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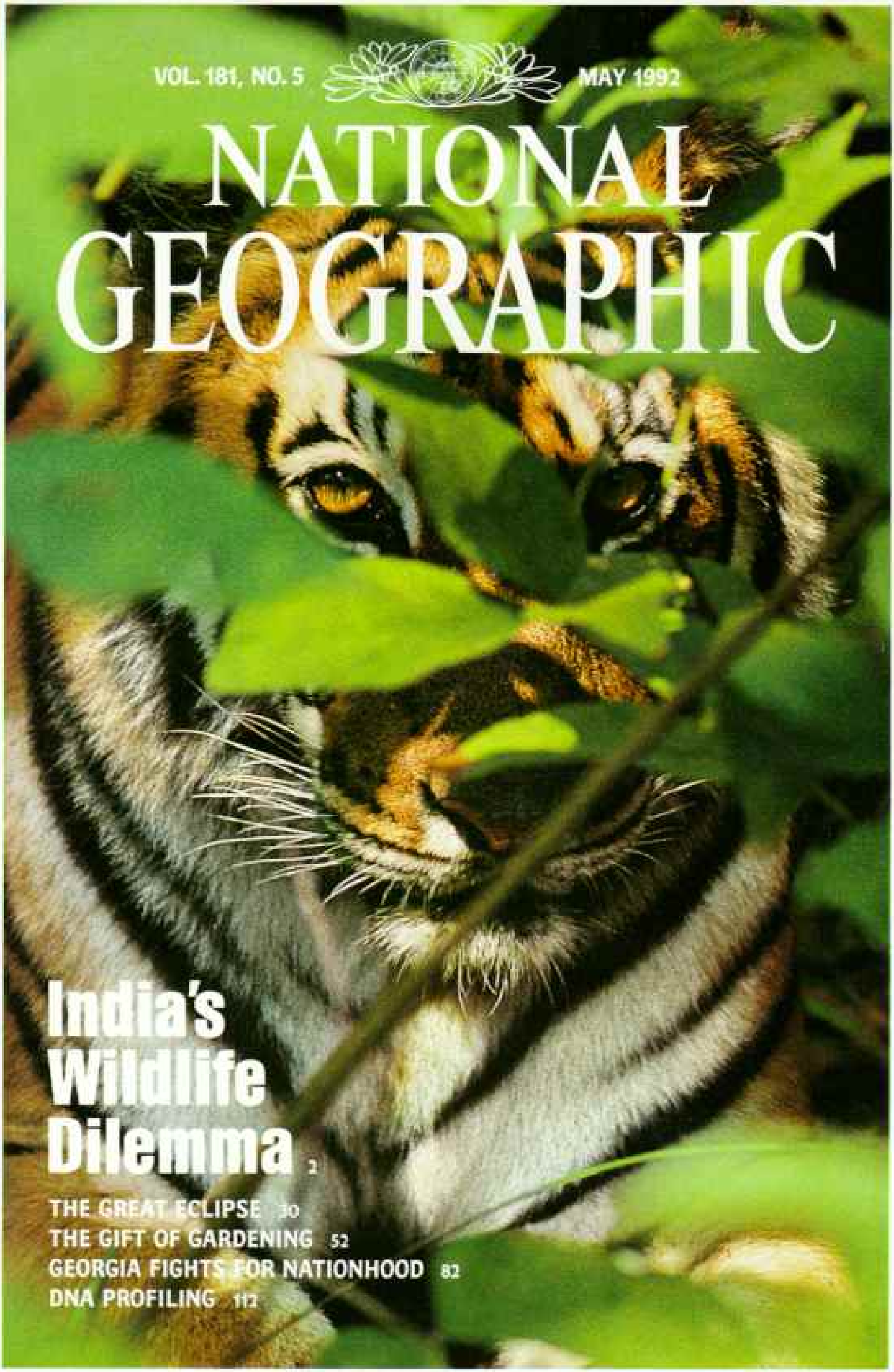

India's Wildlife Dilemma

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COVER: Silent specter of the forest, a tiger prowls India's Bandhavgarh National Park. Photograph by Raghu Rai.

India's Wildlife

First a poacher wounded the leopard. Then the leopard killed two villagers. Now the drugged cat is being taken to a wildlife

Dilemma

By GEOFFREY C. WARD
Photographs by RAGHU RAI
MAGNUM

sanctuary for treatment. The core problem: too little land for people and animals.

Good reason for crocodile smiles, the creation of nine hatcheries has helped increase the number of India's club-snouted gavials from 250 in 1974 to 3,000 today. Fishermen,

however, fear that a surging population will devour their catch, while cost-conscious bureaucrats have declared the project a success—and cut off federal funding.

Spiraling horns proclaim a victory for preservation at western India's Velavadar National Park. Numbering about 1,500, India's largest protected herd of blackbuck still occasionally

falls prey to dogs from villages that press close against the preserve boundary.
Unlike compact, well-staffed Velavadar, most Indian parks are infrequently patrolled.

WHEN I WAS A BOY in the mid-1950s, living with my family on what was then the southern edge of New Delhi, jackals slipped into our garden almost every evening. Wild boars rooted along the grassy banks of the River Yamuna not far away, and you could not drive ten miles out of town in any direction without spotting herds of blackbuck antelope frisking through fields of wheat and mustard.

No nation on earth is home to more varied or spectacular wildlife than India. And few countries have made a more resolute effort to preserve their native species in the face of seemingly hopeless odds. There were perhaps 80 national parks and sanctuaries 30 years ago. Now there are more than 450—at least on paper—and still more are planned. And Project Tiger, the internationally assisted effort launched in 1973 to save India's national animal from extinction, appears to have succeeded: In less than two decades the official census of Indian tigers in the wild has roughly doubled.

And yet, after nine trips to India over the past decade, visiting parks and sanctuaries and talking with the officials in charge of them as well as with ordinary villagers who struggle to survive on their periphery, it seems clear to me that the future of India's wildlife is now more in doubt than ever.

The jackals I remember are rarely seen or heard now. New and already overcrowded workers' colonies clog the Yamuna's banks. The city has spread in all directions until it encompasses most of the old farmers' fields, and the nearest sizable wild herds of blackbuck are hundreds of miles away.

Shooting accounted for some of the change. In the years immediately following independence in 1947, the old British game laws were gleefully flouted, and firearms licenses were issued to virtually anyone who wanted one, no questions asked.

But not even the steady fusillade that

The need for fodder and firewood forces women to hike several miles from their village into the heart of Sariska National Park. Harvesting plants with sickles and long sticks, they have already denuded this once overgrown area. The government tolerates the intrusions, unable to provide an alternative.

followed could do a fraction of the damage that has been inflicted since by the inexorable growth of the human population. When India won her freedom, there were fewer than 500 million people on the whole subcontinent. Now, even with Pakistan and Bangladesh partitioned off, there will soon be a billion people living in India alone.

This human tide continues to sweep away the great forests that covered an estimated 40 percent of the country at the turn of the century. As forests were cleared to make way for commercial planting, cut down or lopped for firewood and thatch, or chewed over by countless head of livestock, that figure has been reduced to some 15 percent. And only about 3 percent, scattered across the country in tattered, isolated patches, has specifically been set aside for wildlife.

The number of officially endangered species has risen from 13 in 1952 to 140 today. "Unless things improve, unless something is done fast," says Brijendra Singh, a hunter-turned-conservationist and former member of the Board for Indian Wildlife, "we've had it."

FROM THE TOP of the watchtower overlooking a water hole in the heart of Nagarahole National Park in the southern Indian state of Karnataka, that sort of talk seems wildly alarmist. I have seen no other place where you can get so clear a picture of the wild India that turn-of-the-century visitors saw.

Four broad fire lines have been cut through the gray-green jungle here, and sitting in the tower as the late afternoon shadows lengthen is something like attending a complex tennis match. Your head swivels back and forth from clearing to clearing as, one by one, the animals emerge for their evening drink.

Each species has its own way of approaching the water. Sambar and chital deer cling to the tree line, their ears twitching with anxiety. Barking deer, red-brown and little larger than cocker spaniels, undulate through the grass as if moving through waves. Three wild boars race for the water, snorting as they go and scaring a pair of peahens into noisy flight.

The larger animals come too. A young bull

Historian and journalist GEOFFREY C. WARD's story on Douglas MacArthur appeared in the March 1992 issue. RAGHU RAI, a native of Punjab, has been published in numerous magazines. His photographs illustrated "India: Life on the Edge" in the December 1988 GEOGRAPHIC.

Animals and humans vie for space

With 2 percent of the world's land and 16 percent of its people, India is fast losing its wildlife habitat. Sanctuaries such as Nagarahole—where men collect gaur skulls for a study of predator behavior (opposite)—give scant haven to India's embattled animal species. Isolation of small groups weakens gene pools, but plans for protected corridors between parks are stalled.

elephant splashes into the water, drinks his fill, hears me move, whirls round and round in melodramatic fury, flapping his ears and trumpeting all the while, then crashes off through the brush.

After things calm down again, a bull gaur, largest of the world's wild cattle, materializes at the water's edge. Standing six feet at the shoulder, he looks like a water buffalo on steroids, his body a dark, daunting wall of muscle out of all proportion to his small head and tiny, white-stockinged feet. Mynah birds flit on and off his back as he lowers his head to drink.

I was spending that evening with Ullas Karanth, an American-trained researcher studying the relationship between prey and predator within the park.

"Ninety-seven percent of this country is earmarked for people," Karanth says. "Only 3 percent for parks and animals. On that 3 percent there must be no compromise. We must learn to live with the fact that the park's neighbors will always be hostile. It is primarily a policing job. We can do it if we're serious. You must take a long view. When I first came here in the late 1960s, there was poaching everywhere. Poached tigers were paraded on the road, and nobody did anything. Now there is none of that."

There is none of it at Nagarahole largely because of the unusually dedicated park warden, K. M. Chinnappa. Tall and whippet-thin, with flashing eyes, he has devoted most of his adult life to the welfare of his park. He has never wanted to live anywhere else—he hates even to visit cities, he says, because they "rumble at night"—and his idea of a good time is to wander his forest on foot, following the elephants that are his passion. "I love them," he says. "Their size. Their gentleness. Their innocence.

"We are here for the animals," he adds. "That is our duty." In performing that duty he has fought poachers hand to hand, survived a plot to frame him for murder, and spurned offers of bribes to open up his forest for profit.

"Our goal is no grazing in this forest," he says. "*No* tree cutting. *No* poaching." Ullas Karanth believes Nagarahole may enjoy the highest density of hoofed prey species in Asia.

Nagarahole is a relatively safe haven for wildlife, thanks to Chinnappa's resolution—and to the happy fact that the men and women working the big coffee plantations bordering much of the park have little to gain from intruding upon it. Most parks, ringed by gaunt herdsmen and land-hungry farmers, are not so fortunate.

AS WE SLAM OUR WAY up the scrub-covered hillside in an open Land Rover, the angry, staccato coughs of langur monkeys volley back and forth across the long, narrow valley that forms the heart of Sariska National Park in the arid state of Rajasthan. They have clearly spotted a predator on the prowl. Fateh Singh Rathore, the field director in charge of Sariska, sits in the back, urging the driver on. "Quickly, quickly, quickly," he mutters, as we grind around a curve.

Fateh is one of my oldest friends in India, a proud Rajput with a flaring gray mustache, a winner of two awards for valor who for nearly 30 years has fought to save the forests of Rajasthan.

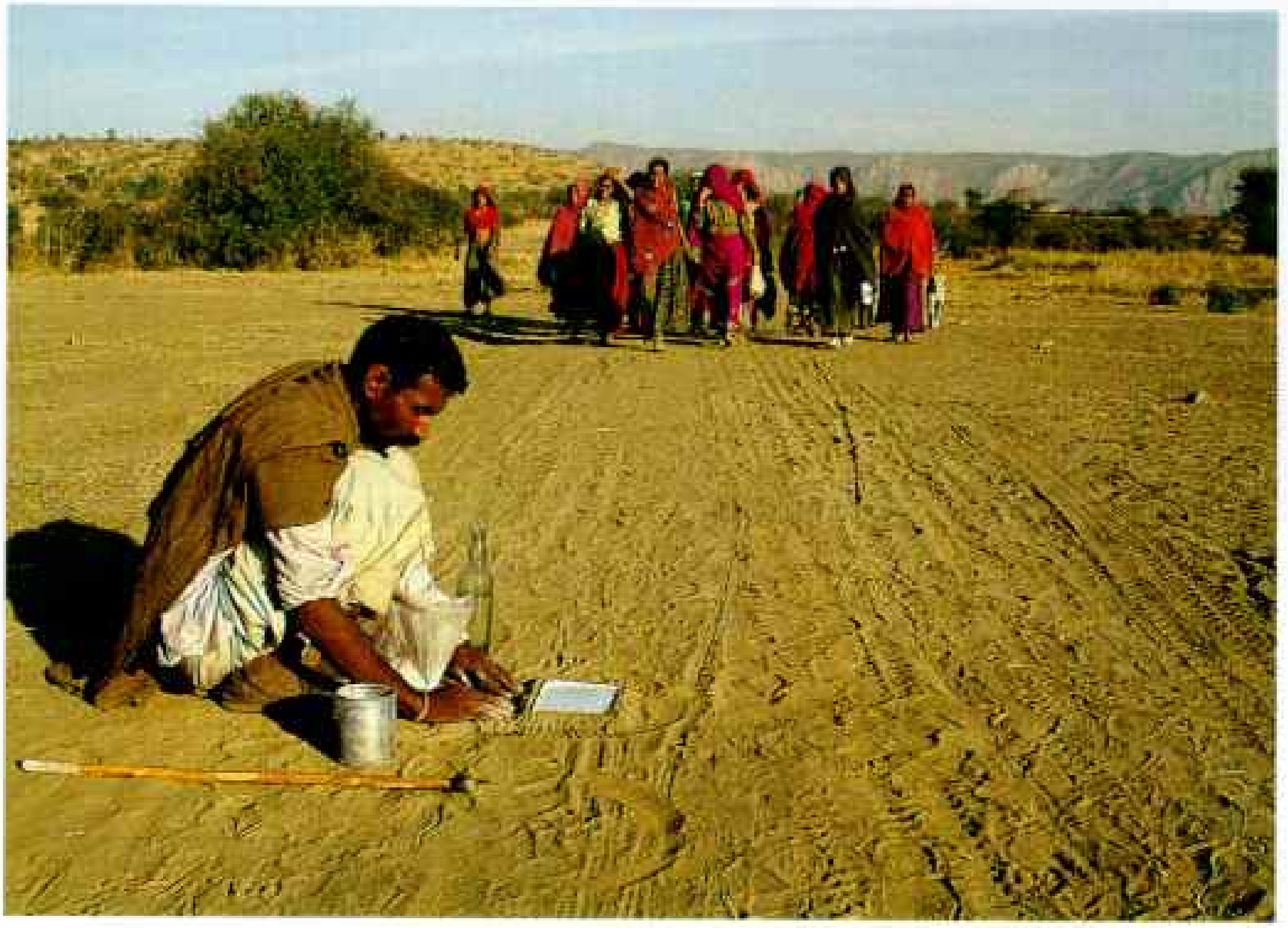
A tiger's gaze burns in Bandhavgarh National Park, where 20 of the predators are protected by a natural forest buffer zone. Elsewhere in India, parks push dangerously close to villages; at least 50 people are killed by tigers each year. Musk deer (below), protected by law, are poached for a gland used in making scents.

The Land Rover jerks to a stop. On the slope just above us, a leopard crouches behind the chital he has just killed. Paws crossed neatly on his prey's white belly, the big cat pants from exertion and glares at us, his muzzle smeared with blood.

We stare back until it grows too dark to see. As we drive back to Fateh's quarters, wrapping ourselves tightly against the sudden desert cold, I find myself babbling about how handsome the leopard had been, how lucky we had been to see it.

Fateh is uncharacteristically silent. He agrees finally that leopards are handsome, but he explains that their presence in broad daylight is just further evidence of the sad fate of the tigers the park is meant to protect. If tigers were present in sufficient numbers in the heart of the park, he says, leopards would keep to its periphery.

Sariska is one of 18 Project Tiger reserves and, like many of India's best sanctuaries, was once the hunting preserve of a local maharaja. In 1988 there were officially said to be 45 resident tigers, although that figure was very likely inflated by bureaucrats more intent on impressing their superiors than protecting wildlife. In any case, Fateh says,



Law of the jungle passes sentence on a sambar fawn in Ranthambhore National Park (left). Guards at Sariska (above) and other sanctuaries cast tiger prints in plaster (detail right) to conduct censuses. A more modern approach, tracking tigers with radio collars, was tried at one park but banned after a dispute among political rivals over the effects of the collars on wildlife.

"How beautiful you are. Do you want to jump on me? Please don't jump on me." With hypnotic rhythm, wildlife official Fateh Singh Rathore calms a pair of tigers in the ruins of a mosque in Ranthambhore. Many preserves once belonged to men like the Maharaja of Alwar (below, with gun), whose throng of beaters flushed tigers into range. His hunting grounds are now Sariska National Park.

SARISKA PALACE HOTEL

a year later there were no more than 16.

What happened?

They were shot. Eighteen tigers and 30 or more leopards are believed to have been killed in and around the park during the six years before Fateh took up this new post in 1988. He has rounded up some of the alleged offenders. A local tribesman confessed to having done the actual shooting with an ancient muzzle-loader, but he reportedly was aided and abetted by nearby villagers eager to ensure the safety of their sheep and goats and cattle, by poorly paid forest department personnel just as eager for a share of the profits, and by a big-time smuggler in Delhi who paid the poor hunter just a thousand rupees (then worth $75) for each tiger skin, then smuggled them out of the country for a sum far greater.

Such poaching is all too common and punishment of poachers all too rare. There are few witnesses. Forest and police officials themselves are sometimes involved and often look the other way. A single poacher named Veerappan is said to have accounted for 300 elephants along the border between Karnataka and Tamil Nadu—and to have cut and sold off thousands of protected sandalwood trees in the bargain—while the police and forest departments of the two states seemed unable or unwilling to track him down.

Sariska is a deceptive place. It sprawls over 300 square miles, and any first-time evening visitor who sees the herds of deer that line the tarred road running through its heart is convinced it must be one of India's richest parks. In reality only a strip of valley ten miles long and a mile wide has received genuine protection, and even here I've seen grass cutters scurrying at the sight of Fateh, dropping their big bundles of fodder as they ran. The deer have been lured along the road to please tourists by a system of artificial water holes. Back from the main road the slopes are surprisingly lacking in animal life.

Fateh wants me to see the damage visitors never see. We drive for a time along a low stone wall that divides protected acres of wild platinum-colored grass blowing gently in the breeze from the nearly grassless, stony

ground outside where cattle continue to graze unchecked. There's a break in the wall, and Fateh shouts to a forest guard to shoo a cow back outside. The cow trots a few yards before stopping to wait for us to leave.

We climb the wooded hillside, grateful for the dappled shade, then lurch on to the summit. The sun is suddenly blinding. There are five villages scattered across the broad plateau, low clusters of graziers' huts circled by crude walls woven of thornbushes. Otherwise there is nothing but treeless, grazed-over wasteland. A herd boy, balanced on a stick and one leg, watches us pass. The three haggard buffalo under his care do not even look up, continuing to nose their way over the parched ground in search of some surviving scrap to eat. A lone nilgai antelope clatters off across the desert of fist-size stones.

Unless things improve, the whole park will one day look like this. Fateh is struggling to reverse things, and he has had some impact.

The traffic that once honked its way down the valley has largely been diverted, and worship at a temple sacred to the monkey god Hanuman that used to bring hundreds of pilgrims into the park each evening has been limited to two days a week. Fateh has built new roads for patrolling and diverted watercourses to spread precious water more equitably through the parched forest. Where there had been no animals when he took charge, there are now scattered bands of sambar and nilgai. We saw the pugmarks, or tracks, of a tigress and three cubs and the spot where they had sat together and played during the night, the dust still holding the faint marks of their twitching tails. And we saw where the tracks of a big male had crossed theirs.

"We must have the time to change things." Fateh snaps his fingers. "You cannot do it like *that*."

The odds against him are formidable. Scores of villages surround the park, their inhabitants enviously eyeing its grass and wood. His staff remains small and poorly paid. There have been threats to kill him from herdsmen and from mining interests he has tried to bar from the park. He has managed to cajole the residents of at least one village to move out of the park to a site just beyond its borders, only to find the state and central governments reluctant to come up with the funds to relocate them.

"I'm put here to save wildlife," he says, as he starts his Land Rover. "Some power put me here. I don't know his name or face, but I know I have a job to do. If I finish it, then I'm off."

Shortly after I left, Fateh was abruptly transferred from the park. How it will fare without him, no one can tell.

I MET H. S. PANWAR, director of the Wildlife Institute of India, in a stony riverbed on the edge of the newly created Rajaji National Park in the Himalayan foothills. He is a small, voluble, resolute man, so busy with so many projects that he had asked me to talk with him there while he waited for the arrival of a busload of American ecology students.

The institute trains forest department officials in wildlife management and offers credits toward advanced degrees in field research. I've often run across its eager young degree candidates in my travels. Bright and energetic, they all seem galvanized by their work but anxious about their prospects. "Research funds are sometimes hard to come by in India," one young man explains. "India has so many continuing crises that wildlife is a low priority. The best I can expect is a teaching job—and then there will be still more trained biologists with no jobs to go to. Perhaps I'll have to find work abroad."

Panwar understands their concern and is doing his best to shift those priorities, but it is an uphill struggle. He and his colleagues have also drawn up ambitious plans to link the isolated parks into a network, but Panwar is ruefully realistic about them too.

"Plans look wonderful on paper," he says. "It is the implementation that is lacking." Buffer zones set up around the parks were meant to safeguard the sacrosanct core areas, but patrolling is inadequate, and determined intruders have little trouble gaining access. And the parks were supposed to be connected with one another by corridors, strips of forest or scrub jungle through which elephants could migrate and young predators could venture into new jungles in search of territories of their own. But the land was never actually allocated, and farmers have long since turned it into fields and pastures.

India's national parks remain islands, and many of them are threatened from within as well as without. Rajaji itself is filled with the camps of graziers—*gujars*—and their buffalo.

Jaws snapping, a gavial defends its nest from egg gatherers at the Kukrail Crocodile Breeding Centre in Uttar Pradesh. At Kukrail, gavial young are nurtured in closely monitored ponds for four years before being released into rivers. A hatchling (below) too weak to break through its shell got help from a staff member, who cracked the egg open.

In the old days the herdsmen and their livestock spent from October to February here, then moved up into the mountains to summer their herds in alpine pastures. That way the fodder in both places was given time to recover each year. But the herds have now grown so large that the hill people have barred their pastures to the gujars, and most simply stay year-round in the valley, where their herds methodically devour the forest.

