PER 24 HOURS OF PAIN RELIEF
(Based on Maximum Daily Dose)

BRAND	COST
Aleve (3 pills)	$0.31
Advil (6 pills)	$0.63
Extra Strength Tylenol (8 pills)	$0.78
Genuine Bayer (12 pills)	$0.94

Based on IRI drug outlet pricing data on 50 count bottles (1/1/95–4/2/95).

You may have recently heard of reports in leading medical journals, such as the Journal of the American Medical Association, linking acetaminophen (the active ingredient in Tylenol) to possible liver damage. These patients took more than the maximum daily dose of acetaminophen, and many of these patients were either fasting and/or consuming alcohol. If you consume three or more alcohol-containing drinks per day, you should ask your doctor for advice for when and how you should take any OTC pain reliever. In fact, it was recently announced that all OTC pain relievers should have an alcohol warning.

Look for a list of the approved uses for the product, how often and for how long you can take it, and especially for any warnings or side effects of which you should be aware. For example, if you suffer from stomach pain, you should check with your doctor or pharmacist before taking aspirin, ibuprofen or naproxen sodium. Remember, when used properly, OTC pain relievers can provide safe and effective relief from most common aches and pains.

THE BOTTOM LINE

For the first time in more than 10 years, there's a pain relief choice that's really different — Aleve. And having a new choice means that you are better able to find pain relief that's right for you.

If you are in doubt about what to take, ask your doctor or pharmacist. Chances are, he or she may recommend Aleve. Even though it's been around for only one year, many doctors have already recommended it.

ALEVE®

PETE SOUZA (ABOVE); JAMES L. AMOS

Potomac's Stepchild, the Troubled Anacostia

POOR RELATION to the Potomac River—much healthier after decades of cleanup—a seven-mile tributary, the Anacostia River, is a different story. In 1993 the conservation group American Rivers called it the fourth most endangered river in North America.

Bedeviled by siltation, pollution, and dredging, the Anacostia flows through one of the poorest neighborhoods in Washington, D. C. In the past six years volunteers of the Anacostia Watershed Society have hauled out 109 tons of trash. Last Earth Day, April 22 (above), the society and Greenpeace picked up seven tons.

"The society's motto, START, stands for Stop Trashing the Anacostia River Today," says president Robert Boone. He hopes that the Army Corps of Engineers will restore the river's meandering contours to reduce siltation and create a wetland.

Road May Breach the Devilish Darién

DAUNTING SWAMPS and rain forest create a formidable barrier between North and South America called the Darién. Conquistadores laid a cobblestone mule trail here. But the Darién has long blocked completion of the 15,000-mile-long Pan American Highway, begun in the 1920s. The last link may now be built.

The main artery of the highway extends from Alaska to Tierra del Fuego. Fear of cattle disease—now controlled—and several lawsuits long held up the Darién segment. Colombia and Panama are discussing plans to build it across two national parks after an environmental impact study is completed.

Guam Rail: Reprieve From Extinction?

SECRETIVE WAYS of the Guam rail, endemic to that Pacific island, helped it survive introduced rats, cats, and dogs. But

these flightless rails could not withstand the coils of another invader—the brown tree snake, which probably arrived by ship from Papua New Guinea after World War II. Now numbering more than a million, the snakes exterminated the rails from the wild by 1986.

But two years earlier researchers began rescuing rails for a captive-breeding program that now totals about 200 birds. Last spring the scientists began releasing groups of 30 to 50 rails 32 miles north of Guam on Rota Island, snake free so far. If Rota's few inhabitants can keep stowaway snakes from coming ashore, the rails have a chance.

—JOHN L. ELIOT

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NATIONAL GEOGRAPHIC

On Assignment

■ EL SALVADOR

Reporting on Rebuilding

"IN EL SALVADOR I packed my rental car with pet food," says freelance photographer TOMASZ TOMASZEWSKI, here hugged by a circus monkey in Nahuizalco. "There were a lot of homeless dogs and cats there, and I just wanted to give them a meal. After I fed the monkey, the owners invited me to join their circus," he says. But Tomasz was expected back in Poland by his wife, writer Malgorzata Niezabitowska, their daughter Maryna, and their four dogs—all adopted strays. The family's adventure driving across the United States resulted in "Discovering America" in the January 1988 GEOGRAPHIC.

"Now that the war is over, Salvadorans are trying to be decent to one another," says Assistant Editor MIKE EDWARDS, bottom, covering a political rally in the eastern city of San Francisco. "They are such warm people; it makes you wonder how they could have been so violent."

Though recently his beat has been the former Soviet Union, the 27-year GEOGRAPHIC veteran is no stranger to Central America. He first visited as a press aide to Peace Corps director Sargent Shriver in 1963 and later reported on Mexico, Honduras, and Nicaragua—among his 33 articles for the magazine.

Mike earned his first byline at age 14, covering high school sports for the *Cobb County Times* in Marietta, Georgia. "Seeing my name in that newspaper was the biggest thing that had ever happened to me," he remembers, "and writing is all I've wanted to do ever since."

TIM ROBERTS

TOMASZ TOMASZEWSKI

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