The result—under the nose of the Wildlife Institute, within a few miles of the headquarters of the state forest department—is a steadily accelerating disaster. The trees on the crests of the still green hills have already been lopped for firewood, so the summer sun pours in to desiccate the forest floor. Monsoon rains wash the loosened soil down the slopes, widening the riverbed, causing flash floods, doing still further damage.

An effort was recently made to provide the gujars with alternative housing outside the park. Hundreds of thousands of rupees were spent building concrete structures utterly

unlike anything the herdsmen had ever known before and providing too little room for the animals that are their livelihood. Understandably enough, they refused to move.

The gujars remain. The concrete city stands empty. Buffalo are everywhere. Rajaji is disappearing.

A brightly painted tour bus turns off the main road and lurches across the riverbed toward us. "We can no longer look to government for all the answers," Panwar says as he waves to his approaching visitors.

At first, an enlightened central government seemed the brightest hope for India's wildlife. Indian politics are intensely personalized, and New Delhi has traditionally shown some concern for conservation, in large part because prime ministers Jawaharlal Nehru, his daughter Indira Gandhi, and his grandson Rajiv Gandhi all took a personal interest. But now that assassination has removed the Nehru-Gandhi family from politics, at least for the foreseeable future, the enthusiasm of its successors has yet to show itself.

Meanwhile, day-to-day care of the sanctuaries is left to the states, where clashing priorities weaken even the most carefully drawn-up plans, and too many officials see the forests simply as a means to personal gain.

H. S. Panwar refuses to be intimidated by the overwhelming odds. "If we conservationists are pessimists," he asks, "how can we expect politicians to take up our cause?"

His American visitors are climbing off the bus, cameras in hand, looking around at the dying forest that to them seems so alive.

IN INDIA, as elsewhere, wildlife conservation is primarily a middle-class movement, and foreign visitors are now far outnumbered by prosperous Indian families eager to see their country's wildlife. Thousands of persons a day sometimes pack into the tiny Keoladeo Ghana bird sanctuary near Bharatpur to catch a glimpse of the masses of wildfowl breeding there each year; on a single afternoon 12,000 visitors were reported in the Periyar Tiger Reserve in southern Kerala hoping to spot wild elephants.

Such success exacts its price. At Kanha, in the central state of Madhya Pradesh and one of India's largest parks—more than 750 square miles and a long day's drive from any city—the number of visitors threatens to disrupt what was once among India's most tranquil sanctuaries. Again and again during my visit several years ago, carloads of people passed us on the rutted track, shouting at the animals, calling out to ask whether we had seen a tiger, treating the forest as if it were a zoo.

"In 1900 this tract contained as much game as any tract I ever saw in the best parts of Africa," a British forest officer fondly recalled in 1928. "It is still probably true to say that it contains more numbers and more

species than any other tract of its size in the whole of Asia."

Those days are gone forever, but as I drove through the Kanha meadows, I saw hundreds of deer, including scores of the rare barasingha, or swamp deer, a magnificent, big-antlered animal whose name literally means "12-tined." Stags strutted through the tall grass, their great spreading antlers festooned with grass to intimidate their rivals. Fawns gamboled about the edges of the herd, their

Stalking a free meal, a lion trails the goat used as bait by census takers at Gir National Park, last stronghold of the Asiatic lion. This subspecies was on the brink of extinction in 1913, when a local ruler estimated there were two dozen left in Gir forest. Today nearly 300 lions prowl these woods; since 1988 they have mauled 150 humans.

big ears barely visible above the foliage.

Each morning and evening I saw other sights that I will always remember: A herd of 12 huge gaur, just 20 feet away, pushing their way through the trees and the morning mist; two tiny four-horned antelope, among the rarest of India's hoofed animals, scurrying off through the undergrowth, followed by their still more diminutive offspring no larger than a house cat; a sounder of 16 wild boars jumping, one by one, across the road ahead of us, like so many targets in a shooting gallery.

But it was a sound I heard at Kanha that will stay with me longest.

The tiger rules here, and the whole forest vibrates to his movements. Late one afternoon I sat in a jeep on the edge of the largest meadow. Half a dozen spotted deer browsed beneath a clump of trees. Silver-gray langur monkeys played in the branches above them. The distant clatter of two far-off barasingha stags locking horns drifted toward us. A cool breeze feathered the tall grass.

Suddenly, the spotted deer froze, ears up. One frantic doe barked in terror, her left front hoof held high. Then she leaped into the air and skipped sideways 15 yards. The monkeys danced up and down with rage.

The tiger roared.

The sound seemed to split the air. It was the loudest, angriest noise I've ever heard, and he repeated it five times. His frustration at missing the doe was understandable: A big tiger devours upwards of 60 pounds of meat in a night, and naturalist George B. Schaller estimates that, on the average, tigers at Kanha make at least 20 tries before managing to kill.

The meadow fell quiet again. The deer returned to their ceaseless munching. The monkeys groomed one another's fur. After three minutes or so, faint alarm calls reached us from the distant tree line. Another deer had spotted the hungry tiger as he moved on.

Most visitors come to Kanha to see as well as hear a tiger, and at dawn every day tame elephants and their mahouts scour the jungle for a tiger on its kill. When they find one, they stage a "tiger show," ferrying tourists to and from the site to take pictures. So many visitors now line up to climb aboard the elephants that ladders for mounting are placed at strategic points along the forest roads. Numbered brass checks are handed out to keep the queues orderly.

After two or three days the tourists go away, but the men, women, and children of India's villages have little choice but to remain. Struggling simply to exist, they see fodder denied to their livestock awarded freely to wild animals, and they resent equally the honest officials who bar them from cutting the forest and the corrupt ones who demand bribes to allow them inside. And many fear the depredations of animals that venture out to eat their crops, menace their livestock, and, sometimes, take their lives.

IT HAD BEEN THREE WEEKS since the tigress killed 18-year-old Rajesh Kumar, but the earth where he had lain after he was dragged into the sugarcane was still stained with blood, and we could still hear the horror in his grandfather's voice.

I was on the outskirts of the village of Govindanagar, near Dudwa National Park in the northern part of the Kheri District of Uttar Pradesh. Listening with me to the man's tale were "Billy" Arjan Singh, a 75-year-old author and tiger expert who has lived in Kheri for almost half a century, and Kishan Chand, a forest official who headed the chronically undermanned local Tiger Watch, meant to monitor the activities of tigers.

It had been early morning, the old man said, and he had sent his grandson into the fields to shoo birds from the freshly planted wheat. When the boy failed to answer repeated calls to breakfast, he set out to look for him. At first he seemed simply to have vanished. Then the old man spotted his sandals and saw scuff marks leading into the tall, thickly planted cane.

He parted the thicket, bent forward, and peered inside. His grandson lay sprawled on his back. Crouching just behind the corpse was the tigress, growling steadily. The grandfather fled, and by the time he returned with several men from his village, the tigress had slipped away into the cane.

Had the tigress been seen since she had killed the boy? "No," a tall Sikh said, "but her big pugmarks and those of her two cubs have been seen several times, scattered through the fields." The whole village was frightened, a grizzled Muslim added. No one dared stir outside his hut after dark.

Everyone was very polite as Kishan Chand explained to the grieving old man how he should go about applying for compensation

from the forest department for his loss. He was entitled to 10,000 rupees, or about $400 at the current exchange rate. (Had the boy been a minor, his loss would have brought only 5,000 rupees; a buffalo was worth 3,000, a cow just 800.)

As the conversation continues, a very old woman totters along the path toward us. Too ancient to be thought immodest if she lets herself be looked upon by strangers, she stops to listen.

Then, suddenly, she begins to shout in a strident, cracked voice from behind the corner of her sari: "Government cares nothing for us. It only cares about tigers. They should kill all the tigers before we are all killed."

The men look sheepish. Some smile. She has spoken out of turn, but she has also spoken for many of them.

Billy does his best to placate her. In the old days, he reminds his listeners, when the villages were few and there were still substantial stands of forest, tigers were seen as the night watchmen of the fields, their steady threat a reliable deterrent to the deer and wild boars that now routinely devour the crops. Some of the older men nod agreement.

But now the forest has dwindled to nearly nothing. The ragged patch of trees from which the errant tigress and her cubs had evidently strayed was a mile or so away across the fields, and little larger than a neighborhood park in some American city. What were the animals to do?

The younger men smile pleasantly but do not nod. It would not do for them to show disrespect toward an elder, but they have no such pleasant memories to comfort them.

Later on, speeding back toward Billy's home in his ancient Land Rover, I ask how long it will take for the old man to get his compensation. "More than a year, once all the paperwork is done," Kishan Chand says. "That is a big part of the problem."

To an outsider it seems small wonder that the villagers of northern Kheri increasingly take the law into their own hands. Nearly 40 of them have been killed by tigers since 1984, and about the same number have been badly mauled. Over the past few years more than 20 tigers have been killed in and around Dudwa: Some were shot, others poisoned; still others had their heads blown off by bombs placed in their kills. After several dead tigers were found floating in canals and lying along railroad tracks, a local politician claimed that Kheri's tigers had, for unknown reasons, begun "committing suicide."

Northern Kheri encompasses in vivid, concentrated form most of the problems that plague India's parks. When Billy began farming here shortly after World War II, much of the district was still forest and swamp and grassland, part of the great Himalayan *tarai* belt that then stretched all along the border between India and Nepal. Boggy, malarial, thickly grown, it had nonetheless been a sportsman's paradise.

But after independence, everything changed. Swamps were drained, forests cut down, grassland turned into fields of sugarcane, animals slaughtered wholesale—all to make room first for thousands of refugees fleeing the partition of the Punjab, then for hundreds of thousands of landless squatters. Wildlife retreated into what forest remained.

Birds in the hand represent months of work at the Serahan Pheasant Breeding Centre in northern India, where the rare Himalayan monal is found. Just days old, these chicks were hatched by domestic hens, freeing mother monals to lay more eggs. As adults, the pheasants will be released into the wild.

Up to his ears in food, an Indian one-horned rhinoceros wallows in a bed of water hyacinth at Kaziranga National Park, while a piggybacking cattle egret feasts on

insects surrounding the huge herbivore. Besides grazing on aquatic plants, shrubs, and trees, rhinos sample crops during nighttime raids on nearby farms.

To preserve at least a little of it—and to save one of India's last surviving herds of barasingha, Billy lobbied successfully to have a 200-square-mile forest adjoining his farm declared Dudwa National Park.

Its broad meadows and groves of lofty sal trees are still beautiful, and Billy remains their implacable guardian, but even he admits that the future of Dudwa looks doubtful. There never has been an effective buffer zone at Dudwa, as required by statute. Farmers have been permitted to grow their thick stands of sugar right up to the edge of the forest, providing perfect cover for pregnant tigresses—and ensuring that human and animal will meet at close quarters. This is almost surely what caused the tigress to kill Rajesh Kumar at Govindanagar. Nor was a corridor ever created linking Dudwa with any other forest, so young tigers, driven to the edges of the park by their elders and ready to claim territories for themselves, have nowhere to go but into the farmers' fields in search of prey.

And human beings were never effectively kept out of the park itself. Until 1988, when Billy obtained a court order forbidding it, armies of wood gatherers were permitted to roam the forest more or less at will. "Mixed use doesn't work," Billy says. "Tigers are naturally fearful of human beings, but familiarity breeds contempt—and tragedy."

Driving through the park one day, a year before the wood-gathering ban went into effect, I had a vivid glimpse of what he meant. A bullock cart plodded toward us, bearing a huge, gnarled tree trunk. Not a hundred feet behind stalked a big male tiger, belly nearly to the ground, eyes so intent on its intended prey that at first it did not see our vehicle. Whether it was the bullocks that had caught his eye or the oblivious old man who drove them, we will never know, for our presence ruined the tiger's stalk: He finally stopped, glared at us, glared at his retreating prey, then turned off into the forest.

But Billy's ban may have come too late. The human tide continues to rise. In 1977 there were 21 villages on the periphery of the park; there are now more than 80, and more are planned. Yet there is still no provision for supplying the villagers with alternative fuel, and a politician won a state assembly seat not long ago by promising to reopen the forest.

And, since some 20 tigers are known to

have been destroyed in the district over the past few years, the official estimate that 90 tigers somehow survive within Dudwa itself seems wildly inflated. In seven visits to the park during my last trip to India and with Billy as my guide, we saw no tigers at all, and pugmarks only twice.

ONE EVENING several years ago I sat on the flat roof of a small house on the western edge of Ranthambhore National Park in Rajasthan. With me was another old friend, Valmik Thapar, an anthropologist and former filmmaker from New Delhi who has found his real vocation studying the tigers that live here amid ancient Hindu and Muslim ruins.*

The setting sun bathed the stony, treeless hills with gold, and in that burnished light a regal procession moved slowly along the only road—scores of women in red and orange

*See "Tiger! Lord of the Indian Jungle," by Stanley Breeden, GEOGRAPHIC, December 1984.

Walking observation platforms let tourists observe Kaziranga's rhinos and buffalo in safety. Yet the park's deadliest creature prowls on two legs. Poachers here kill more than a dozen rhinos each year for the horn (below), which can be worth $9,000 a pound to smugglers trading on the horn's medicinal reputation.

going home, each balancing on her head a bundle of grass longer than she was tall, in a line that stretched a quarter of a mile. Behind them, scores of gaunt buffalo and cattle and goats, their bellies filled with precious grass and foliage, also plodded toward home. The musical *tunk* of wooden cowbells echoed across the valley. A visitor could not help but admire the beauty of it.

"It *is* beautiful. Who can deny it?" Valmik said. "But the park is literally being eaten up, and there are far too many people to stop. They are simply not going to go away."

When I first knew Valmik, his interests did not extend much beyond the jungle, where he preferred to spend all but the hottest hours of every day observing his tigers. But he has changed, and he believes the whole Indian conservation movement has to change as well. These days he rarely gets a chance to venture into the jungle that has been his second home for nearly 20 years. He is far too busy with the activities of the new

Ranthambhore Foundation he and a group of other concerned citizens have established here to try to bring together the park and its neighbors.

"Why should we blame these people for being shortsighted?" he asks now. "They're not stupid. They've been living here since long before we city dwellers got interested in this place. Yet no one asked them whether there should be a park. No one warned them that entering the park to graze their herds or gather firewood as they always had would suddenly make them criminals. They're right that the park does not yet benefit them. It's our job to change that, to help them see that their survival and that of the park are linked, that if the forest is destroyed, their lives and all our lives will be destroyed as well."

It is a daunting task. Villagers are traditionally wary of change, and still more suspicious of citified outsiders. Valmik began by buying several acres of degraded land, digging a well, and building the simple house in which we sat. He then planted trees and otherwise allowed the landscape to revive on its own. The result is a lush oasis, alive with birds and small animals, shaded by some 50 species of trees, many of them native varieties grown from seeds gathered in the forest.

The example was not lost on his neighbors. Soon villagers from as far away as 15 miles were turning up, asking for seeds with which to reforest their land. A nursery and seed bank now distributes some 40,000 seedlings a year, and in at least two villages the people themselves have formed forest-protection societies with nurseries of their own.

Meanwhile, with financial help from friends in India and abroad, the foundation began sending a medical van into a dozen villages each week to provide health care. If the people's health could be improved, Valmik and his friends reasoned, they might be persuaded to concern themselves with the health of their environment. It seems to be working. Other foundation-sponsored projects followed. A dairy cooperative and the introduction of better buffalo have demonstrated the advantages of improved, stall-fed animals that thrive—and yield far more milk—without ever having to enter the forest. A crafts cooperative in Sherpur, the village nearest Valmik's farm, brings together women of many castes and faiths to produce brilliantly colored scarves and quilts and other traditional handicrafts that enjoy a brisk sale in Delhi and bring new income to the village. There are plans for research fellowships, improved veterinary care, a permanent clinic, and a pilot project to develop practical alternative fuels for cooking.

THERE ARE EARLY SIGNS of real success. The people of Sherpur recently asked for and then helped dig a cattle ditch a mile long, so at least their approach to the forest can be made as green again as it was in the time of their ancestors. And schoolchildren in the area have planted some 20,000 trees in and around their villages.

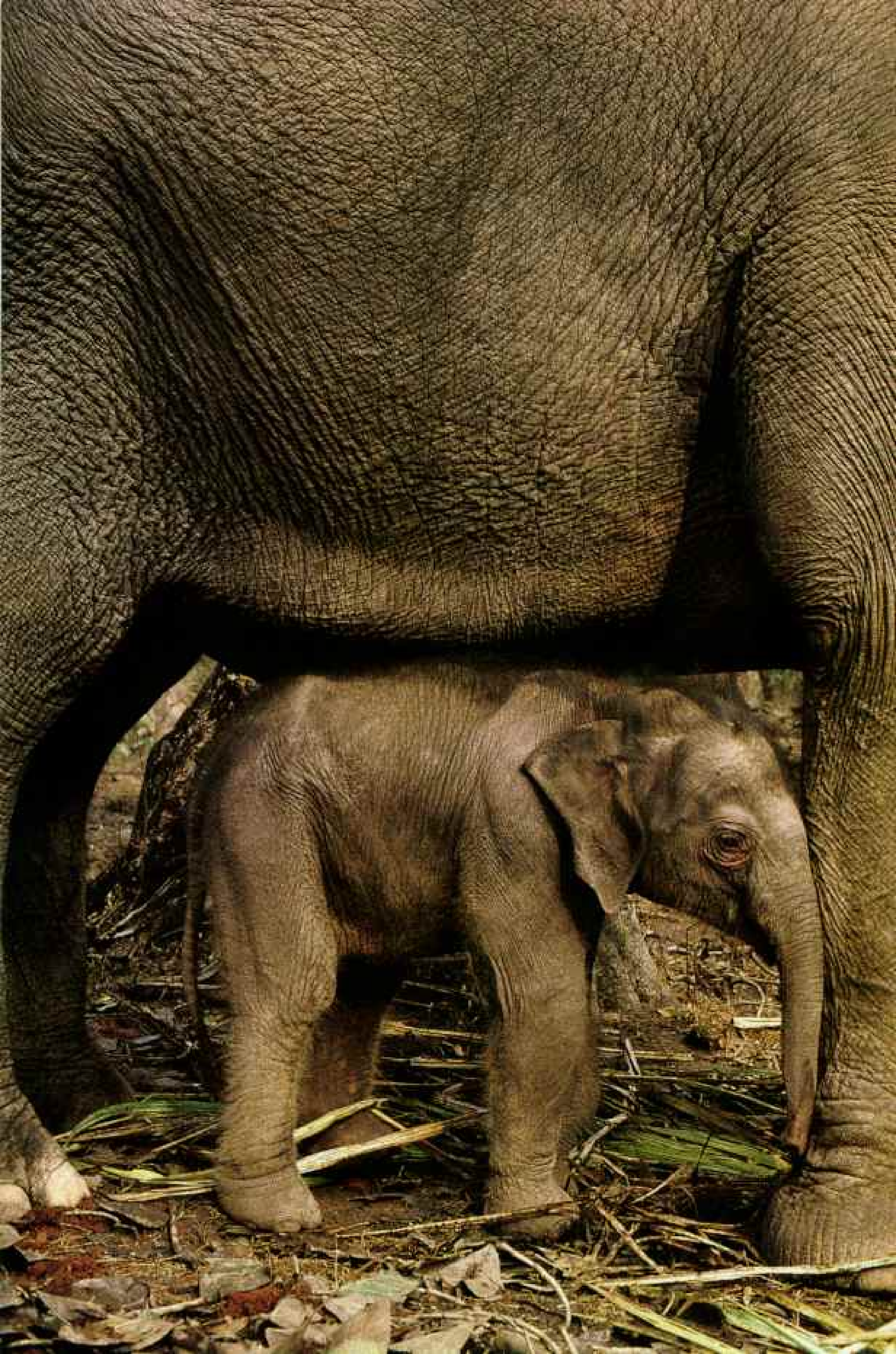
Ranthambhore is becoming a catalyst for a new kind of Indian conservation effort, aimed at restoring the relative harmony that once existed between the forests and those who live around them. The Indian branch of the World Wildlife Fund has launched a similar project just down the road, and as part of a large-scale ecodevelopment plan the Rajasthan forest department has begun planting fodder to be given away to graziers who agree not to take their animals into the park.

Valmik welcomes everyone's help. "We must all work together," he says. "All these things are needed. But all of them will take time."

For the present, the Ranthambhore Foundation extends to just a few villages. Ranthambhore itself is just one park; its 40-odd tigers and their hoofed prey constitute only a tiny fraction of India's wildlife legacy. But if the park can be saved despite all the problems that surround it, it will demonstrate at least that survival is possible. "If it can be done here," Valmik believes, "it can be done anywhere."

He is tireless and hopeful but also cautious about the future. "Let's see," he says. "It's only a beginning." □

Sheltered by her mother, a newborn calf tests sturdy legs at Kanha National Park, where such captive elephants provide transportation for tourists. The proliferation of humans and livestock, in a nation of dwindling resources, casts a shadow of doubt over such sanctuaries and threatens the wildlife within.



THE GREAT
ECLIPSE

Photographs by
ROGER H. RESSMEYER
STARLIGHT

Night fell as the sun rose on July 11, 1991, when a total solar eclipse darkened Mauna Kea Observatory on the island of Hawaii. A multiple exposure recorded the spectacle from start to finish—along with an awestruck technician atop the telescope dome at left. At totality the lunar and solar rims fit like stacked spoons (following pages), revealing normally invisible solar prominences, one taller than ten earths.

ROGER H. RESSMEYER WITH JOSEPH S. STANCAMPIANO, NGS STAFF, AND JAIN RESSMEYER

FOLLOWING PAGES: TOTALITY AS IMAGED BY A MEADE INSTRUMENTS CORPORATION TEN-INCH F/6.3 SCHMIDT-CASSEGRAIN TELESCOPE, ROGER H. RESSMEYER WITH JOSEPH S. STANCAMPIANO

THE EMERGING SUN AT THE END OF TOTALITY ON JULY 11 DAZZLES WITH ITS "DIAMOND RING."

THE DARKNESS THAT ENLIGHTENS

By JAY M. PASACHOFF

IT IS A CURIOUS FACT of astronomy that one of the best ways to study the sun is to have its glowing disk hidden from view. With its great light seemingly extinguished, the usual glare of earth's atmosphere drops away. Then, in a sky as dark as night, the sun's faint outer atmosphere—its veil-like corona—comes boldly into view.

The total solar eclipse that swept a cone of darkness across the earth last July 11 dramatically banished the daylight. For unforgettable minutes hundreds of scientists and millions of other watchers saw fantastic prominences—masses of gas—looping from the sun's surface out into the corona.

It was a special eclipse. Usually astronomers and their equipment go to the eclipse. This time the eclipse came to the astronomers, passing directly over the world's largest array of giant telescopes, on Mauna Kea volcano in Hawaii. Mauna Kea's altitude—13,796 feet—and its clear, dry air gave astronomers and their machines an unmatched earthly view of the phenomenon.

The eclipse darkened the great urban mass of Mexico City. The moon's central shadow drew a swath of darkness 9,300 miles long and as much as 160 miles wide, bringing nearly seven minutes of totality in some areas—a duration that occurs only every 18 years, 11 days.

Why do astronomers find eclipses so fascinating? While telescopes can be adapted to partly simulate an eclipse, a real eclipse offers the best visibility for observing the corona. At eclipse we see the corona as a crown of light around the sun; its shape is sometimes more round, sometimes more elliptical. We see its glow extending a million miles from the edge of the sun. The corona is composed of the same gases as the rest of the sun: 90 percent hydrogen, almost 10 percent helium, and a tiny quantity of the other elements.

The corona flows outward into the solar system as the solar wind—streams of charged particles. These travel 93 million miles to earth and even pass beyond the outer planets.

Eclipses are a time-tested tool of solar astronomy. Observers pursuing the 1868 eclipse determined through spectroscopy the existence of the gas

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JAY M. PASACHOFF is professor of astronomy and director of the Hopkins Observatory at Williams College in Massachusetts. He is author of *Astronomy: From the Earth to the Universe* and *A Field Guide to the Stars and Planets*.

hellum, from *helios*, the Greek word for the sun; only later was it found on earth. Other eclipses showed over time that the corona changes shape in step with the 11-year sunspot cycle.

But few eclipses attracted scientific observers like that of 1991. Many clustered on Mauna Kea. My experiments, tackling the mystery of coronal heating, did not require elevation. My team set up two tons of telescopes and electronics on the Big Island at Waikoloa. All we needed was clear skies.

A Research Project Supported In Part By Your Society

On the evening before E day the thousands of tourists who had flocked to the Big Island thrilled to a fiery sunset, caused by globe-girdling particles from the volcanic eruption of Mount Pinatubo in the Philippines. The particles rode stratospheric winds far above Mauna Kea; surely it would affect our viewing.

Dawn broke on the 11th with an unusually heavy cloud cover. On Mauna Kea, scientists worried about a rising fog. High cirrus clouds veiled the sky.

The sun rose at 5:49 a.m. Forty-one minutes later the moon took its first bite of the sun, like some celestial Pac-Man. We glimpsed the vanishing sun through the clouds, and for a time it looked as if the sun would climb above them. Then, totality. But only after the clouds had won the race.

The teams on the mountain fared better. There, the fog retreated, and the corona showed through the high clouds and volcanic haze. Most instruments worked well; only the haze and cirrus remained an unknown factor.

Those observations and others will nourish solar astronomy for years. Among the experiments and early results:

- The Canada-France-Hawaii (CFH) telescope, its room-size mirror the largest ever pointed at the sun, produced film and videotape that unexpectedly showed small regions in the corona changing brightness within seconds. Yet neither the CFH nor another large telescope on the mountain have found the predicted tiny explosions that could explain why the corona is so much hotter than the surface.
- Electronic detectors able to make infrared images searched the inner solar system in vain for a ring of glowing dust reported two decades earlier. Despite the clouds and volcanic haze, the scientists say it should have shown up prominently. Perhaps the ring had been temporary, deposited by a passing comet.
- Other detectors were used to study prominences, magnetic fields, and the spectrum of the corona. The results reveal how the atmosphere of the sun varies in temperature and density.

Total eclipses occur somewhere in the world every year or two. I plan to see one that will start over Uruguay and cross the South Atlantic Ocean this June 30. And when a particularly alluring eclipse crosses South America in 1994, I will gather up my students and my tons of equipment to try again to untangle some of the sun's mysteries—but not, I hope, harassed by clouds. • • •

THEIR FULL MEANING LOST FOR MILLENNIA, THE MEGALITHS OF STONEHENGE MARK THE MOVEMENTS OF THE SUN.

HDS CARTOGRAPHIC DIVISION

THE MOON'S RACING SHADOW

Text and photographs by
ROGER H. RESSMEYER

Beacon of darkness sweeps across the earth's face (right). Four images taken at 60-minute intervals on July 11, 1991, by the GOES-7 weather satellite were combined with a global view from the satellite on the same day. This is the first such time-lapse look at the path of the moon's shadow.

Moving in the same general direction as the earth spins, and always faster, the shadow's relative speed is greatest where it brushes earth at the lowest angle. Thus as dawn broke 1,300 miles west of Hawaii, the umbra, or path of totality (red line, map above), began racing eastward at more than 18,000 miles per hour. On Hawaii six minutes later, the speed had dropped to less than 5,600 mph. Over the Gulf of California, where the sun was high and earth's rotation best kept up with the shadow, its speed had slowed to 1,400 mph. Totality there lasted six minutes, 51 seconds—only 40 seconds short of theoretical maximum and the longest total eclipse until 2132.

Within the umbra, viewers saw a total eclipse; in the penumbra, only a partial eclipse was visible.

The margin between total and partial eclipse is slim. In 1925 observers on the north side of 96th Street in Manhattan saw the sun totally eclipsed, but just one block south a sliver of sunlight shone through.

ROGER H. RESSMEYER, author of *Space Places* and an upcoming children's book, *Astronaut to Zodiac*, is a frequent contributor.

NOAA IMAGE PROCESSED BY JOHN
BATTER, EARTH SATELLITE CORPORATION

A GALLERY OF ECLIPSES

Lunar eclipse
The moon passes into earth's umbral shadow, an event visible to half the planet at once. Bathed in light refracted by earth's atmosphere, the moon appears reddish.

Partial solar eclipse
The moon does not cover the entire sun; only the penumbra touches earth. The view is similar from within the penumbra of a total solar eclipse.

Annular solar eclipse
For more than half its orbit the moon's apparent size is smaller than the sun's, allowing a ring of the photosphere to surround the moon.

Total solar eclipse
As the moon completely blocks the sun, the corona is visible above the solar surface.

Umbra

Penumbra

Corona
The sun's hot luminous outer atmosphere—some 2,000,000°F—is visible a million miles out during totality. It extends as the solar wind to the limits of the solar system.

Photosphere
The sun's 300-mile-thick visible surface churns at 10,000°F.

Chromosphere
The layer just above the photosphere appears as a thin rosy ring during the first and last moments of totality.

Prominence
Gigantic arches of gas can plume hundreds of thousands of miles. Their shapes conform to the sun's magnetic fields.

Sunspots
The intense magnetic fields of sunspots block the flow of energy, making them cooler and darker than the surrounding photosphere. The strong fields also help shape the corona.

Magnetic fields
The sun's strong magnetic fields are created by turbulence in the photosphere and the layer below it. Magnetic lines of force determine the shapes of prominences and the configuration of the corona.

Solar flare
Magnetic activity causes charged particles and energy to burst from the sun's atmosphere. Flares trigger auroras and can disrupt communications on earth.

Coronal streamer
Ionized gases stream outward along magnetic lines of force. The majestic displays vary with the shape of the corona; ancient Egyptians saw them as the sun god's wings.

A GLORIOUS CONJUNCTION

In a coincidence unmatched in the solar system, the sun's diameter is 400 times that of the moon's, and the moon is about 400 times closer to the earth than the sun. That combination allows the moon to cover the sun's disk as it passes between the earth and sun. Were the moon's diameter 140 miles less, totality would not occur; viewers would never see the corona.

Historians have dated events from long ago by using accounts of eclipses. A Chinese scribe may have been the first to document one, 4,000 years ago.

Total solar eclipses are doomed to extinction. If the moon continues to recede from the earth at about an inch a year, in a billion years it will be too far away to cover the sun.

PAINTING BY GREG HARLIN
CONSULTANTS: DRAKE DEMING, NASA/GODDARD SPACE FLIGHT CENTER; JAY M. PASACHOFF, WILLIAMS COLLEGE; JACK ZIRKER, NATIONAL SOLAR OBSERVATORY

DARKNESS SWEEPS HAWAII

The tip of the moon's shadow cone, 140 miles wide at Mauna Kea, is sharply defined as it slides eastward across the early morning sky.

I've been lucky enough to photograph nine solar eclipses—starting when I was just 16—but the drama of totality has never lost its impact for me.

One image I wanted to record was the moon's circle of darkness passing overhead and racing toward the horizon. Taken at three-second intervals facing east, these four photographs show the inky central area of totality ringed by sunlight, like a lone thunderhead surrounded by clear skies. Our photographic team took the last exposure as the shadow sped over a blanket of clouds toward its next landfall in Mexico.

Never before has a total eclipse passed over a major international observatory like the University of Hawaii's Mauna Kea—with its array of highly sensitive telescopes from France, the Netherlands, the United Kingdom, Canada, and the United States.

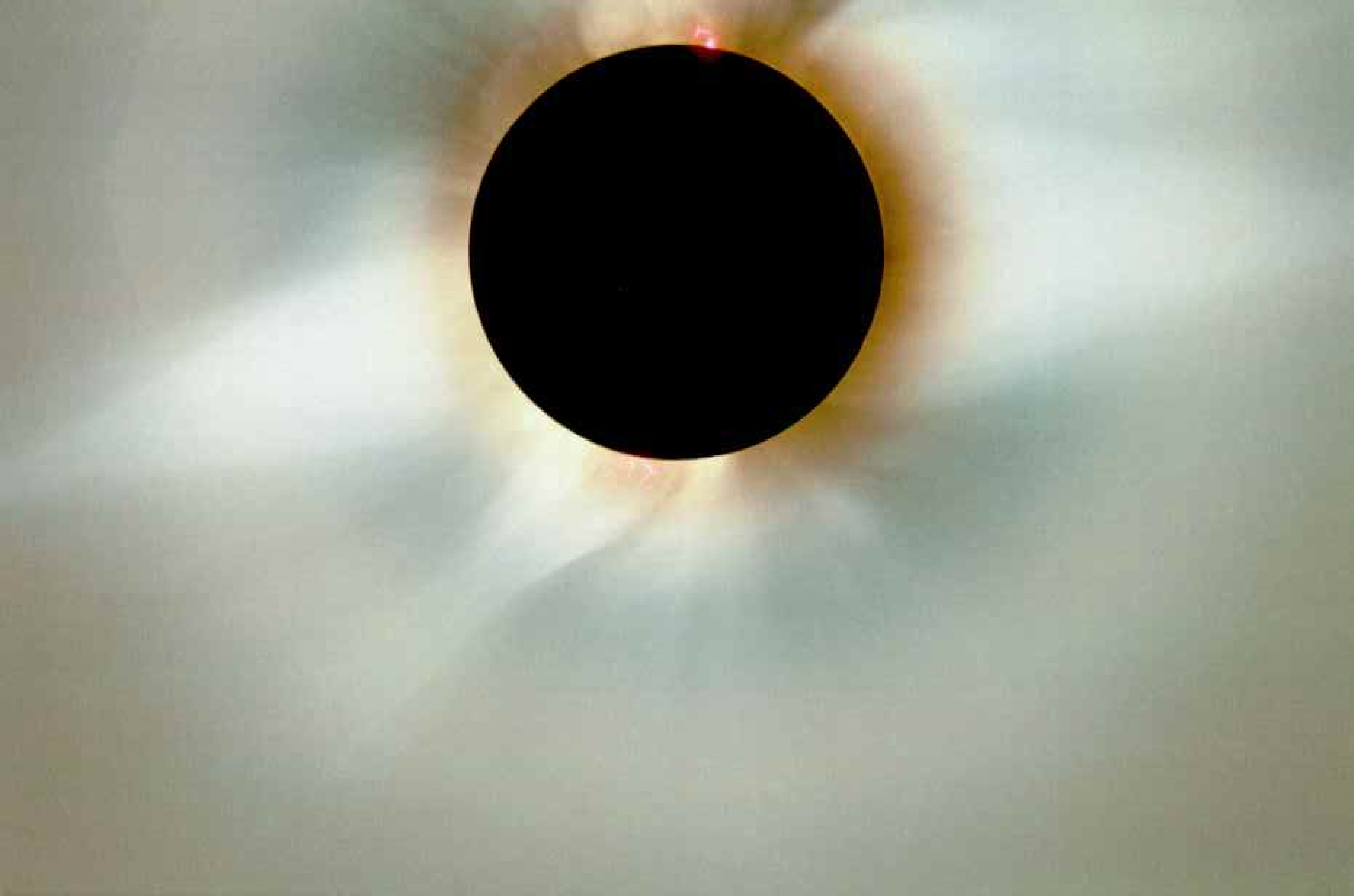
In the thin atmosphere of 13,796 feet, the telescopes of Mauna Kea—seen from a cinder cone less than a mile away on the bleak, rock-strewn mountain—stand ready during the very first moments of totality.

ALL EYES FOCUS ON THE VANISHING SUN

Totality presented a do-or-die deadline for us and 50 scientists at Mauna Kea's telescopes, silhouetted against the darkened sky in a fish-eye lens view (right).

Though scientists spend years preparing for these moments, glitches seem inevitable. Just 90 minutes before totality, Caltech's radio telescope, tented to keep the sun from frying its circuits, was crippled: A wheel for rotating the telescope had jammed. Technician Allen Guyer (above) crawled under the housing and retracted the wheel.

Clipboard in hand, astronomer Serge Koutchmy (below) stood watch during totality in the control room of the Canada-France-Hawaii telescope. Said Koutchmy, who was studying the sun's corona, "It was much more important for me to stay inside and control the experiments."



THE SUN REVEALS ITS FILMY HALO

Since the first eclipse daguerreotype in 1851, photographers have tried to capture the glory of totality on a single frame. But on film the range of coronal light is too great. Typically the region nearest the sun is overexposed, and the outer reaches underexposed.

Serge Koutchmy overcame the problem by using a filter more dense in the middle. His photograph of the July 11 eclipse is similar to what the human eye sees when it registers both brightest and faintest details of totality, the only safe time to look at the sun.

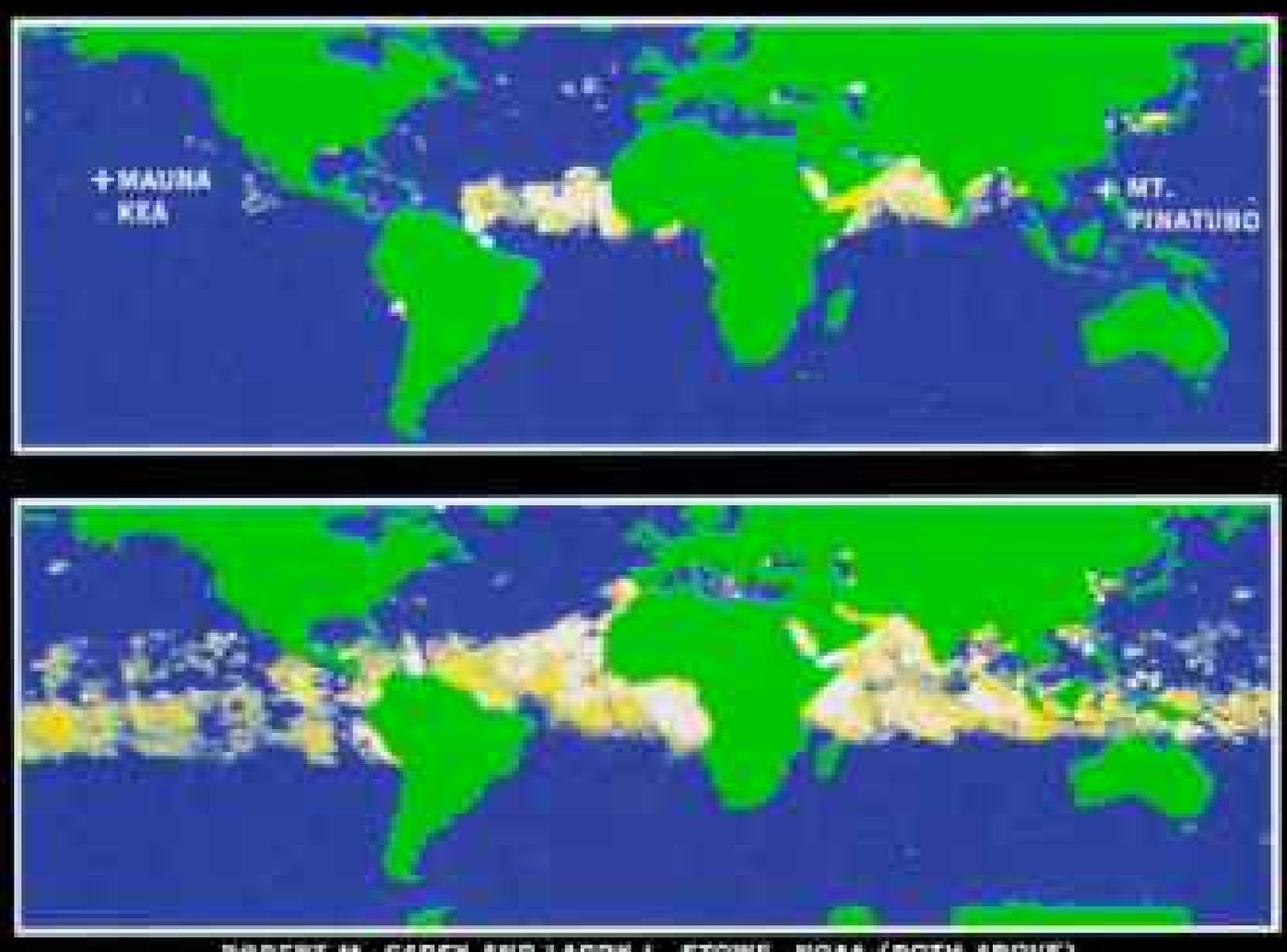
SERGE KOUTCHMY, CNRS, FRANCE

A VOLCANO'S BAD TIMING

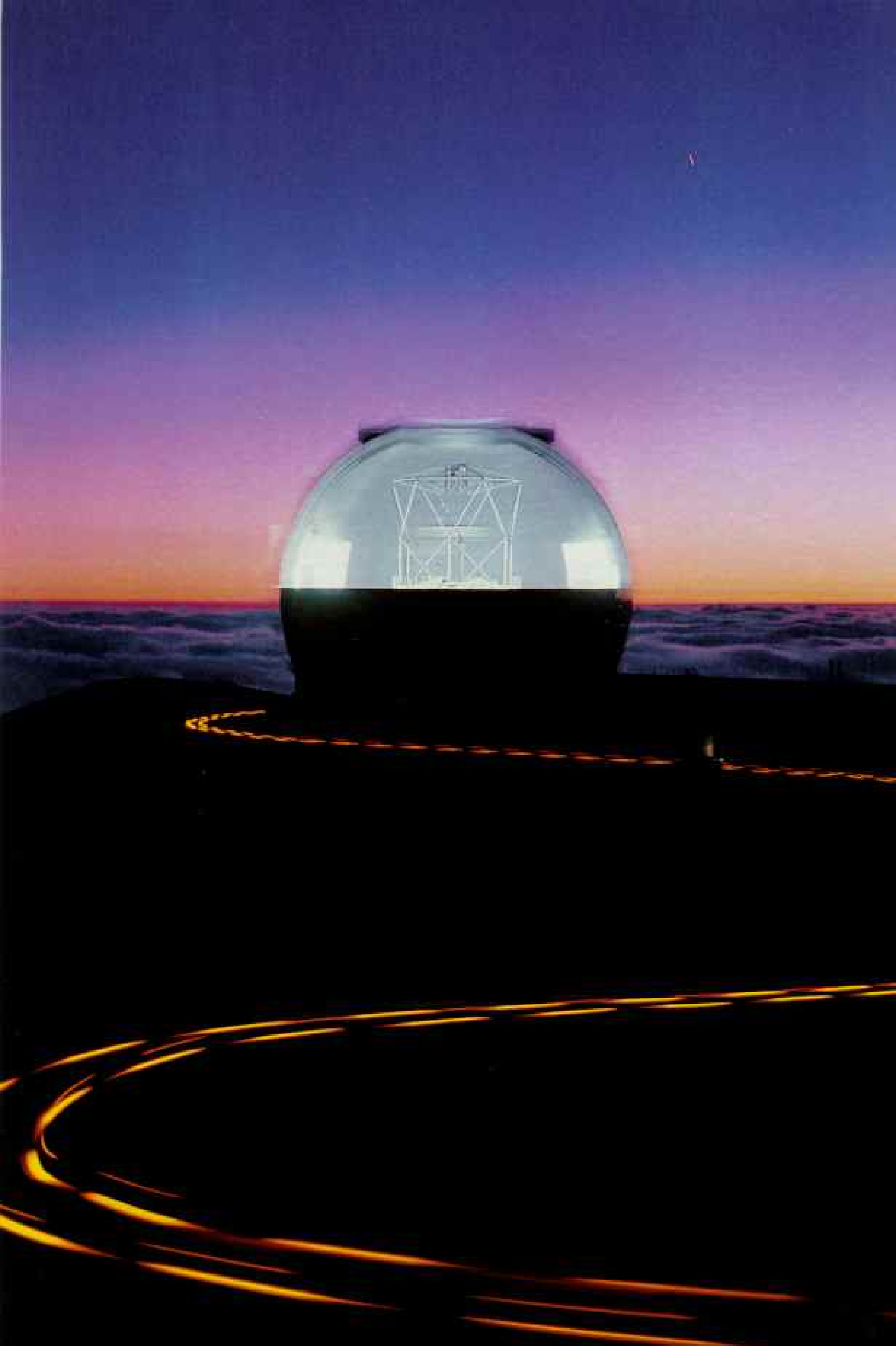
The huge eruption of Mount Pinatubo in the Philippines created spectacular sunsets (above) and headaches for astronomers, whose readings were distorted by the resulting haze.

The upper satellite mosaic, made a week before the June eruption, shows desert dust in the lower atmosphere (data were recorded only over the dark oceans). A global belt of haze, visible in the lower image made the week of the eclipse, formed in the stratosphere after the eruption.

Sunset on Mauna Kea last May (right) was far less colorful. A car's hazard lights become streaks in a time exposure. The Keck telescope—the world's largest—is revealed under its dome because the opening rotated across the view.



ROBERT M. CAREY AND LARRY L. STOWE, NOAA (BOTH ABOVE)



INTERCEPTING ETERNITY

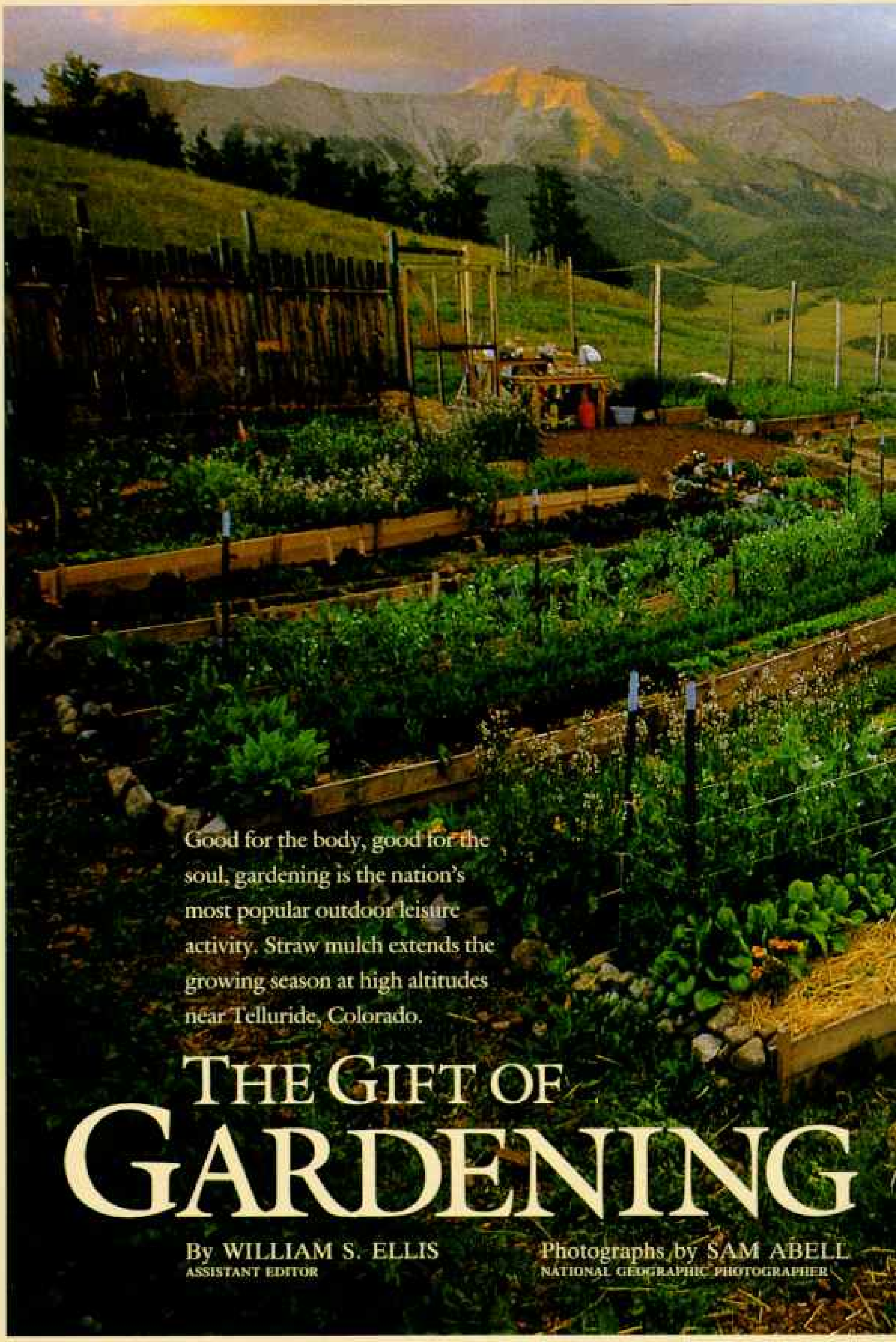
"A hole had opened up in the universe," said Hawaii Air National Guard reserve flight surgeon Wes Young, who took this photograph during an F-15 training mission on eclipse day.

WES YOUNG

The U. S. won't see another total eclipse until August 21, 2017, and the next time the moon's umbral shadow crosses a major observatory—darkening two such sites in Chile—will be July 2, 2019.

I'll be 65 then, but I hope to be there. Perhaps I'll be retired and ready to put my camera aside for one long moment—at last fully indulging myself in the heavens' greatest show.

I can't wait. □



Good for the body, good for the soul, gardening is the nation's most popular outdoor leisure activity. Straw mulch extends the growing season at high altitudes near Telluride, Colorado.

THE GIFT OF GARDENING

By WILLIAM S. ELLIS
ASSISTANT EDITOR

Photographs by SAM ABELL
NATIONAL GEOGRAPHIC PHOTOGRAPHER

SOMETIME JUST BEFORE THE ADVENT of Easter week, I came to be on a road in central Vermont, and there were men and women in the yards of the houses along the way tilling and spading and acting for all the world as if they were in control of that still cold and flinty earth. I wasn't surprised. As a gardener, I knew it was the time of year when a gardener's passion flares unbridled, a time to emerge from the shadows of winter in search of the first signs of renewal (already presaged, of course, by Mr. Burpee's seeds bursting from their window-bound cells of warm growing mix).

Among those out that day there were some, I knew, who held the chilling fear that winter would tarry too long for the tomato plants to fill their cages or for the orange daylilies to reach high in bloom around the mailboxes. Well, the dreams that gardeners dream on nights of howling winds come true in good time, and, in any event, orange daylilies *always* bloom.

Such is the ritual of the annual awakening in the world of the gardener in the United States. More than that, however, as the National Gardening Association (NGA) has found, it is an acknowledgment by members of 80 percent of the nation's 93.3 million households that gardening is without rival as an outdoor leisure activity. Americans by far prefer to bring a peony to exquisite bloom or a golden summer squash to sweetness of flesh than to play golf, catch fish, or go camping and wish on falling stars.

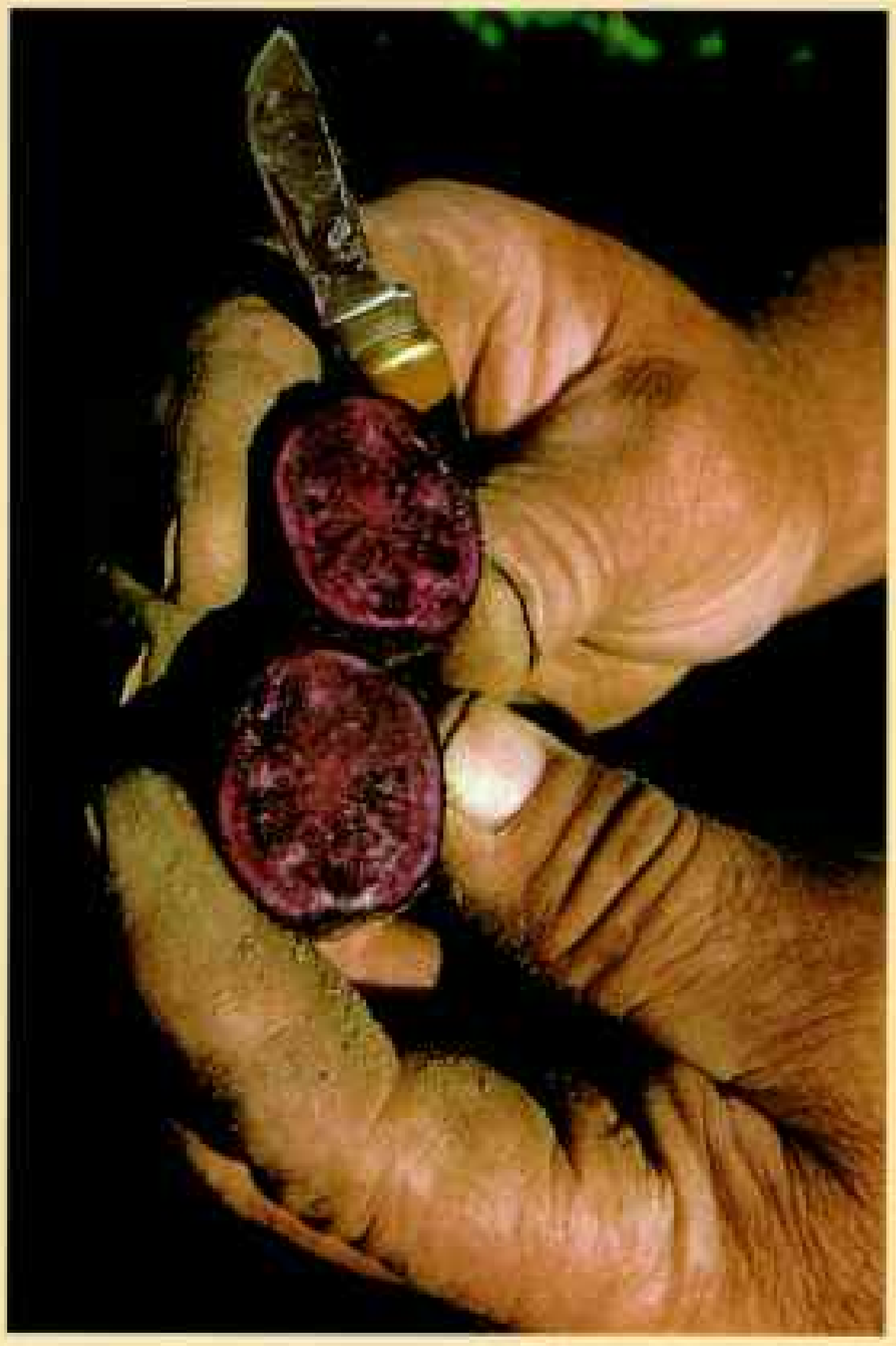
"In 1990 retail sales of lawn and garden materials amounted to more than 20 billion dollars," Bruce Butterfield, research director of the NGA, says. "Six years ago the figure was 14.2 billion dollars. These sales are increasing 10 percent a year." It can even be said that Americans spend more each year on gardens than on pizzas.

This reaffirmation of gardening as a bridge to better living has surged markedly in the past several years. The reasons are not clear, but economic uncertainties may play some role. Vern Grubinger, an agricultural extension agent in Brattleboro, Vermont, who receives hundreds of requests each spring and summer for help with problems in the garden, thinks many people are now growing their own vegetables as a hedge against financial hardships. "A gardener can save a couple of hundred dollars in food costs that way," Grubinger says.

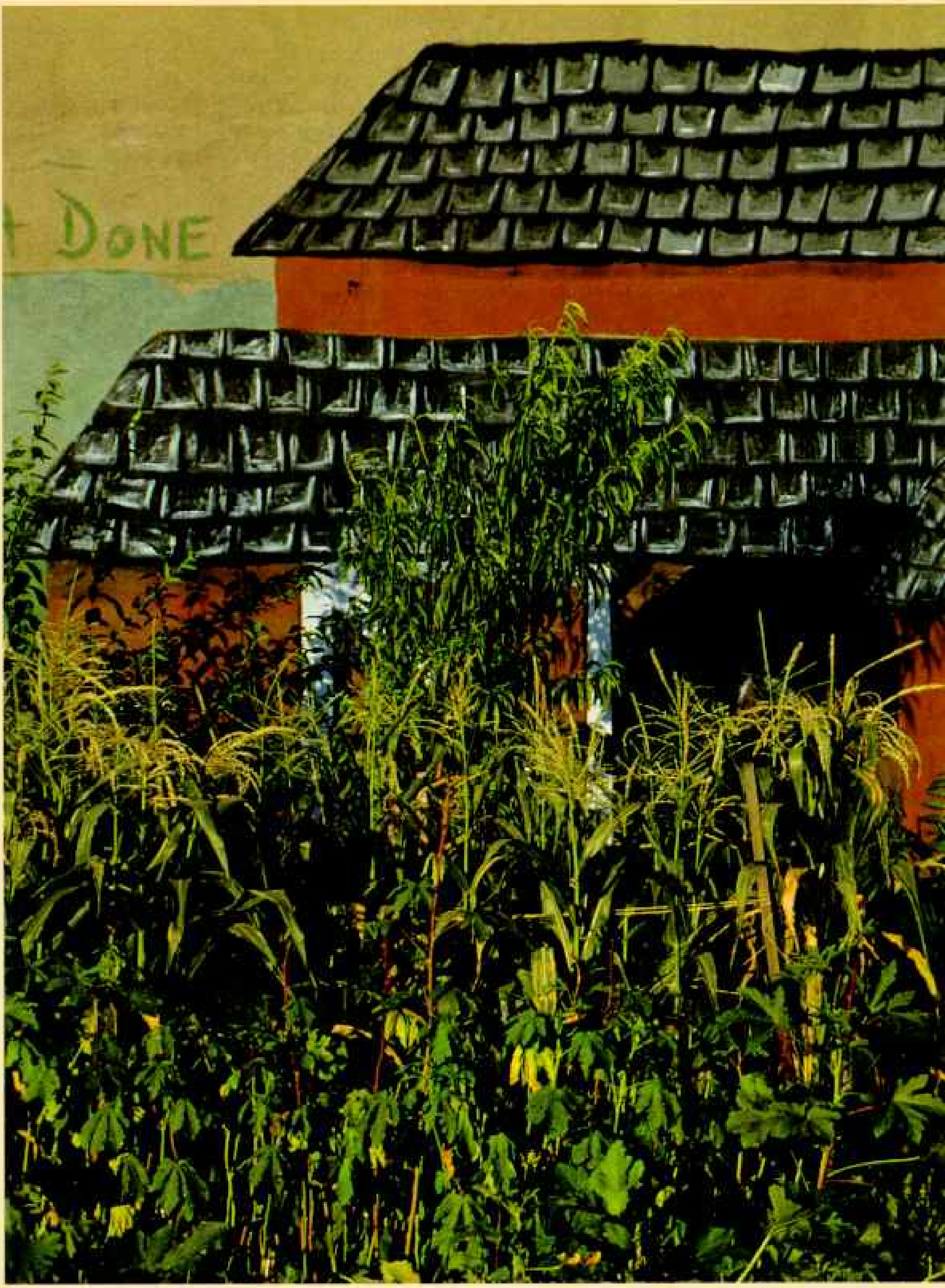
For whatever other reasons, gardening has grown in the nation because it has reached out to tap into the vast pool of baby boomers, the generally well-educated and health-conscious men and women who were born in the two decades following World War II. They are of that age now where the garden offers reassurance and continuity. Many are in their 40s—years enough to appreciate deeply the genius of life and growth in the soil.

Born in 1947, Ed Perlman is of that generation, but he is not new to the soil. He has earned all the merit badges for good gardening, and now, being particularly skillful at growing plants in containers, he prepares such exotica as blooming pelargonium topiaries for use as Christmas decorations at his home in Washington, D. C.

For his talents Perlman has had to pay a price of time, and that, he



The good earth of Idaho yields Sunset variety potatoes for seed-company owner Jan Blüm and colleague Ed Dutton. He slices open a Peruvian Blue potato (below), one of the company's heirloom plants—old, rare varieties handed down by families over generations.



The corn is high at Aspen Farms, a 1.5-acre oasis in West Philadelphia, where a mural painted on an abandoned warehouse adds a bucolic touch. More than 350 such community gardens

flourish under the Philadelphia Green program. Furnished with plants, tools, and advice, inner-city residents spruce up neighborhoods while raising produce to eat, sell, or give away.

declares, is the way it must be. "The worth of a garden and a person as a gardener cannot be judged in a season or even two seasons," he said. "It takes years."

He's right. Gardening does remain an unalterable commitment to time and patience. For the six clematis vines, alone, in my garden I have pursued perfection for five years, to make them hold over the fence as clouds of soft color. The artemisia along the edges of my lily pond have started to mound as they should, but it has taken three years of careful midwifery—three years of dirty fingernails, bending, stooping, and aching knees. As for the geranium Wargrave Pink, it has taken to its place in the garden with no greater speed.

So I have learned that for all the wondrous birthings in the wormy cradles of the soil there are failures and disappointments. The impatiens bloom, certainly, and bloom until they die when summer dies, sick to death by then (I say) of their own megawatt colors. But it takes more than just a while for a garden to develop form and character, to touch the souls of those who walk there.

Eye and palate are catered to in the garden of Hanneli Reeves. In the backyard of her Mendocino, California, home, she picks an edible nasturtium flower. Reeves literally makes gardening an art. A shallow bed hung on a fence sprouts a design of succulent plants called hen and chickens, held in by chicken wire.

In nearly 75 million American households there is someone who gardens—impelled, says horticulturist Anthony Huxley, by "that contact with the green wild world that seems to be an instinctive need."

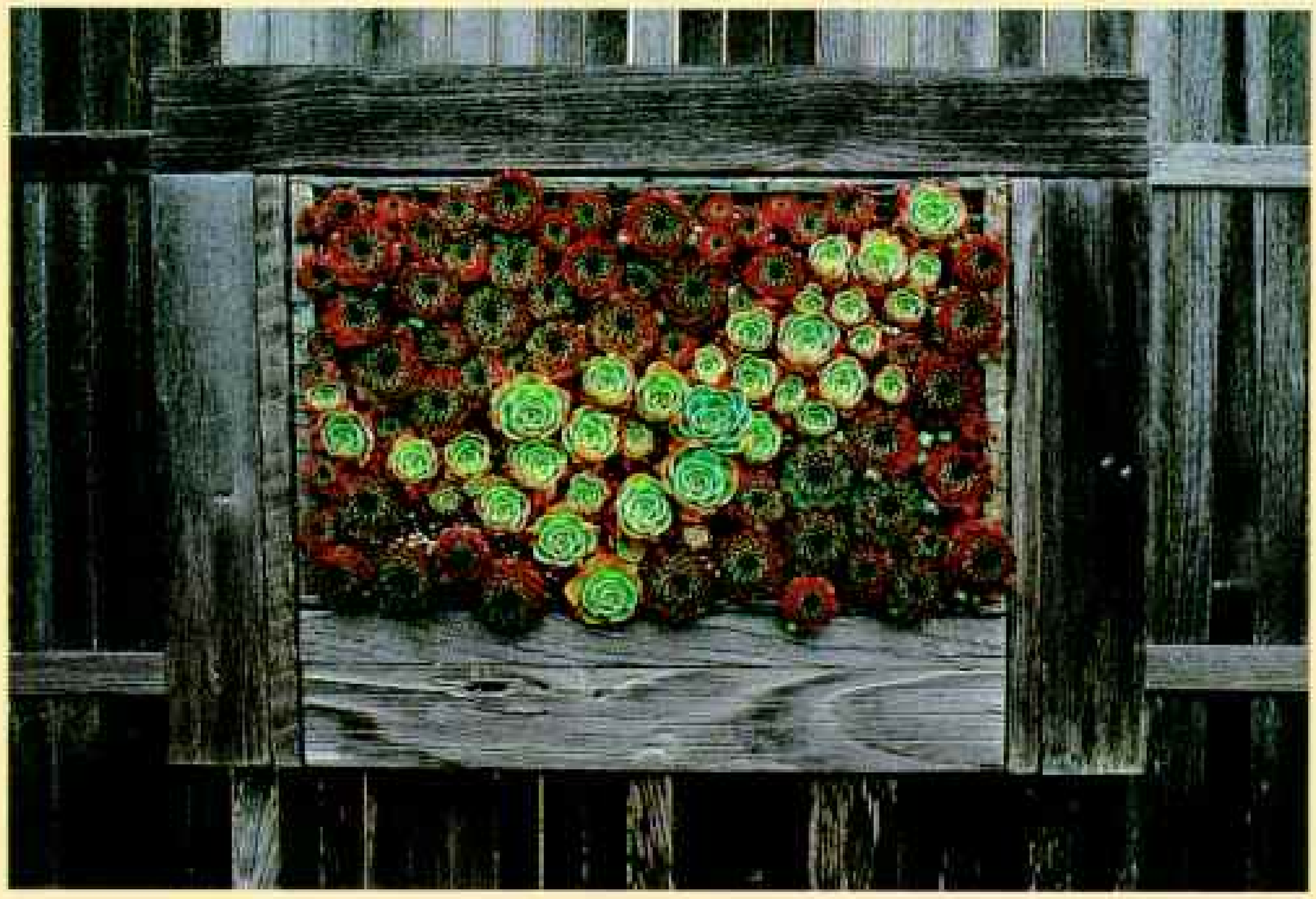
SAM JOHN PASSARELLA has plenty of time. As a prison inmate in Tennessee, convicted of charges involving assault and kidnapping, he has served 11 years of a term extending into the next century, but he gardens now and says he doesn't give much thought to his "red date," or scheduled release, in 2013.

"I don't even care that much about getting out as long as I can continue to work with flowers, especially roses," he said. In his mid-40s, Passarella still has the face of an acolyte, but he weighs more than 400 pounds, and when he moves, it is like the docking of a ship.

We walked in single file through narrow aisles of a greenhouse at the Middle Tennessee Reception Center in Nashville, a holding facility for prisoners awaiting transfer to other institutions. Passarella recited the names of the plants as we passed through, and when he came to a bench where there were rose cuttings taking root in containers, he said almost in awe, "Look at that; we're bringing life into the world."

His title is head gardener at the center, and he said he is learning something new every day—about composting ("It's amazing") and deadheading and pH factors and more. And he told me he stands ready to swear by all the saints that the plants have made a changed man of him.

The concept of calming the beast in a person through gardening is not new in this country and is even older in England (the fair-minded will concede the preeminence of England in all matters of the garden). It has long been known that being around plants can be of significant benefit to the physically and mentally disabled and to older persons and inner-city youngsters turned surly.



"Once you start looking at gardens and gardening as they affect people, you find a powerful tool," said Charles A. Lewis of the Morton Arboretum in Lisle, Illinois, an authority on the relationships between plants and people. "In the process of gardening one becomes very personally involved. You become aware of larger forces in the world than man-made ones."

"Almost every plant carries a story of its discovery," says Joanna Reed, who continues to garden and stitch her crewelwork despite bouts with arthritis. Now in her 70s, she has scoured the region for wild varieties that accent her renowned 17-acre country garden near Malvern, Pennsylvania.

The loss of his legs to a circulation problem doesn't stop Eugene Braden from tending his cabbage in Ypsilanti, Michigan.

AT VIRGINIA POLYTECHNIC INSTITUTE and State University in Blacksburg, Diane Relf of the Department of Horticulture said that stress levels rise and fall in relation to the proximity of plants. "In a public area where there are no flowers, there often will be more litter than where, say, some marigolds have been planted," she told me. Citing a study of patients in a Pennsylvania hospital, she said that those in rooms with views of outside greenery recovered from surgery more quickly than those who had windows facing walls. They were also more civil to the nurses.

For all that, only in recent years has horticultural therapy gained standing among the therapeutic sciences. One university, Kansas State, even offers a four-year degree in the discipline.

In the detention facility at Nashville, selected inmates attend classes and work in the greenhouses for a period of six months. The supervisor is Jeff Philpott, a young vocational horticulturist, and every weekday he stands before them for 90 minutes to explain the workings of plant life.

"I've had people in here with third-grade reading levels, and I've had college graduates," Philpott said, "and all of them are amazed when they find out how essential plants are to the existence of us all."

When they discover that by using good gardening practices they can sustain the life of something so decent as, say, a lily of the valley heavy with scented bells, it follows that all but the hardest of them will feel better about themselves and the world. (Still, prison is prison: Regular gardening tools *could* be fashioned into weapons, so unsupervised inmates dig in the pots and raised beds with small plastic eating utensils.)

The inmates in the class completing the course arrived at the prison basketball court and sat under signs that read "Don't Dunk." Each received a diploma, and the ladies of the Tennessee Federation of Garden Clubs served food, having put the chicken wings and other dishes through the metal detectors at the entrance. The federation strongly supports the program; one member, Charlotte Branstetter, proposed the idea in 1986.

On the other side of the country Cathrine Sneed Marcum has developed a horticultural program for inmates at San Francisco County Jail No. 7, with provisions for continued participation upon release.

There is a greenhouse and 12 acres of gardens at the jail where inmates

An autumn medley of produce ripened under the care of the Israel family, self-described "flower children" with roots in the 1960s. The Arlington, Washington, spiritual community cultivates an

eight-acre organic garden that feeds its hundred members. Sales of such products as herb wreaths, garlic braids, and green salads have helped make the group nearly self-sufficient.

grow food for soup kitchens. "Knowing what it is to be hungry, they take joy and pride in that," Marcum said. When released, former prisoners can grow fruits and vegetables at the garden that Marcum established behind the Just Desserts bakery, some of which the bakery buys.

As for the healing value of working in the soil, Marcum credits that for the remission of the illness that has threatened her own life. She said it was the therapy of the garden that gave her the strength to survive.

There are now more than 700 members of the American Horticultural Therapy Association. Among them is Nancy Easterling of the North Carolina Botanical Garden in Chapel Hill. In those pleasant and piney surroundings is the Learning Garden, where bumblebees hang upside down in the air to get to the bashful flowers of a giant Solomon's seal *(Polygonatum commutatum)*. The garden is Easterling's creation, and sometimes children come here from the psychiatric ward of a local hospital to learn about plants and soil and to help heal their illnesses.

"What the Learning Garden can do," said Easterling, "is add a little bit of structure to what these children see all around them. When they enter here, they feel like it is their place, their world." Youngsters go there to feel and smell, and sometimes to try to pet the worms. There is usually one among them who discovers that a blade of lemongrass held between the thumbs makes a good whistle.

Coaxing bouquets from the soil boosts the self-esteem of an inmate at San Francisco County Jail No. 7. Lest metal tools become weapons, an inmate at the Middle Tennessee Reception Center digs with plastic.

Gardening can soothe prisoners' violent impulses and instill a newfound reverence for life.

IN PHILADELPHIA Martha Straus of Friends Hospital works in the greenhouse with men and women with emotional problems, as well as with alcoholics and drug addicts ("What a place to grow pot," said one). Friends Hospital, opened in the early 1800s, pioneered horticultural therapy; it was the first in the nation to have a greenhouse for use by patients.

The treatment rooms where Straus works are heavy with floral smells, and that itself is part of the therapy. "Smell is one of the senses that have the most impact on you," she said. "It keys memories such as those of associating with flowers as a child, being with your mother or grandmother in the garden when they planted pansies, feeling the pansies brush against your hand, and remembering they were like velvet." Such memories serve well to help rid the patients of their demons.

Gardeners in America are going to their memories more than ever now, and that is being reflected in the rising interest in heritage plants and seeds. "Take tomatoes," said Kent Whealy. "Gardeners want them to be as flavorful and as tender as they can be, and they want tomatoes that produce over the whole season instead of coming ripe all at once. Many of the older varieties are vining tomatoes that continue to set fruit at each node and continue to grow all season long."

Whealy's business is saving the seeds of the vegetables grown in this country before hybridization was started by large commercial growers—before ethylene-gassed market tomatoes put a grimace on the face of America.

Those were times when old gardeners in rural places grew Dad's Mug tomatoes and Albino Bull Nose peppers. They grew spiny Cow Horn okra that *itched*. Some seeds were passed on, but many were lost when the growers died. In addition, the seed companies dropped many plant varieties from their catalogs as hybrids took their place. Of the great number of varieties of vegetables available in this country at the turn of the century, more than 80 percent have been abandoned. Many plantsmen are seriously concerned about the loss of this unique and valuable gene pool.*

In 1975 Whealy and his wife, Diane, founded the Seed Savers Exchange as a means of preserving what old-time vegetables remain. Now there are seeds for 2,500 different varieties of tomatoes in the bank of the exchange, along with those of 600 varieties of potatoes, 700 peas, 2,400 beans, 500 peppers, 400 types of lettuce, and much more. Seed Savers is located on the 140-acre farm where the Whealys live, near Decorah, Iowa, a pleasurable town not far from where the Mississippi runs. About 1,200 varieties of vegetables are grown there for seeds each year, thus ensuring a continuing supply.

Many of the seeds were brought to this country by immigrants from Europe. Diane Whealy's grandfather came from Bavaria, and not long before he died, he passed along three varieties of seeds—a pink beefsteak tomato, a fast-growing prolific pole bean, and a purple morning glory with a red star in its throat—to the Whealys. It was then they decided to devote their time to preventing such gardening heirlooms from being lost forever. And they have done that so well that in 1990 Kent Whealy was named a winner of a $275,000 MacArthur Foundation "genius" award.

There is now a network of some 5,000 gardeners around the country who join in the activities of the exchange. In summer, when roadsides are drifted with Queen Anne's lace, hundreds travel to the Whealy farm to hear talks on gardening and to swap seeds. They sit on folding lawn chairs by their trucks and cars. John Amery was there with two buckets full of soybeans.

"I got these from a minister in Indiana," he told me. "As you can see, they are mutated. The minister claims that was an act of God. Mutation or not, they're low in oil, good for eating, good for tofu. Take some."

Of all the rare seeds perpetuated there, one is unique. It is called the Mayflower bean, and it has trailed through the history of this country for close to 400 years. No other seed in the Whealy's collection has a documented family history going directly back to the *Mayflower*.

Over the years, as immigrants introduced new varieties into the rich soil of places like southwestern Virginia and the Delaware River Valley, the beets and potatoes became rounder and smoother. In 1870 a new tomato appeared in Ohio; the skin was flawless and of a deeper red than ever seen before. And one Calvin N. Keeney of New York State developed the first stringless snap bean (the snapping of beans in the kitchen, the Velcro-like ripping of corn being shucked—ah, those are the ruffles and flourishes of Americana).

Lush greens by the armful and the play of her nephews reward Betsy Hall in the Telluride Institute's Mountain Garden, at an elevation of 9,400 feet. As a gardener for the small think tank, Hall tests plants and procedures that boost quality and output in brief high-altitude growing seasons.

The institute's watchword is "sustainable agriculture"—organic methods that enable the land to yield crops without harmful chemicals or wasteful irrigation.

IN FEW PLACES has the tradition of gardening remained as strong as it has in eastern Pennsylvania, particularly in the area around Philadelphia. Longwood Gardens is there, near Kennett Square. It was in 1906 that Pierre S. du Pont, who would later become head of both the Du Pont Company and General Motors, purchased the site where Longwood now stands and began the development of the gardens.

And it is all still dazzling with the many fountains, conservatories, and

*See "The World's Food Supply at Risk," in the April 1991 issue.

perfect displays of perennials and annuals. To many gardeners of merit, there is no garden in this country more splendid than Longwood, nor flower show more complete than the one held in Philadelphia each year.

Less than 30 miles north and a little to the east of Longwood is the town of Malvern and a farm called Longview. Joanna Reed, who is 75, maintains a country garden of flowers, shrubs, and trees there. It is a garden to which other gardeners come for inspiration.

Having evolved over the past half century, the garden does much of the work itself. "If the plants like it where they sit, they will seed themselves," she said. "So much happens on its own in this garden. It's not an inanimate object. It's not like a painting even. When you stop painting and go back to it, it's right where you left it. But you go back to your garden and you find it's moved on, you know. It's developed on its own."

Joanna Reed sometimes goes into her garden at six in the morning and does not come out until dark. Someone once put a pedometer on her to measure the

distance she covered during a day among her plants; the reading was 18 miles. She walks and works there amid an exuberance of plantings, seemingly of effortless placement but of impeccable flow and balance. There are orange poppies and silken lamb's ears *(Stachys byzantina)*. Basil is in residence here and there, and throughout the garden are different cultivars of salvia with flowers in spikes and panicles of blue, pink, pale yellow, and white.

Past a ferny place where rhododendrons grow, we came to a katsura tree *(Cercidiphyllum japonicum)*, and she told me it is one of her favorites in all the garden. "In the winter," she said, "it has all this tracery that makes it look like an etching. In the spring, as the leaves bud out, it's just a glow of

rosy mauve, and then it's beautiful and stately all summer. In the fall the foliage turns into apricot and smells like cinnamon. Now what more could you want from a plant?"

Parts of the garden sit so low that rainwater would collect if not for the tunnels dug by moles and voles. At the edge of it all is the Pennsylvania Turnpike, where trucks and cars whoosh by. It has been that way since 1951 when the road opened, and by now, I suspect, Mrs. Reed has come to accept the traffic as no more troubling than the insistent spread of fleabane with its flowers of crystalline white.

In Philadelphia, gardens now flourish in many parts of the inner city. Flowers and vegetables grow on what were empty lots strewed with the flotsam of crime and despairing lives. It is all part of Philadelphia Green, a program of community outreach sponsored by the Pennsylvania Horticultural Society.

"Understand, greening is not the be-all and end-all of a neighborhood turning itself around," said J. Blaine Bonham, Jr., executive director of the project. "But it has proved vital in rekindling people's spirits and a belief in their neighborhoods, including North Philadelphia, one of the most devastated urban areas in the country."

Bonham and his staff of 35 work with neighborhood residents who want to start a community garden. In addition to guidance and technical assistance, they supply the plants, gardening tools, fencing, and soil for raised beds. There is a waiting list of between 400 and 500 requests to establish a garden.

The New York Botanical Garden sponsors a similar program in New York City called Bronx Green-Up. The program reaches deep into the borough, with 150 lots in cultivation, including one near 182nd Street and Prospect

Nearly too lovely to eat, a "wild and edible salad" produced by the Israel family features blossoms atop greens from nearly three dozen plants.

In Camden, Maine, Stephen Huyler is a lord of the leaves and his wife, Helene, a water lily fairy at their annual Midsummer Night's Dream party. The gathering celebrates their garden of more than 2,000 species.

Avenue called the Garden of Happiness.

There was a man at the garden who said that his name was Robert Smith and that he was raised in North Carolina. He was growing collard greens. There was Maria Oreiz from Puerto Rico, and her crop of vegetables included cilantro, an herb favored in Hispanic dishes. Also gardening there was a man who looked older than his years; he was short and wiry, and he blew ashes from his cigarette before cutting a huge eggplant in his plot and holding it over his head like a tennis champion with the Wimbledon cup.

"Before, there were weeds here, as tall as you, and the drug dealers would hide in them when the police came," Austin Jacobo, a leader in the community, told me. "There were junk cars here too, and old refrigerators. But now look. It's like beauty in the morning. You know beauty in the morning? It's something good. That's what the garden means to us. Something good."

Terry Keller is a woman with a certain patrician presence, yet she seems at ease on a street in the Bronx where two sneakers with laces tied together dangle forlornly from an overhead utility wire. She is in charge of Bronx Green-Up, and sometimes it seems to her that she has to fight for every step of progress. Pointing to a section of broken sidewalk near a garden, she said, "I have a commitment from the city to fix this, but I had to shame them into doing it. I had to say to them, 'There are wonderful sidewalks where rich people live, so how can you allow this?' "

Nature's way has few champions as ardent as the Rodale Institute, custodians of a 333-acre research center near Kutztown, Pennsylvania.

Frowning on pesticides and chemical fertilizers, Rodale once was mildly revolutionary. Its organic gardening practices now are common, promoted through a successful health-oriented publishing house. "The mainstream is now flowing our way," comments one official.

She knows, however, that the program is a big success. The gardens are becoming social centers where the prevailing atmosphere is one of pride and tolerance and hope. "It's good not only for the people who participate but also for those who just walk past the garden and look in," Keller said. "But right now I'd give my right arm to have someone give us $10,000 so we can buy the soil we need for one year."

The program is in danger because of deep cuts in municipal funding of the Botanical Garden. For more than a century that great museum of plants and trees across the street from Fordham University has provided inestimable benefits to horticulture in America. It is a refuge sought out each year by 500,000 visitors. There are people living in the Bronx who have been escaping

to the Botanical Garden for relief and renewal all their lives. Sometimes they come to spend a few hours in the warm, glassed-in old Victorian conservatory, and sitting there, close to where orchids bloom beside waterfalls, they dream of having gone to Florida for the winter.

THERE ARE GARDENS to be found elsewhere in New York City, even in the high reaches of Manhattan's towers. Keith Corlett designs terrace and roof gardens, but sometimes the views are such that it is best to close the garden off and let the pleasure flow from within. He does that with vines such as wisteria, set to grow vertically and overhead, and with evergreens. All are planted in heavy containers. In high-rise gardening, consideration must be given to the substantial weight of moist soil and to temperature differences 20 or 30 floors up, and—it is no small matter—the freight elevator had better be working.

Keith Corlett, who was born in England, is clearly a man in love with New

York. He despairs of those who complain that the city "is not what it used to be." To that, he replies, "New York never was what it used to be."

Still, the city garden on the terrace is cherished mostly for the anti-urban embrace it provides. It is a benediction of peace and well-being, and it falls not only on sophisticated gardens in the sky but also on the one in Portland, Oregon, where Geraldine Hayes has planted snapdragons in front of the house—in old automobile tires painted white—and vegetables in the back. Of the peas, she said, "They upped nicely this year."

It falls too on the mistress of a 12.7-million-dollar mansion on the East Coast, who must move because her husband is bankrupt, a victim of the recession. We walked together over the great sweep of lawns, through the gardens, and along the lake bordered with yellow irises. She said that of all the things that must be sacrificed now, she will miss her plants the most. "Jewels mean nothing to me any more. Clothes mean nothing. But the gardens do."

Bill Rogerson, a sweet-natured man, is not so introspective about his gardening. He goes about it as a prizefighter training for a bout. The idea is to grow big, to set records for weight and size, to come up with melons and squash that put all others to *shame!* He holds the record for a cantaloupe that came in at 59½ pounds, "bigger than a basketball," and has grown a 279-pound watermelon.

"People see my name in *The Guinness Book of Records*, and they write asking for my autograph," he said. "Ain't that sickening?"

We were about to set off in his pickup truck for a place on his farm in Robersonville, North Carolina, where, he promised, I would see something I wouldn't forget.

He told me of collard greens 89 inches tall and an ear of corn more than three feet long. His peanuts grow to four inches.

We came to a place far off the main road, a clearing the size of a tennis court. There was something in the middle of it all, camouflaged with boughs and leaves, and I had thoughts of a gun emplacement. There was a single vine, a huge thing with no end, it seemed—one, I later learned, that grows a foot and a half overnight.

It was not without a certain dramatic flair (and a smile of devilish shading) that Bill Rogerson then brushed the cover away to reveal . . . a pumpkin, the biggest pumpkin I guess the world has ever known, a pumpkin that, but for the want of a fuse, would

A scouting trip to Russia by High Altitude Gardens yielded pungent red nuggets known as Grandpa's home pepper (below, at right), grown indoors year-round on windowsills in Siberia. The Ketchum, Idaho, firm trades in seeds of regional plants such as Great Basin wildrye, at left, and a herbaceous flower called silky lupine.

likely be banned by international agreement, a pumpkin that weighed. . . .

He wasn't ready to say. "It has a way to go yet," he told me as we drove off to see one of his five-pound tomatoes.

ROGERSON'S VEGETABLES are artistry in size, and at this time of horticultural resurgence others are making their mark on artistry of form. Just as there are superstars of architecture and interior design, so too are there leaders in garden design. Among them are Ryan Gainey of Atlanta, Georgia, James van Sweden and Wolfgang Oehme of Washington, D. C., Edith Eddleman of Durham, North Carolina, and Ann Lovejoy of Bainbridge Island, Washington.

They and others are giving the garden in America a new identity. They're bending the rules, and the results are something to see. There is most of all a new kinship between the plantings and the site. Plants native to a place and many varieties of ornamental grasses promoted by van Sweden and Oehme are given heavy play. Even the lowly hydrangea wears a new respectability.

Edith Eddleman caught national attention with her design for a perennial border emphasizing native species at the North Carolina State University Arboretum at Raleigh. She began her work in 1983, gradually bringing life to the mammoth bed (300 feet long and 18 feet wide) that was as striking and innovative as anything on the American scene. When she finished, it was a border with one thing or another in bloom for ten months of the year.

Today she does not set out with any preconceived effect in mind. "In designing a garden," she said, "I start with one plant, then I connect other plants to it, and other plants to those. It's an organic thing. I like to think of myself as a plant chemist."

It is not so much color that Eddleman strives for with her designs, although she certainly achieves that, but rather how a plant stands, how it is shaped and textured. She may start with a yucca, spiky and sharp as a sword, and end with the soft yellow button-like bloom of Moonbeam coreopsis, but there are no jarring transitions in the middle, only friendly foils.

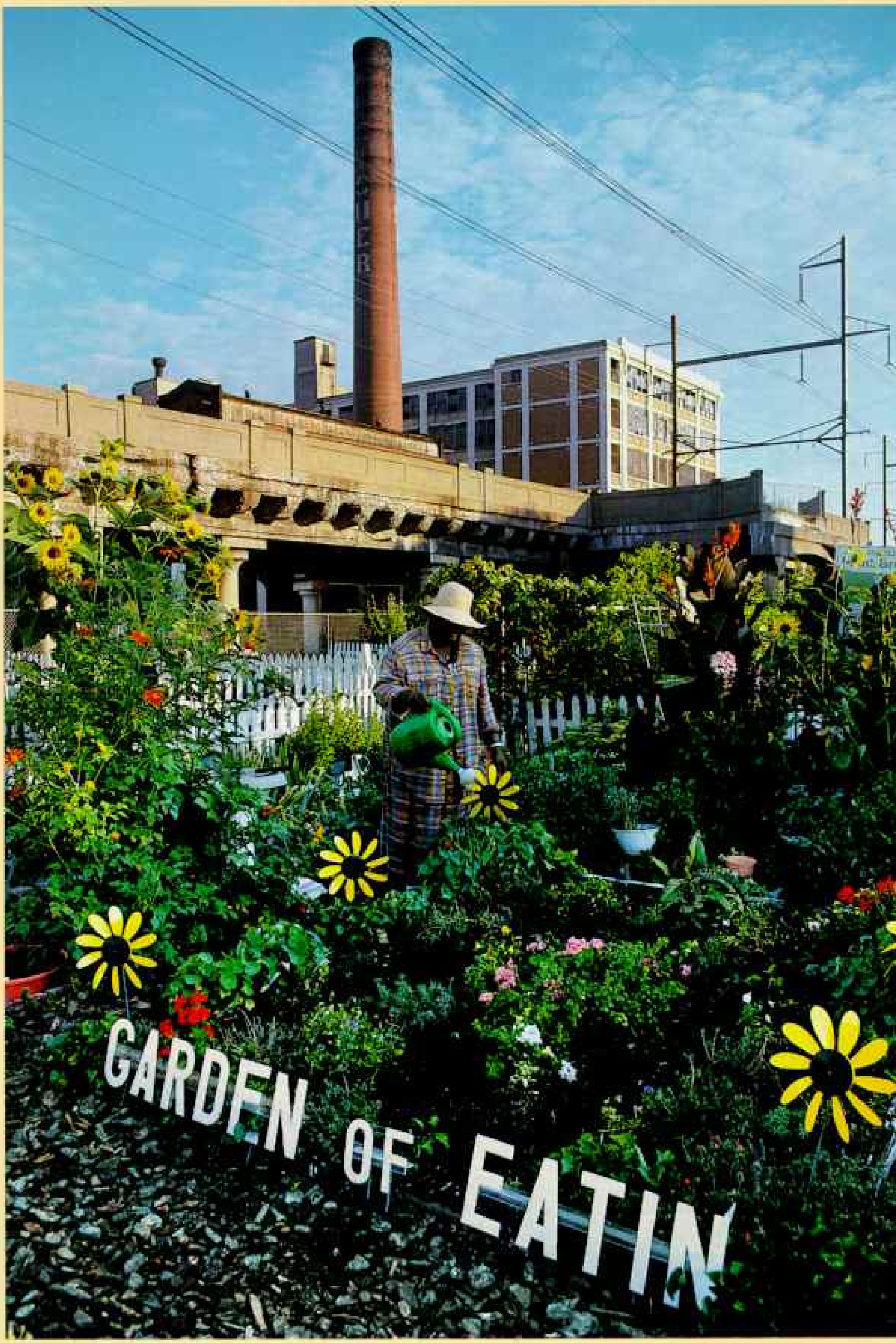
Farther south Ryan Gainey is much in demand as a garden designer. He is a romantic, and to him design involves not only the garden but the house and other surroundings as well. Indeed, I was along

Vigilant protector Robert Sacilotto examines the "beautiful and amusing" insect-eating pitcher plants he grows by the thousands in Stanardsville, Virginia. To help fund a preservation project, his nursery distributes a dozen varieties of the plant, which has dwindled along with its wetlands habitat.

A sweet, thick-skinned watermelon grew from red seeds found by Arthur Combe in 1921 in an Indian cave in Arizona. Alycia Walsh, Combe's great-granddaughter, holds a descendant.

The austere harmony of a Zen rock garden gets painstaking grooming at the Bloedel Reserve, a 150-acre sanctuary on Bainbridge Island, Washington. Replacing a swimming pool on the

formerly private estate, this place of contemplation is part of a larger Japanese garden designed, in the words of reserve director Richard Brown, "to inspire and to refresh the human spirit."


GARDEN OF EATIN

when Gainey visited a wealthy client in an Atlanta suburb to advise her on what colors to use for painting her house. He did not want the structure to clash with the garden.

"It's all very important, and it has to be all woven together," he said. "I mean the combination of plants, trees, grass, light, air, space, garden decoration. And the patterns, the stones, realizing where the sun's going to come in the wintertime. It is all very much a *tableau vivant*. It changes with the season, and it changes with the way the wind might do something, or the way the sun might catch something. It is a combination of that which is living and that which is still life. It is gardening, and it is the most complex form of artistic expression there is."

SUCH SERVICES AS GAINEY PROVIDES are not for the poor, not even for the average gardeners of today, who do not aspire to peacocks on the lawn or formal groupings of box (the reference is to boxwood, but in elitist garden circles it is considered loutish to use all the word). They are concerned more with the garden as a personal thing and as a statement of environmental concern.

Americans dump 69 million pounds of pesticides on their gardens and in their homes each year. As much as a tenth of the urban water supply has been tainted by the chemicals.

But the trend now is to organic gardening and biodegradable materials. New-wave gardening demands old manure. Photodegradable plastic mulches are being developed that change color with the seasons. They are dark in spring to absorb heat, then lighten to reflect intense summer sun. Scientists are testing an alternative to chemical sprays and powders: genetically engineered pesticides in which bacteria that are dead but toxic to insects are sprayed on plants.

Ann Lovejoy, a leading writer on gardening subjects, told me she never uses chemicals in her garden in Washington State. "If something is so sick that you need chemicals, throw it away," she said. "What sense does it make to poison something to grow something else?"

To all that, the rose grower is likely to say yes, but what of the aphid? What of the black spot and the mildew and all the other curses laid down on the most beloved of flowers? How are they to be controlled, short of chemical warfare?

Rusting cans and old tires covered a vacant lot in the Point Breeze neighborhood until its transformation by the Philadelphia Green program. The Gray's Ferry Avenue garden yields cabbages for Dominique McConnell and her aunt, Mattie Robbins, who cans much of her produce.

There is an answer, and more and more gardeners are seizing on it. They are planting old-fashioned, disease-resistant roses, including those that grow as shrubs and those that take to a trellis or a wall like Spiderman. The incomparable scents of those roses are being rediscovered, and for the gardener now of an age to remember, it is a return to a time when it seemed that Old Blush bloomed in every yard.

There is a place in Brenham, Texas, called the Antique Rose Emporium,

and the man who runs it, Mike Shoup, is a rose rustler. He goes around the Texas countryside taking cuttings from antique roses he finds in cemeteries and in fields where houses and other buildings once stood. He finds them in most any place touched by the history of early settlement in the Southwest. For all its violence and hardship the frontier in America was not without the sweet bloom of roses.

"We have collected about 500 varieties of old roses," Shoup said, "and we offer about 220 in our catalog. One probably goes back to before the time of Christ, having survived through cuttings taken through the years."

The settlers came with their cuttings, sometimes stuck in potatoes to keep them moist. They would grow in the soil of the new places and serve as a reminder of the old. One called Harison's Yellow was brought from New York and came to be, some believe, the "Yellow Rose of Texas." As Shoup said, "Roses are beautiful, and you have the bonus of history."

We were on a road where the dust flew gray and gritty, and we came to

A kaleidoscope of tomatoes displays 11 of some 80 varieties grown by Chino Nojo, an upscale truck farm in Rancho Santa Fe, California.

Artfully grown Japanese red mustard and other salad greens are gathered at the Center for

Seven Generations in Occidental, California. Financed by the philanthropic C. S. Fund, the center donates vegetables and cut flowers to people with AIDS.

Addie Breedlove's house, to where the soil is so poor that her front yard is without a blade of grass. But she sweeps the dirt lightly and rakes it for a nice pattern, and says she can't do it much longer because her shoulder has been bothering her since she drove the horse that pulled the plow. She is 91.

What Mrs. Breedlove does have in her yard are some roses that are at least 150 years old. She doesn't spray them, and yet they are healthy and the perfume remains strong. There are China roses among them that flower so fully and so fast that they are rarely seen when not in bloom.

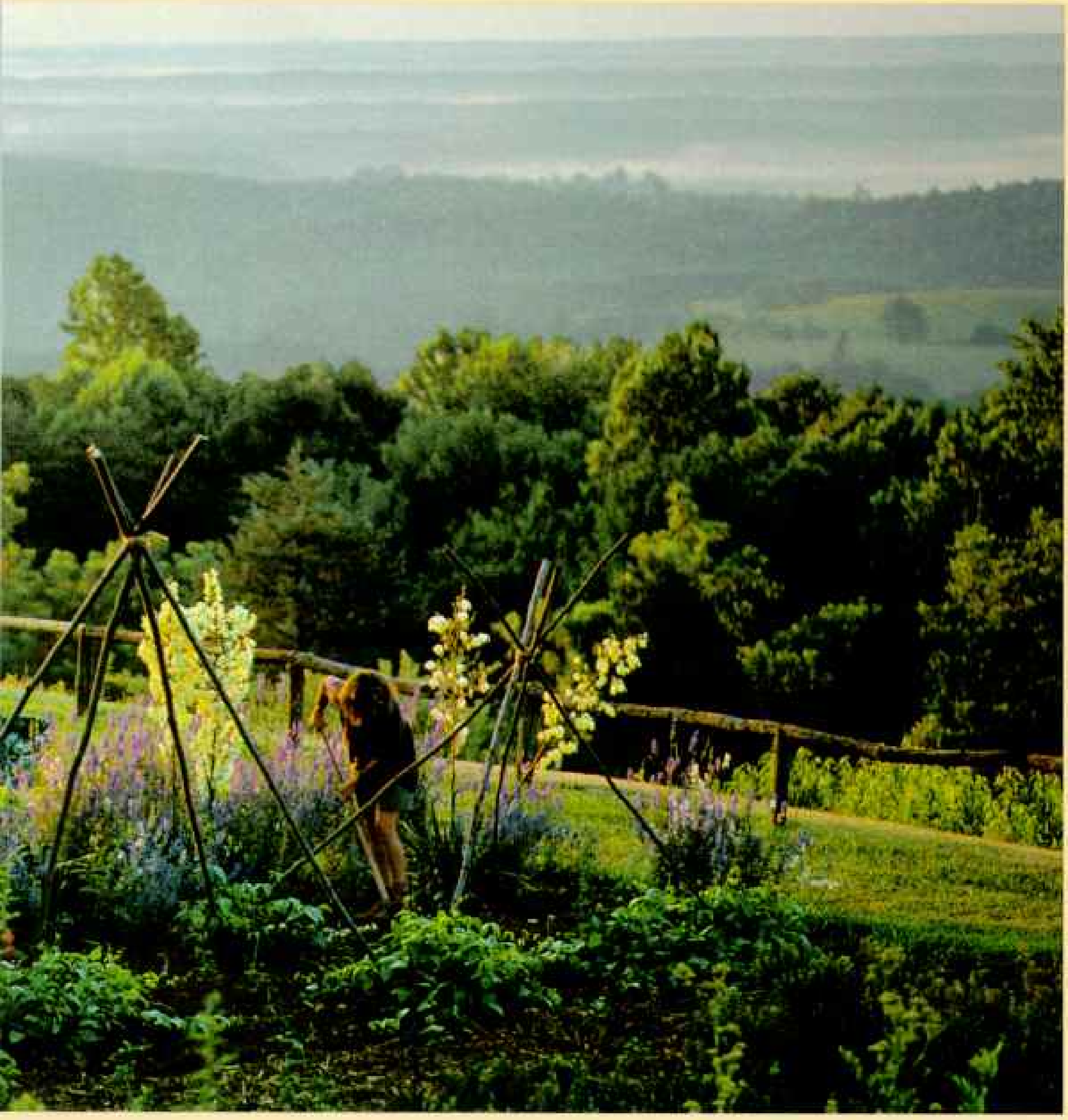
"The Man up there," Addie Breedlove said, pointing to the sky, "told me just as certain as I'm talking to you, he told me to get outside or else

Masterful at gardening as well as statecraft, Thomas Jefferson tended plants from the Old World and the New. His garden at Monticello, restored in the 1980s, was his passion. "No occupation is so delightful to me," he wrote, "as the culture of the earth."

I'm going to die in this house. So I get out and work with my flowers, and, *whooee*, I tell you I like that."

In one form or another, hundreds of thousands of Americans are expressing the same sentiment. Dan Barker is so fond of gardens that he gives them to the poor in Portland, Oregon. He goes to their houses with frames for raised beds and makes a garden, putting in soil and leaving seed or plants and fertilizer. Some years after serving in the Marines in Vietnam, he was robbed at gunpoint. He resolved then "to alter the social environment." With his Home Gardening Project, partly funded by the federal government, he feels he is doing that.

"When I give someone a vegetable garden, he or she comes to understand compassion and so do their neighbors," Barker said. "In addition, the vegetable garden gives them self-esteem and self-reliance. Their health and well-being are improved. It works."



Gardening doesn't end with the coming of winter. There are the catalogs to read—Park Seed, Wayside Gardens, White Flower Farm, and all of the others that attracted eight million households to place orders in 1990. There is, for example, Smith & Hawken with its offerings of very good but pricey tools (with handles of ash "that are warm to the touch"). The financial history of the California company might serve as a metaphor for the great rise of interest in gardening over the past dozen years. In 1980 the firm's business amounted to $40,000; today the figure is 75 million dollars. Paul Hawken, who runs the company, believes the gardening rage will continue: "Nothing will change it. Not advertising, not anything I do, not anything you do. It's just the natural process of 76 million baby boomers getting older and settling down."

That's it.

They're north and south, east and west, everywhere there's earth to grow—middle-aged and halfway home, and digging like there's no tomorrow. □

GEORGIA FIGHTS

By ANGUS ROXBURGH

Photographs by TOMASZ TOMASZEWSKI

FOR NATIONHOOD

A bust of native son Joseph Stalin takes an honored place at a dinner in Georgia, a new state made of hope and civil war and paradox—where one faction's democracy is another's tyranny.

Old enough to remember, young enough to hope, 87-year-old Dimitri Bostoganashvili savors the rebirth of freedom after casting his ballot last May in local elections, among Georgia's first democratic elections in 70 years. Here in the village of Zemo-Machkhaani, and throughout the nation of 5.5 million people, long-outlawed national flags were pulled out of mothballs as Georgians attempted to pick up where they left off in 1921, when three short years of independence ended at the hands of the invading Red Army. Though the Bolsheviks had promised a workers paradise, what they delivered was a new form of Russian imperialism, hard on the heels of 117 years of autocratic rule under the tsars. Unrelated to the Slavic Russians, Georgians speak a distinct Caucasian language, written in a unique alphabet.

On the high slopes of the Caucasus Mountains, shepherds seek summer pasture for the huge herds of sheep they have driven as far as a hundred miles from Georgia's eastern steppes. Despite its formidable mountain barriers, Georgia endured scores of invaders through a tumultuous history that also included moments of glory and greatness. At the end of the 12th century, under the legendary Queen Tamara, a powerful Georgian kingdom ruled much of Caucasia. Beset by Persians and Ottoman Turks from the 15th century on, a much fragmented Georgian nation increasingly looked north of the Caucasus to its mighty Russian neighbor for protection. Under Tsar Alexander I, most of Georgia was gathered piece by piece into the Russian Empire early in the 19th century.

"YOU WILL HAVE TO BREAK the wings of this Georgia!" declared Joseph Stalin. "Tear them apart!"

With these words the Soviet dictator vowed to smash the "hydra of nationalism" in his native Georgia. Today communism is dead there, and the country, one of the smallest former Soviet republics, has finally achieved the independence it dreamed of during 70 years of Soviet rule.

But instead of jubilation, anguish filled the Georgian capital of Tbilisi as 1992 began. Along Rustaveli Avenue, which I remembered as a leafy street where citizens took evening strolls, the way was blocked by burned-out tanks and buses. Georgia's first popularly elected president, Zviad Gamsakhurdia, had been ousted from power by sheer force, proving that it is easier to break away from the Soviets than it is to start a new democracy. Gamsakhurdia had won the hearts of many of his people by leading them out of the Soviet Union, but he had since squandered the good will by stifling dissent and silencing his opposition.

"To call Gamsakhurdia a fascist is probably going too far," said Nodar Natadze, respected academic and leader of one of numerous political groups. "But he did lack democracy, and he effectively replaced communist rule with his own one-party rule."

In the struggle for power at the beginning of 1992, more than a hundred Georgians died at the hands of fellow Georgians. National Guardsmen who ousted Gamsakhurdia claimed power under a quickly organized military council, which promised new elections and a fresh try at democracy. The council even declared it would welcome the return of one possible candidate for office: Eduard Shevardnadze, the former Communist Party chief of Georgia who later gained fame as a reform-minded foreign minister for the Soviet Union. A native Georgian, Shevardnadze accepted honorary chairmanship of a group of opposition parties called the Democratic Union. Still, Georgia's future remained uncertain.

The violent turn of events seemed especially tragic to me, for I had crisscrossed Georgia with photographer Tomasz Tomaszewski in 1991, just as the republic was stretching its wings after the long years of Soviet rule.

All things seemed possible. I could see the country's immense potential. Rich in farmland and minerals, Georgia is tucked between the Caucasus Mountains and the Black Sea. It is a land of gently rolling tea plantations, age-old vineyards, and sweeping vistas that would be the envy of any tourist board. There was great energy and spirit in the people, who had been among the first to declare their independence from the Soviets, at a time when it was still dangerous to do so.

Georgia traces its origins back for millennia, to what scholars believe was one of the cradles of civilization. Wrenched free of the Soviet yoke, Georgians last year withstood a scrape with dictatorship under their first popularly elected president, Zviad Gamsakhurdia.

Reacting to his autocratic rule, angry opposition groups filled the streets of Tbilisi last fall, including those rallying under a monarchist party's flag (opposite, at left).

This is the story of how Georgia began its perilous transition to democracy in the springtime of 1991, the year it tried to shed the terrible legacy of Joseph Stalin and stand on its own. When I arrived there, the country's mood matched every cliché in the book—it was sunny, the vines were springing into leaf, the countryside was a riot of flowers, and every Georgian was brimming with confidence—the kind of overconfidence that blinds people to impending disaster.

The story begins in Stalin's hometown, Gori. I was about to go to bed when a local man came to my room. "Something terrible has happened," he said, lips trembling.

Through dark streets he drove Tomasz and me to a morgue to inspect the body of 15-year-old Zaza Kakashvili, who had just been killed by Soviet soldiers. Zaza and his school friends had been playing soccer in a corner of a Soviet Army base, when an armed soldier and two officers appeared and ordered them out. Zaza tripped trying to escape. They shot him while he lay on the ground.

REPUBLIC OF GEORGIA

AREA: 69,700 sq km (26,900 sq mi). **POPULATION:** 5,500,000. **CAPITAL:** Tbilisi. **RELIGION:** Georgian, Armenian, and Russian Orthodox; Muslim; Jewish. **INDUSTRY:** Manganese, steel, textiles. **EXPORT CROPS:** Grain, tea, citrus, grapes.

ON THE DAY of Zaza's funeral the womenfolk sat upstairs in the boy's house, where he lay in an open coffin, his soccer boots at his feet and an odd collection of objects near his head—bottles of champagne, cigarettes, chocolates, mineral water, wafers. His mother, just 36, wailed uncontrollably over his face: "My tortured boy, our family is destroyed. You were supposed to cry over my coffin, not the other way around."

All morning several thousand schoolchildren and their parents gathered outside Zaza's school—just across the street from the house where Ioseb Bessarion Jughashvili (who was later known as Joseph Stalin, "man of steel") was born. They set off on a silent protest march past the Red Army garrison. When they reached Zaza's house, his casket was carried out, held high and open to the sun, and the procession continued, past the dictator's fearsome statue in front of

ANGUS ROXBURGH, who has covered the Soviet Union for the *Sunday Times* of London, is now a Moscow correspondent for BBC Television. TOMASZ TOMASZEWSKI photographed the collapse of communist regimes in "Dispatches From Eastern Europe," in the March 1991 GEOGRAPHIC.

Not just for a bountiful harvest were the faithful of Alaverdi lighting their candles last fall. In the town's 11th-century Georgian Orthodox cathedral, an elderly parishioner with an offering of chickens for the harvest festival also kindles a commemoration for Georgia's martyrs in the struggle for freedom from the Soviet Union. With its own patriarch, Georgia's church, dating back to the year 337, is nearly seven centuries older than Russia's.

the town hall and down the avenue back to the school.

Here, his school friends and teachers made speeches. "Let the Russians remember: A Georgian greets a friend as a friend and a foe as a foe." "Zaza, you join the martyrs of the independence struggle. God, take your son."

Suddenly the school bell rang out—a last farewell to the dead boy—and the crowd wept as one. Zaza was carried to the cemetery above the city. In the army base down below, a Soviet tank revved its engine, throwing up a cloud of dust. The mourners closed their eyes to this needless provocation.

They buried the boy with his boots, wafers, and champagne.

Only a few Georgians—mainly intellectuals—recognize such barbaric events as part of the legacy of Stalin. For the majority, especially in the villages, he remains a Georgian hero. The little hovel in Gori where he was born was turned into a shrine, surrounded by marble pillars, during the dictator's lifetime. No one suggests destroying it.

Behind it, the huge museum dedicated to Stalin's life is closed for "reconstruction." But the views of the museum director, a doughty matron called Nunu Amirejibi, suggest that it will remain a place of homage: "My personal opinion is that Stalin was a great figure. You can't say he was all bad."

"Was he a criminal?" I ask, as we stand in the eeriest part of the museum, where Stalin's death mask lies in a darkened sanctum, picked out by a shaft of light.

"There were others around him who did evil things. Stalin could not know everything that was going on."

Outside, in the shady, tree-lined Stalin Avenue, which runs from the museum to the huge Stalin monument in front of the town hall, I ask passersby what they think of him.

"Only enemies of the country were killed under Stalin, not innocent people."

"He was powerful, a Georgian known all over the world, that's the main thing."

One criticism emerges: "He did not do anything for Georgia. He was a bad Georgian, because he kept us in the Empire."

It seems strange that people who so love their independence and country can feel anything charitable for the man who jailed or murdered thousands of their kinfolk and kept their homeland so long under subjugation. Perhaps their view illustrates pride in a native son who made a name for himself. "Stalin," they seem to be saying, "was a monster, but he was *our* monster."

"I have no money and no way out," says Esma Kosayeva, whose home in the South Ossetia capital of Tskhinvali was bombed in September, while her husband was across the mountains in Russia, seeking guns in the autonomous republic of North Ossetia. Losers in the rush to freedom, Georgia's

Ossetian minority provoked violent reaction from their neighbors by declaring sovereignty for their region and announcing their desire to join Russia.

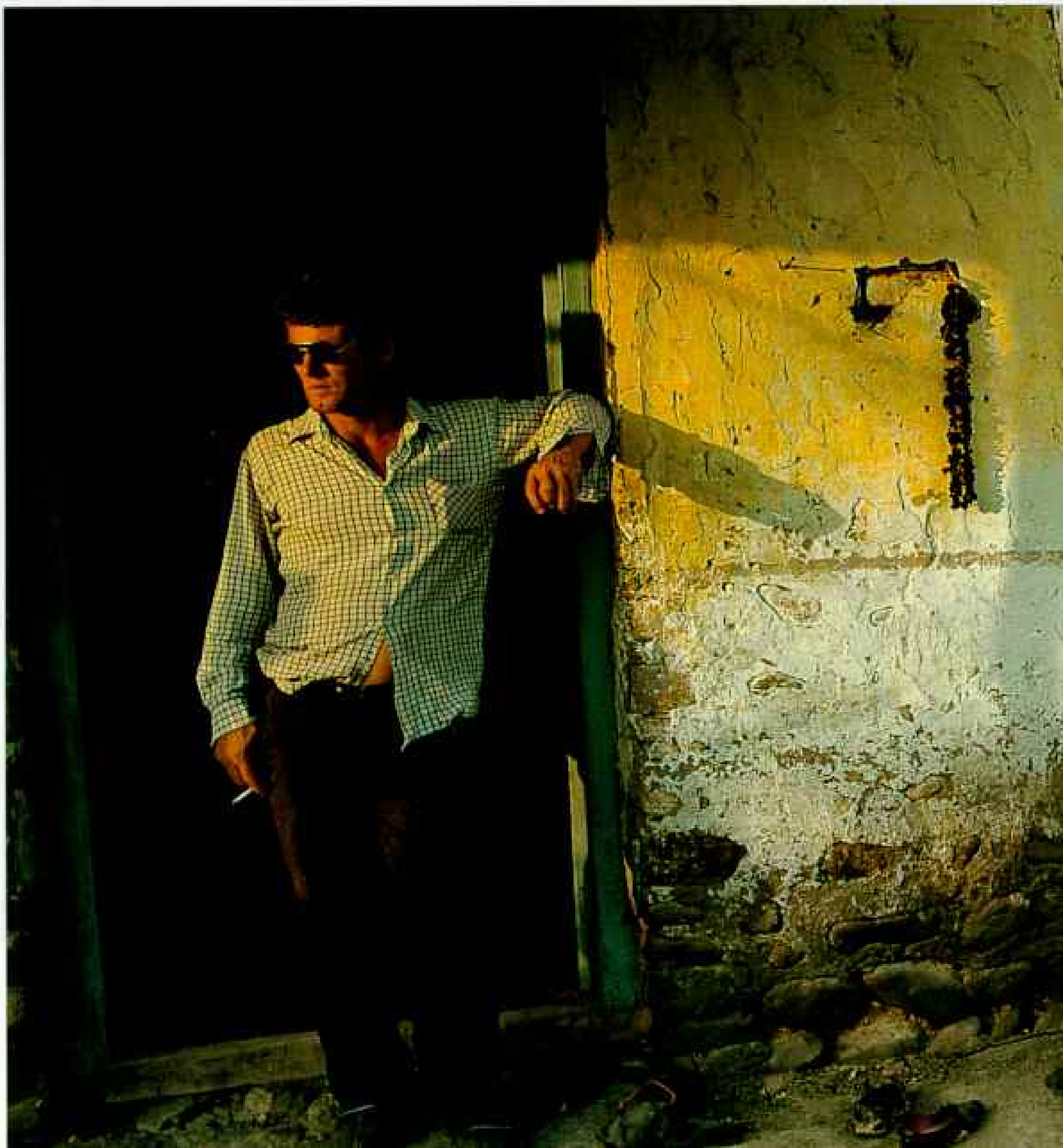
Thought to descend from an ancient people called the Alans, Ossetians speak a Persian-based language unrelated to Georgian.

GEORGIANS are a proud and fiery people. Nothing offends them more than to be called Russians. And rightly so, for the only thing they have in common is the frontier that straddles the massive Caucasian mountain chain between the Black and Caspian Seas. In every other respect they are different.

Before the civil war broke out, I could sense the Georgian temperament by just strolling down Rustaveli Avenue, the grand main street in Tbilisi. Here, in the warm evening, the women, dressed predominantly in black, promenade arm in arm, while the young men swagger with a typically southern mix of raw aggressiveness and breezy good humor. This is the Middle East, not Siberia.

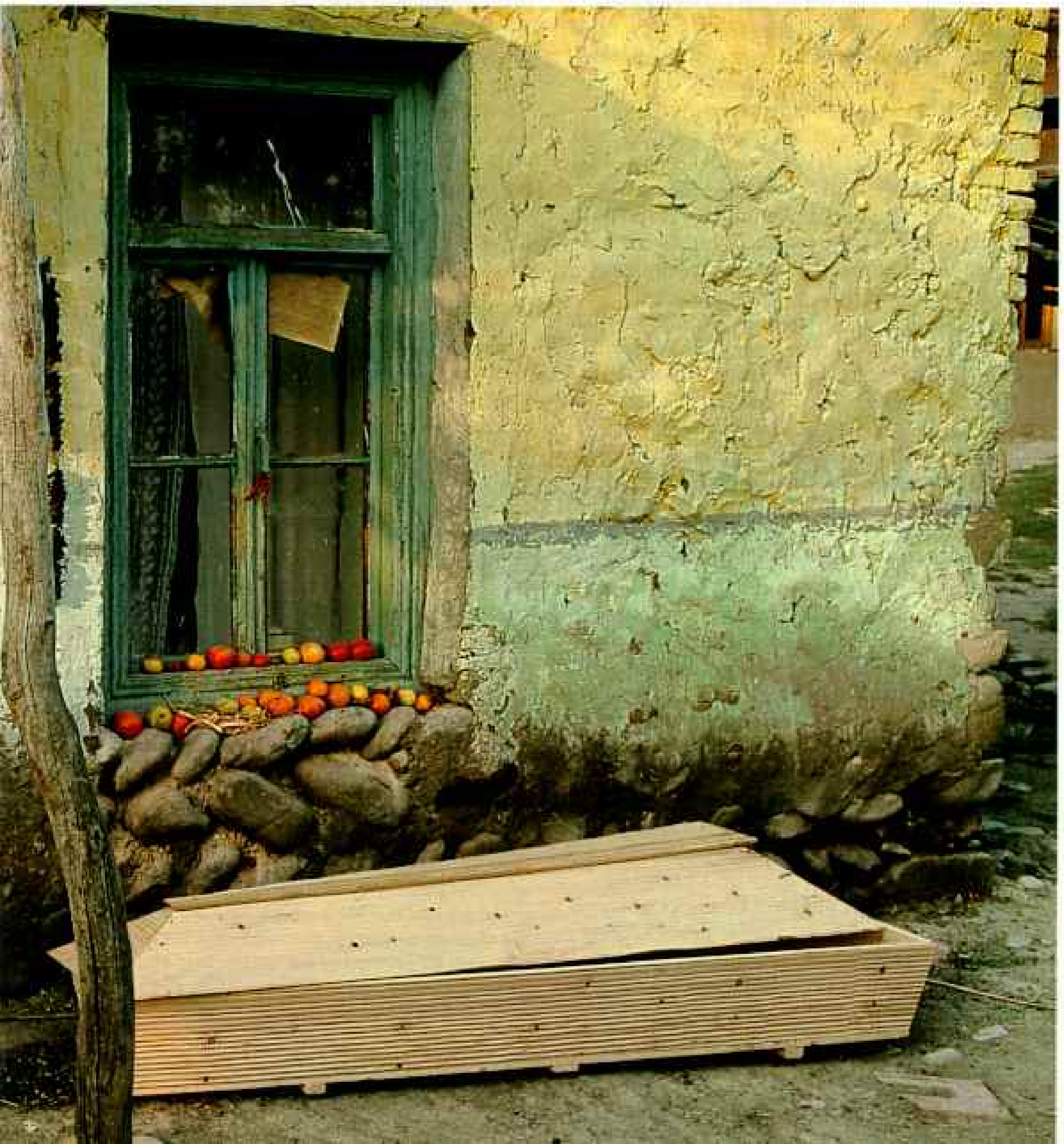
These days, to address a Georgian in Russian—unless you make it clear you are not Russian and are only using it as a means of communication—is likely to evoke, at best, a rude reply. Yet their own language is a nightmare for any foreigner to learn. It is unrelated to Russian or any other tongue beyond Caucasia. I have a hunch that it is precisely the unintelligibility of Georgian to all outsiders that has allowed the Georgians to preserve themselves as a distinct nation, with their own folklore, traditions, and mentality, through centuries of foreign domination.

The language is even written in a kind of "secret code"—a beautiful alphabet, with



A bloodied but lucky survivor of the Ossetian conflict receives treatment in the Tskhinvali hospital. Meanwhile, a hastily built coffin (below) awaits one of those less fortunate.

Georgians believe that South Ossetia—formed in 1922 when Stalin was nationalities commissar of the Soviet Union—was invented to limit Georgian power. Ossetians, however, base their claims of sovereignty on a historic presence in the region.



elegant curving characters that bear no relation to Latin or Cyrillic.

Sakartvelo, or "land of Kartvelians," as they call it, embraced Christianity in the early fourth century. "That was 650 years before Russia did it," says Soso Chkhaidze, a Georgian filmmaker, explaining how this nation views its northern neighbor as something of a latecomer to civilization. But Georgia succumbed to regular invasions by Mongols, Persians, and Ottoman Turks after a period of flourishing nationhood in the 11th and 12th centuries. And by the end of the 18th century Georgia had to look to Russia for protection from its Muslim enemies. It was the beginning of 200 years of Russian domination from which the Georgians are only now emerging.

"We had an ancient language, but we suddenly had to conduct our affairs in Russian," Soso Chkhaidze told me, referring to the centuries-old insult as if it had happened just yesterday. "And our monarchy—the symbol of Georgian statehood—was abolished."

Under the tsars the land of Sakartvelo found itself a mere piece of the Russian Empire, its language and culture suppressed. After the Bolshevik Revolution in 1917, Georgia enjoyed three brief years of independence, recognized by Lenin's Russia and by the United States and Britain. But in 1921 the Red Army invaded and annexed the republic. The Georgians had to endure not just Russian domination but communism too.

The scars remain in every Georgian's mind. When the communists were finally routed in the multiparty elections of October 1990, the situation spun out of the Kremlin's control. The new government immediately set about demolishing the Soviet system within the republic. The communist-dominated organs of local government—the soviets—were abolished and replaced by a system of prefects, appointed by Gamsakhurdia, and popularly elected local assemblies, known as *sakrebulo*. Young Georgian men were encouraged—not that they needed encouragement—to join a new National Guard instead of the Soviet Army.

By the time of our May 1991 visit, the enormous statue of Lenin that once adorned Tbilisi's central square (now called Liberty Square) lay in a junkyard outside the city, headless but still clutching the proletarian cap in an enormous bronze fist.

MANY GEORGIANS are convinced that the Kremlin is to blame for the bloody conflict in the region known as South Ossetia.

It was Stalin—as Lenin's nationalities commissar—who created an "autonomous region" within Georgia for the Ossetians (who unlike the Georgians had supported the Bolshevik Revolution). It was intended as a booby trap for future Georgian secessionists. The division of the Ossetian people between North Ossetia (in Russia) and South Ossetia (in Georgia) ensured that any Georgian attempt to escape from the grasp of Mother Russia would bring a storm of ethnic unrest.

When Georgia began its moves toward independence in 1990, the South Ossetians declared their sovereignty and, at the same time, expressed their desire to remain within the Soviet Union. Within weeks the region was engulfed in civil war. By the time we visited in midsummer 1991, many people had been killed, and the area had been turned into a patchwork of Georgian and Ossetian communities, whose members were separated from one another and afraid even to travel through the other's territory.

The entrance to the region's capital, Tskhinvali, was barricaded with barbed wire and sandbags and guarded by Soviet soldiers and armored vehicles. Knots of Georgian refugees stood around, staring down the road to where their houses had been burned down. "My father was taken hostage 16 days ago," said one Georgian, drawing deeply on a cigarette in the cold wind. "I don't know if he is still alive."

Other groups of Georgians awaited a military convoy to accompany them through Ossetian territory to their villages. We persuaded a Soviet Army major to escort us into Tskhinvali. There, Lenin still glowered down from statues and wall plaques, and communist slogans abounded.

"We get all our food now from North

A bonfire for the vanities of a failed regime consumes ransacked documents in the courtyard of the parliament building in Tbilisi after President Gamsakhurdia fled from his underground bunker here on January 6. Showing their contempt for the once popular leader, who won 87 percent of the vote in last May's presidential election, demonstrators delighted in tossing his likeness into the flames.

Ossetia, through the highway tunnel under the Caucasus," an Ossetian woman told me. "Georgia doesn't feed us. They just kill us. They pull out people's fingernails, gouge their eyes out, burn their houses."

(I often heard Georgians tell exactly the same stories about Ossetians. On a later visit to a Georgian village inside Ossetia we were shown a smoked-out bus in which, it was said, four Georgians were doused with petrol and burned to death.)

In Tskhinvali some local people took us to see a fresh graveyard outside school number 5, where victims of the "Georgian fascist terror" lay. Here, Ira Bigullayeva, a historian from Ossetia, herself married to a Georgian, asked why the West did not support them. "The Georgians are liars. Their hospitality masks their cruelty, their hatred, their hypocrisy. Their tragedy is that they followed that murderer and scum, Gamsakhurdia. It was he who went around saying, 'Georgia is for the Georgians.' We had to look to Moscow for protection."

After the August 1991 coup attempt against Mikhail Gorbachev, which the leaders of South Ossetia rushed to support, the situation became even worse. The intensity of violence and bloodshed grew, and more Ossetians joined the 50,000 who had already fled north to their kinfolk across the mountains. It was hard to imagine how the two communities could ever again live at peace.

I WONDERED WHY GEORGIANS, embarking on a new future, should spend so much time thinking about their traditions and past. "History," Gia Bugadze, a 34-year-old painter from Tbilisi reminded me, "is the only real thing we have in Georgia. The present doesn't exist yet."

As Georgians move from their turbulent past, the danger is that they will lurch from one form of totalitarianism to another, this time based on nationalism instead of communism. With no tradition of democracy, either before or after the Bolshevik Revolution, the people have little to guide them.

In the village of Zemo-Machkhaani, tucked in the easternmost corner of Georgia, we saw democracy bravely struggling to be born, amid chaos and farce. With all the rules changing, the citizenry seemed confused, uncertain about how to proceed on their own.

At three o'clock about 400 men and women gathered under the shade of fir trees and birches in front of the village hall. Above the building flew the flag of independent Georgia—the color of dried blood, with one black stripe and one white one in the corner.

The occasion was the election of the village "mayor"—the head of the 26-member sakrebulo. The election was to be supervised by the district prefect. But he failed to turn up, and the public meeting turned into a forum for pent-up grievances.

A young man called Onise appeared on stage and began commanding the proceedings with a megaphone, and it soon became clear that there was a small political crisis going on in the village. Onise was determined to become headman, and many villagers clearly supported him, but they knew the prefect was going to propose a different candidate. "We must tell the prefect exactly what we think," shouted Onise, to applause.

A little girl got up and recited a poem she had just written about Merab Kostava, the most respected of Georgian dissidents, who was killed in a car crash in October 1989 and is now treated with the reverence the communists once devoted to Lenin. Onise took his cue and barked into the megaphone: "The blood of Merab Kostava must not go to waste. The prefect's absence today demonstrates his contempt for democracy."

The meeting, for all its nationalist and anticommunist sentiment, had a distinctly Soviet flavor: the invocation of revolutionary martyrs, the declaiming of poems, and the adulation of the new leader.

A man in a Panama hat got up and started speaking about Georgia's national poet, Shota Rustaveli. The point of the meeting seemed to be well and truly lost, and the crowd started jeering as the man rambled on. "I think you know about my case," he said, his voice beginning to tremble. My ears pricked up, expecting to hear a tale of persecution. "It's two months now since my bicycle was stolen," he continued, haltingly.

"We're sick and tired of your bicycle," a woman shouted from the crowd, and the man in the Panama hat meekly left the stage. The meeting broke up. No mayor was elected.

A week later the prefect finally turned up to supervise the election in Zemo-Machkhaani. The law required that the new leader be chosen by the members of the village sakrebulo, but an irate crowd outside the

Civil war victim Sandro Shaismelashvili receives a hero's farewell from his family and comrades-in-arms in Tbilisi. The 18-year-old was a member of the Mkhedrioni, or "horsemen," an armed paramilitary group that fought to topple the Gamsakhurdia regime. The youth was said to have been shot in the legs by Gamsakhurdia's bodyguards, tortured, and left to bleed to death. He was among some hundred people killed during the fall and winter conflict.

village hall demanded the right to choose him themselves. Onise, now strutting around like a bantam cock in an electric blue suit, stirred things up again, warning that the prefect could not be trusted to run the election fairly. The prefect, undeterred, went behind closed doors to conduct his business with the village sakrebulo. Onise was defeated, the prefect's candidate won, the village's first exercise in democracy had fizzled. The prefect slipped away to his waiting black car and sped out of the village.

By mid-May Georgia's first presidential election was in full swing. The result was a foregone conclusion: On May 26, 1991, Zviad Gamsakhurdia, 52, sometime anticommunist dissident and political prisoner, would win by a huge majority. Already chosen as president by parliament, soon he would have a popular mandate too. Winning 87 percent of the votes may have ironically contributed to his downfall by encouraging his many excesses.

One week before polling day, we had an opportunity to observe Gamsakhurdia at close quarters. We joined the presidential motorcade on a whirlwind tour of eastern Georgia. Tomasz and I, traveling in car number 7, could scarcely keep up with the president's bullet-proof Mercedes-Benz as it scorched down highways built for mule carts, scattering oncoming traffic.

First stop was Gurjaani, known outside Georgia for its excellent wine. At the town hall the president had a rather strained

MALCOLM LINTON, SIPA PRESS (OPPOSITE)

As the parliament building burns behind them, opposition fighters embrace upon learning that Gamsakhurdia and his cohorts had left their bunker and fled the country. When the fires cooled, many of Tbilisi's landmarks, like the communications building (above), were left as ruined testaments to Georgia's violent rebirth by fire. Fortunately, most of the damage to Georgia's beloved capital was confined to a mile-long strip along Rustaveli Avenue and Liberty Square.

meeting with his prefect. After a few sentences they ran out of conversation. Someone turned up the television to ease the silence. Then Gamsakhurdia beckoned me to sit beside him, and for most of the next half hour he conversed with me in English.

"Surely *all* your opponents cannot be working for Moscow," I said.

"Yes, they are," said the president. "You know, people call me a Mussolini, a Saddam Hussein! Have you ever heard of a dictator who allows his opponents to speak?"

He came across as a lonely man, uncommunicative and obsessed with visions of persecutions and KGB plots. He sat alone, slouching and staring into space, as if he could see the disaster approaching.

By chance, the campaign tour took us back to the village of Zemo-Machkhaani, where we had last seen Onise, the rabble-rouser, in defeat. While Gamsakhurdia campaigned, Onise rushed up to tell us the news.

"I complained to the government about the prefect's conduct of the election last week, and the decision was reversed." Onise was the village leader.

WHERE will this tortuous road to freedom and democracy lead? Can Georgia survive on its own? Few countries can boast such a variety of landscapes and climates. In the north the snowy peaks of the Caucasus are ideal for mountaineering and skiing. In the west are beaches that rival those of Greece and Turkey, with scarcely a foreign tourist to be seen.

In the land of the Svans, one of many subgroups that make up the Georgian nation, the village of Ushguli harks back to medieval times. The rugged people of this alpine region, known as Svaneti, built their famous watchtowers to guard against invaders. Situated high in the Caucasus, Ushguli

occupies a part of Georgia known for its resistance to autocratic rule. A tale from the 19th century relates how all inhabitants of the town shared equally in the execution of a would-be overlord by pulling together on a string attached to the trigger of a rifle pointed at his head.

The subtropical hills of Atchara are a delight to the eye, while Borjomi and other mineral spas of central Georgia and the vineyards of Kakheti could vie with the best in the world. Before the recent unrest, Tbilisi was a charming capital city with tree-lined boulevards and a cosmopolitan atmosphere, thanks to the mix of peoples—Georgians, Armenians, Jews, Kurds, and Russians.

If Georgia develops its tourism and learns to package and market its marvelous wines, champagnes, and brandies, the nation might well thrive. But transforming the rotten economy will be a struggle, and it will surely entail much poverty and strife.

COMMUNISM ROOTED the middle classes, the bourgeoisie that makes capitalism work. Ironically, therefore, the key people in the new free-market economy may turn out to be the same as those who really ran the communist one—the "Mafia." The term, which has nothing to do with the families described in Mario Puzo's novels, refers to the secretive group of entrepreneurs who figure a way to move goods through the nation's underground economy, often at enormous profits.

Through an acquaintance in Tbilisi, I was introduced to two members of this underground world. The first—who suggested I call him Irakli—took Tomasz and me to a restaurant that was closed, but which produced a sumptuous banquet for us at the snap of Irakli's fingers. He did not pay for the meal. The manager thanked him unctuously for having come.

Over the meal, Irakli told us about the "thieves' law" and ethical code. First of all, he said, they prefer the term "thieves" to "Mafia." The thieves, he said, were scrupulously honest with one another and came into being only to compensate for the total failure of the former Soviet planned economy. Thieves were found at every level, from government minister to factory manager to shop-floor worker. The system of payments and kickbacks made sure that the creaking system at least produced something. Each thief was on a "salary" appropriate to his level in the network. Unlike the Mafia in America, this one never went in for murder: If a new boss with no thieving affiliation was appointed who threatened their livelihoods, they did not kill him; they just bought him off and made him one of them. Salaries might have to be raised a little, but the system remained intact.

Our contact whisked us off in a car one night through the darkest Tbilisi streets to meet what he called a "real" Mafia boss in a mansion the boss was building for himself. Geno, a slight figure in a black silk shirt and white trousers, met us and showed us around his new home. "It is worth millions," he confided, "but I never paid a kopek. Every ounce of cement, every piece of wood, every nail, was donated by my friends."

"What did you give *them?*" I asked.

"I stand by them every minute," said this Tbilisi godfather, with great solemnity. "Any time of day or night, if they're in trouble or need help, I'm there."

Where Stalin himself once soaked, women take the waters at Tskhaltubo, whose naturally radioactive springwaters are thought to offer remedies for a number of maladies. Some 80 miles southwest, near the city of Batumi, three tourists claim a normally crowded Black Sea beach, thanks to a slump in tourism caused in part by political upheavals. Modest attractions by Western standards, the rocky shores of Georgia's balmy coast have long been paradise enough for most former Soviets.

The family cellar has first call when Otari Lobjanidze takes his grapes to the wine press; any surplus from his east Georgian vineyard goes for sale. Outside Tbilisi, a man wearing the latest fashion, imported from Turkey, parts with a week's wages for a banquet-ready piglet. As much as any other people in the old Soviet Union, market-savvy Georgians have dressed and eaten well.

He produced bottle after bottle of champagne as we talked in his garden under the stars. The other men around the table obsequiously referred to him as "our elder brother." One of them urged me to notice how Geno shuttled back and forth to bring food and drink: "It is a sign of respect that this great man should serve you himself."

Geno, age 51, told us about his impoverished childhood, kicking about the streets of Tbilisi; his school days with Zviad Gamsakhurdia and later acquaintance with such personalities as Yakov Brezhnev, brother of the late Soviet leader; and his ability to perform any economic wonder in Georgia.

Exactly how he operated remained a mystery. But it seemed certain that the influence of such men would grow, not diminish, in the post-communist order.

DESPITE THE TURMOIL AND CHANGE, the eternal qualities of Georgia left the strongest impression on me. Two things in particular seemed to embody the resilience and optimism of Georgians: the land and the vine.

In the region of Tusheti, part of the great Caucasus chain, we discovered a way of life little changed since man first inhabited these mountains. The onset of summer here is signaled by the arrival of 150,000 sheep—and some 400 herdsmen and horses—from their wintering grounds in the Shiraki Steppe of southeastern Georgia. Their hundred-mile trek, along the broad valley of the Alazani River and up the giddying gorges of the Caucasus, takes 20 days. For three months the flocks graze on the lush alpine meadows of Tusheti. Then in September, as the first snows fall, they start their return journey. By the autumn equinox they are back in the Shiraki Steppe, to pass another winter. So it has been for centuries—probably millennia.

In May Tomasz and I joined the tail end of this great annual migration of men and animals to Omalo, the center of the Tusheti region, where we met Vano Melaidze, a relative of our local guide, Zezva Gochilaidze. Though Vano and his wife did not expect visitors, they quickly produced a meal for us—entirely homemade, from the bread and cheese to the boiled beef and throat-searing *tchatcha*—Georgian brandy distilled from grape seeds and skins.

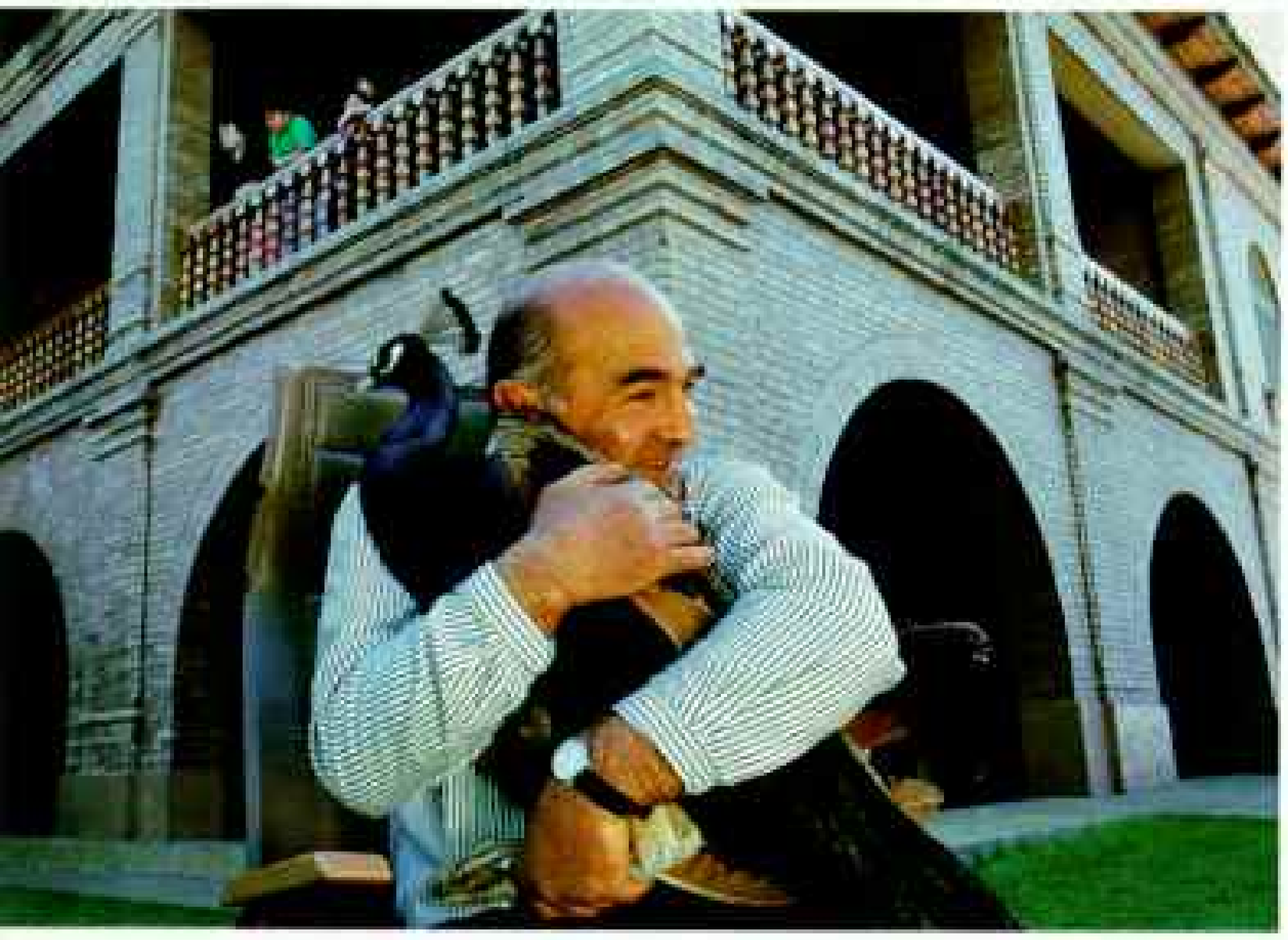
We ate in a tiny room, heated to a suffocating temperature by a little log stove and separated from the bedroom, with its four iron bedsteads, by thin hardboard walls. Cows mooed in the byre underneath the floorboards. Vano and his wife, both in their 60s, had lived here all their lives. They had rarely ventured into other parts of the world, scarcely even to Tbilisi.

For eight months of the year there is no land access to the village, and there is no telephone link with the outside world. A crackling, flickering television screen testified to the existence of electricity—but that, too, soon failed, and we ate supper by the light of kerosene lamps. Although their way of life has hardly changed in six decades, history has not entirely passed Vano and his wife by. After the Bolshevik annexation of Georgia in 1921, the land was collectivized. Today Georgians are making the first moves back to private farming. Vano owns 30 head of cattle.

"You can't compare," he said. "We're much better off now." He added: "If the changes had come ten years ago, I would have a big farm by now"—but somehow he did not convey the impression of a frustrated capitalist, and he did not long for material possessions or comforts.

We stayed with Vano two more nights, snowbound in summer. A blizzard blocked the only road out, through the pass at 10,500 feet. One morning I saw Vano lift a clock from its shelf by the door, study it for a moment, then stride out into his farmyard with a sense of urgency. The clock had stopped in the night, but Vano knew it was time to light the log fire under the milk vat in the cheese-making shed. Later in the day he looked again (the clock showed the same time) and went out to bring the cows home.

In rural Georgia, time is measured not by clocks but by sunrises and solstices, history



"If they ask me, I will not refuse," said Jano Bagrationi when asked if he aspired to office in a free Georgia. Scion of Georgian nobility, he and his wife, Manana, enjoy a family gathering in their Tbilisi apartment, decorated with family heirlooms confiscated by the Bolsheviks and recently recovered.

Under Soviet rule, technocrats like factory manager Roman Rurua rose to power. At his palatial home in Mtskheta he shows off a pet peacock.

not by revolutions and *perestroikas* but by the birth of sons and the burial of fathers, seasons not by calendars but by the planting and harvesting of the vine.

Unfettered after centuries of foreign domination, the people of Georgia are suffering a crash course in nation building—and refuse to settle for less than democracy. The country's most committed "freedom fighters," like this young man standing guard last fall over the television headquarters in Tbilisi, are determined that they will not be fooled again.

"WINE IS THE LIFEBLOOD of Georgia, for it is made of the sap of the earth and the sun," said Konstantin Cholokashvili, an old Georgian nobleman with a shock of white hair. We were sitting in his tiny office in the state museum in Tbilisi, which he had momentarily turned into a little banqueting hall.

As *tamada*, or toastmaster—an obligatory feature of any Georgian feast—Cholokashvili was proposing the ultimate toast, to the mystery and romance of the vine. "When St. Nino brought Christianity to Georgia, she carried a cross made from a vine, the two sticks tied with her own hair. When the Muslims invaded us, the first thing they did was to cut down the vineyards, for wine embodies the Georgian soul. Wine has helped us preserve our national psychology in the face of constant invasions. It is an integral part of our life. Some linguists say that the word 'wine' or 'vino' went into other languages from the Georgian word, *ghvino*. We call October *ghvinobistve*—the month of wine. With wine we say farewell to the dead and welcome to the newborn. With wine we make declarations of love. Victory to the vine!"

In eastern Georgia almost every rural family has its own vines, lovingly tended throughout the year. "I prune them back in March, and they start to weep," said an old man in Zemo-Machkhaani, himself as gnarled and brown as a vine.

He showed me the most sacred part of his garden, where a 200-liter amphora, known locally as a *kvevri*, was buried underground, only the lip showing above the surface. In the autumn he sterilized the kvevri by burning sulfur in it, then filled it with the juice from his grapes and left it to ferment, together with the seeds and skins. Weeks later there was a magical moment as the earth was scraped away, the clay seal broken, and the first of the new season's wine scooped out and tasted—tart, tannin flavored, cool. The remainder was siphoned off into smaller kvevris and sealed until required.

And wine is required often in Georgia. No occasion is complete without a constant supply of jugs, filled from the kvevri. Wine is not simply drunk in Georgia as an accompaniment to food. It is a ritual, which begins with the choosing of a tamada, who dictates when and how much wine is drunk and directs the conversation. Unfortunately it is also traditional that all tamadas have to be obeyed, as I learned from Zezva Gochilaidze in Tusheti.

The toasts—which this experienced tamada spun out for five or ten minutes—followed a pattern: First he drank to the guests at the table, then to the host's family, then to other individuals, then to their ancestors, then to their children, then to the women.

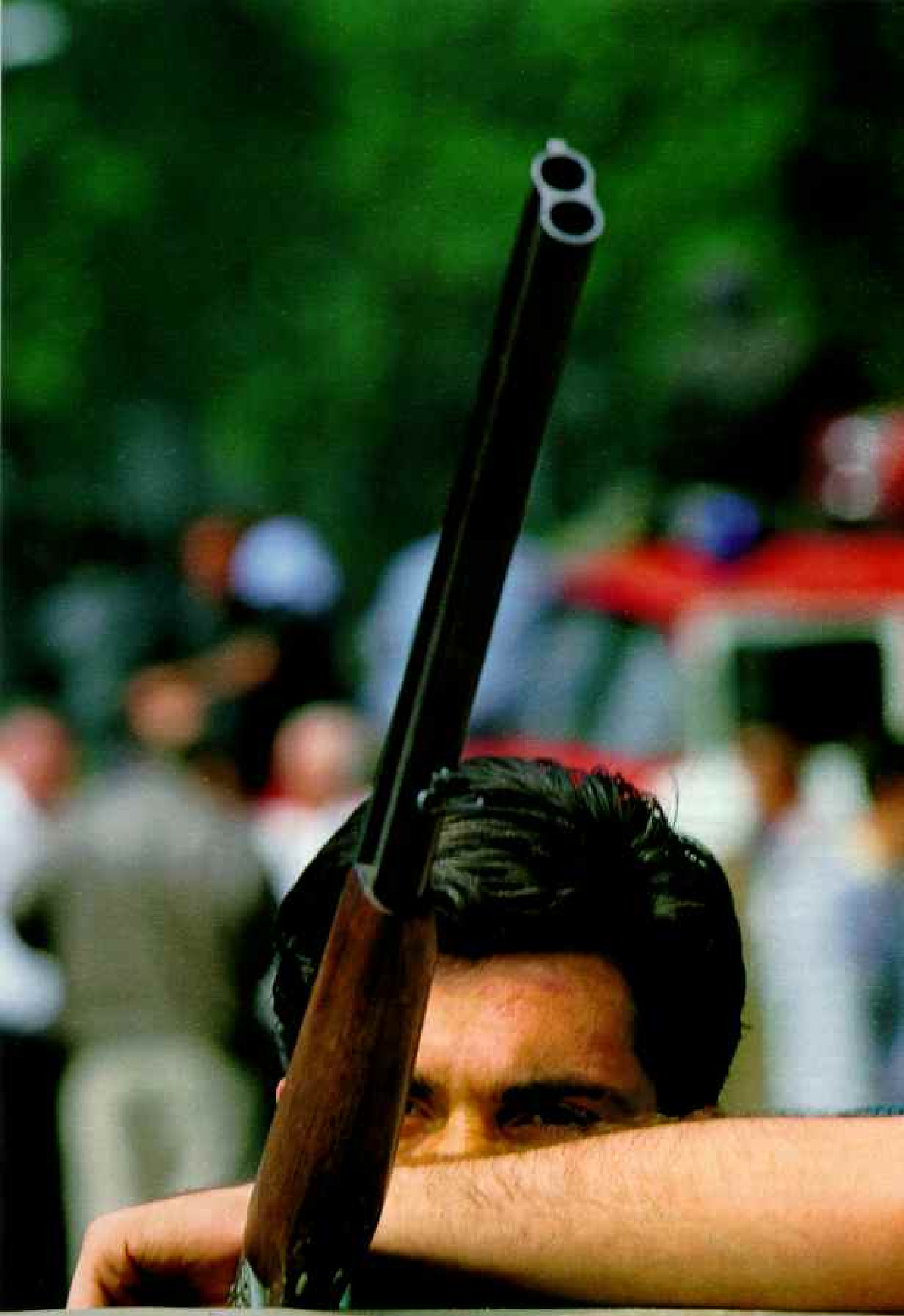
I offered a toast of respect to the shepherds whose tough and dangerous existence we had witnessed in Georgia's mountains. It was a mistake. The tamada was so moved by this that he produced an ibex horn containing a liter of golden wine. "As a gesture of respect," he drank my health, downed the entire contents of the horn, refilled it, and passed it to me with the word *"Alaverdi!"*—which meant that I had to make the next toast and drain the horn.

He grinned down the table at me, with his great hawklike nose and eyes, and reminded me: "I'm the dictator at this table!"

I opted for a simple but essential toast: To Georgia—its traditions, its history, and, of course, its freedom and independence. I remarked that there would be great difficulties ahead in Georgia's fight for independence and democracy, but the tamada brushed it aside. "Sure, it will be hard," he said, "but we'll get there."

He reminded me that some of the commonest Georgian words—*gamarjobat* ("hello") and *gaumarjos* ("cheers")—are forms of the word "victory."

"Georgians are born optimists," said the tamada. "You won't find anyone who does not believe in the ultimate victory of our small and long-suffering nation. *Gaumarjos Sakartvelos!* Victory to Georgia!" □



DNA PROFILING

THE NEW SCIENCE OF IDENTITY

By CASSANDRA FRANKLIN-BARBAJOSA
NATIONAL GEOGRAPHIC EDITORIAL STAFF

Photographs by PETER MENZEL

Mission accomplished: A scientific search finds convincing evidence of ways in which individuals differ at the most basic level. It has produced a technology that answers identity questions in areas ranging from paternity to murder.

Through a series of manipulations at the molecular level, researchers can now make images of specific sequences of DNA (deoxyribonucleic acid). These genetic profiles, in some cases called fingerprints, can be as singular as a signature and establish identity with far more reliability than the conventional blood-typing used to implicate a crime suspect.

But criminal investigation is just one use for this new technology. Zoologists fingerprint endangered species living in the wild to learn breeding patterns. For animals in captivity, fingerprints can identify unrelated pairs that can be bred to increase genetic diversity.

At the Howard Hughes Medical Institute in Salt Lake City, Utah, geneticists isolate a small fragment of DNA (right) marking the gene that causes neurofibromatosis type 1—an often painful condition afflicting one in 3,500 people worldwide with brown spots and benign tumors.

Restoring health to leukemia patients is the primary concern of doctors who use DNA fingerprinting to gauge the success of bone-marrow transplants.

The ability to identify inherited traits transferred through DNA helps reunite immigrant families separated by oceans, both real and bureaucratic.

Researchers also extract DNA from mummified human remains. By comparing ancient peoples and related contemporary cultures, scientists can reach back millennia to better reconstruct human history.

One Family's Fingerprints

Linked by more than a common faith, the Guertlers of Salt Lake City, Utah, represent three generations of the Mormon commitment to family.

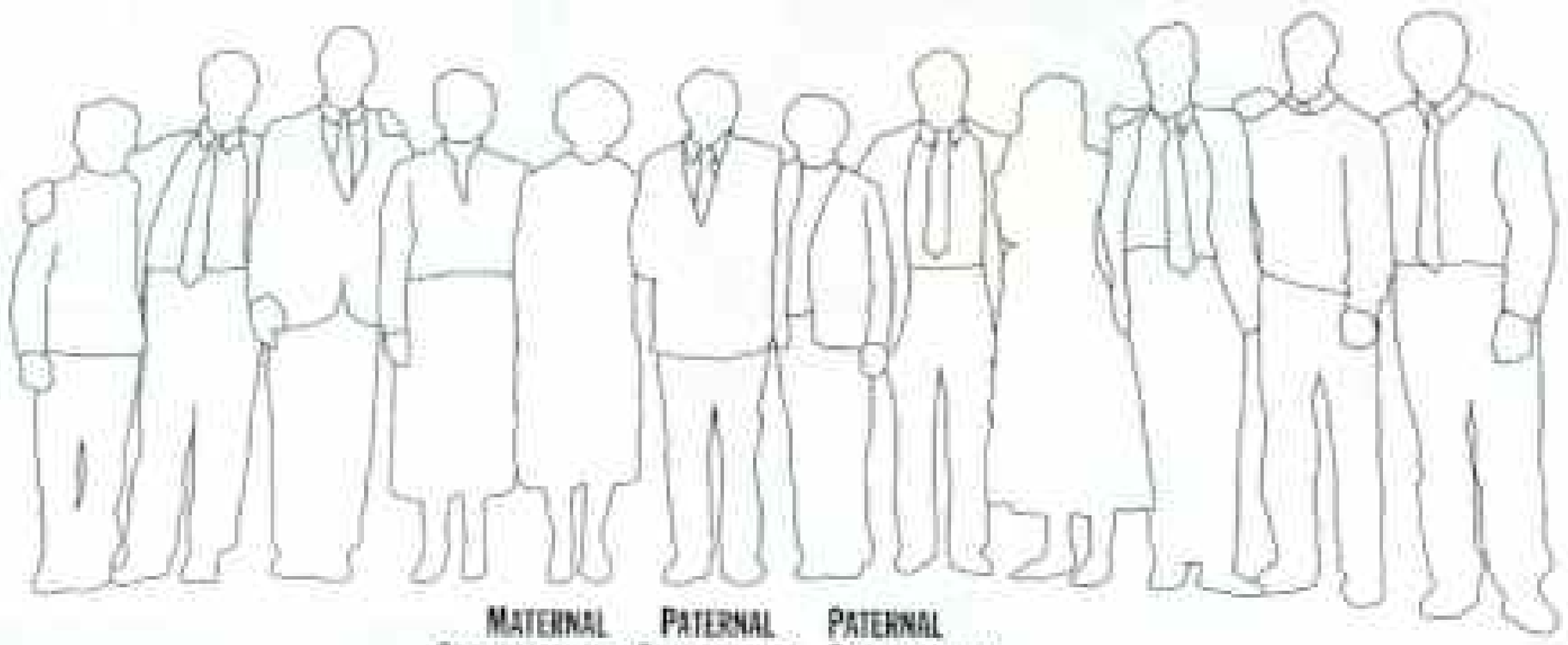
The Guertlers, members of the Church of Jesus Christ of Latter-day Saints, have family records indexed in the world's largest genealogical library, managed by the Mormon Church. That, plus a tendency toward large stable families, makes Mormons a good test case for confirming family relationships through DNA fingerprinting. The Guertler family fingerprints (right) graph what is already known about them.

Most nucleated human cells have 23 pairs of chromosomes, bundles of DNA that contain genes. Genes are sections of the chemical code found on DNA molecules. Offspring inherit roughly half their DNA from their mother and half from their father. Segments of the DNA each Guertler family member inherited are shown as two dark bands in each column. These bands constitute a basic DNA fingerprint. Multiple-band prints can also be produced. When prints are grouped on photographic film in an autoradiograph, they can be compared horizontally in rows representing DNA fragment lengths, lettered A through F.

Bernice, fourth from left, has a genotype, or basic hereditary makeup, of B/F. Mother of seven, Bernice inherited a B from her father and an F from her mother. Her husband, Klaus, fifth from right, inherited a C and E from his parents. Bernice and Klaus's children therefore each inherited a combination of two letters from the group B, C, E, and F.

Geneticists use records of Mormon families to study diseases thought to be inherited. Analyzing blood samples from families with affected members, scientists can pinpoint the gene responsible for a suspected hereditary disease and locate it on a specific chromosome by using probes, synthetic DNA made radioactive. These probes bind to certain segments of natural DNA, appearing as the dark bands of a fingerprint. The bands help researchers locate the gene causing the disease.

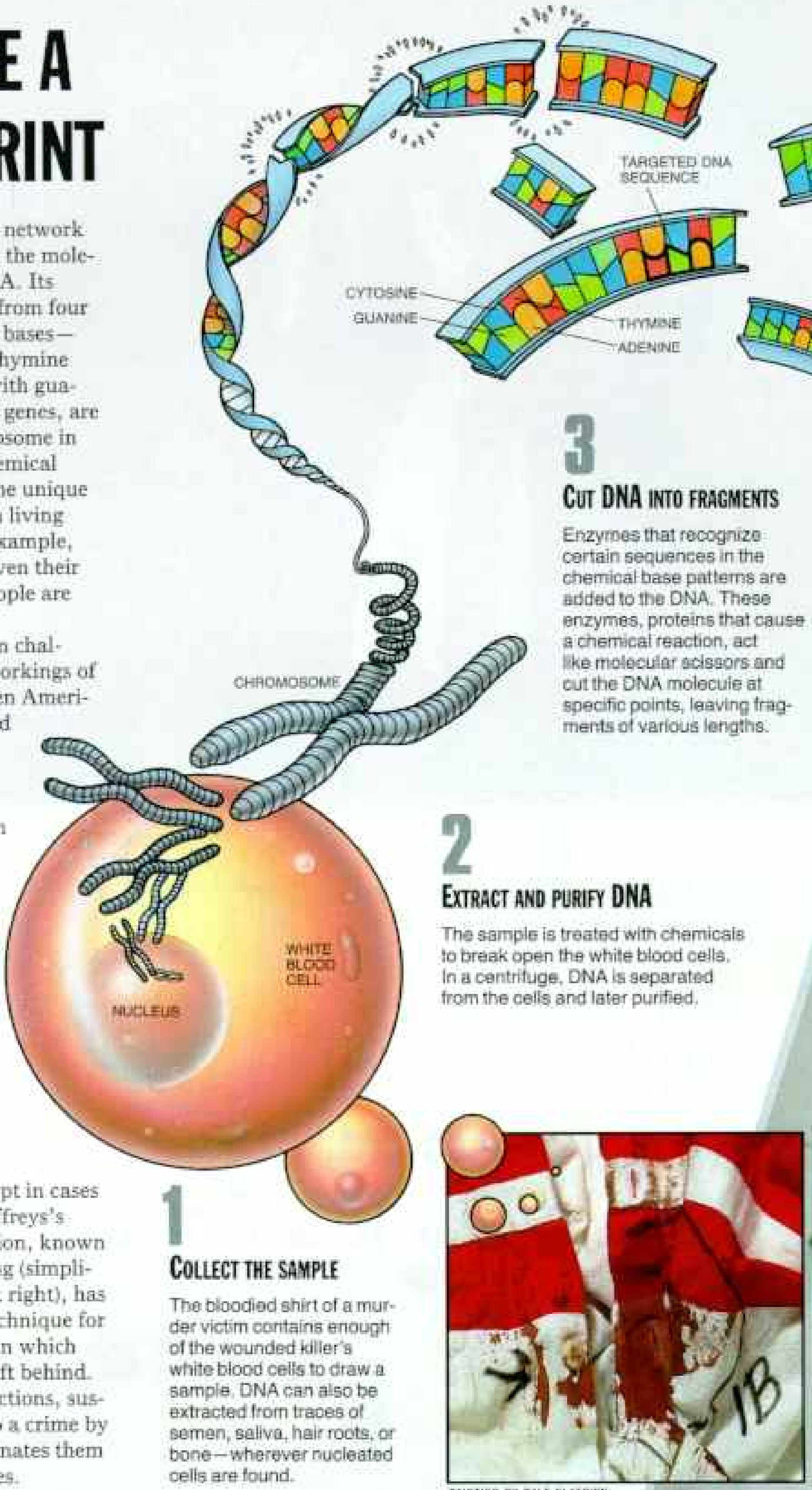
AUTORADIOGRAPH PROVIDED BY DNA DIAGNOSTIC LABORATORY, DEPARTMENT OF HUMAN GENETICS, UNIVERSITY OF UTAH



To Make a DNA Print

Deep in the animated network of the cell nucleus lies the molecule of heredity—DNA. Its twin spirals are built from four interlocking chemical bases—adenine paired with thymine and cytosine paired with guanine. Code messages, genes, are stored along a chromosome in sequences of these chemical bases. Genes define the unique characteristics of each living thing. It is here, for example, that butterflies are given their wing patterns and people are assigned eye color.

Scientists have been challenged by the inner workings of DNA since 1944, when American researcher Oswald Avery defined its role in transferring hereditary characteristics. James D. Watson and Francis Crick described the spiral structure of DNA in 1953. In 1984 Alec Jeffreys, a geneticist in Leicester, England, devised a way to visually identify DNA found between the genes. In certain regions the DNA patterns vary distinctively from person to person except in cases of identical twins. Jeffreys's method of identification, known as DNA fingerprinting (simplified in the painting at right), has become a valuable technique for investigating crimes in which biological clues are left behind. Now, in some jurisdictions, suspects can be linked to a crime by evidence that incriminates them to their very molecules.



3

Cut DNA into fragments

Enzymes that recognize certain sequences in the chemical base patterns are added to the DNA. These enzymes, proteins that cause a chemical reaction, act like molecular scissors and cut the DNA molecule at specific points, leaving fragments of various lengths.

2

Extract and purify DNA

The sample is treated with chemicals to break open the white blood cells. In a centrifuge, DNA is separated from the cells and later purified.

1

Collect the sample

The bloodied shirt of a murder victim contains enough of the wounded killer's white blood cells to draw a sample. DNA can also be extracted from traces of semen, saliva, hair roots, or bone—wherever nucleated cells are found.

PAINTING BY DALE GLASGOW; AUTORADIOGRAPH PROVIDED BY LIFECODES CORPORATION

4

Sort fragments by length

The DNA fragments are placed on a bed of gel, and an electric current is applied. The DNA, which is negatively charged, moves toward the positive end. Several hours later the fragments have become arranged by length.

5

Split and transfer DNA

Alkaline chemicals are introduced to split the DNA fragments apart. At the same time, a nylon sheet is placed over the gel and covered with layers of paper. Blotting draws the fragments onto the nylon where they are later fixed in place.

6

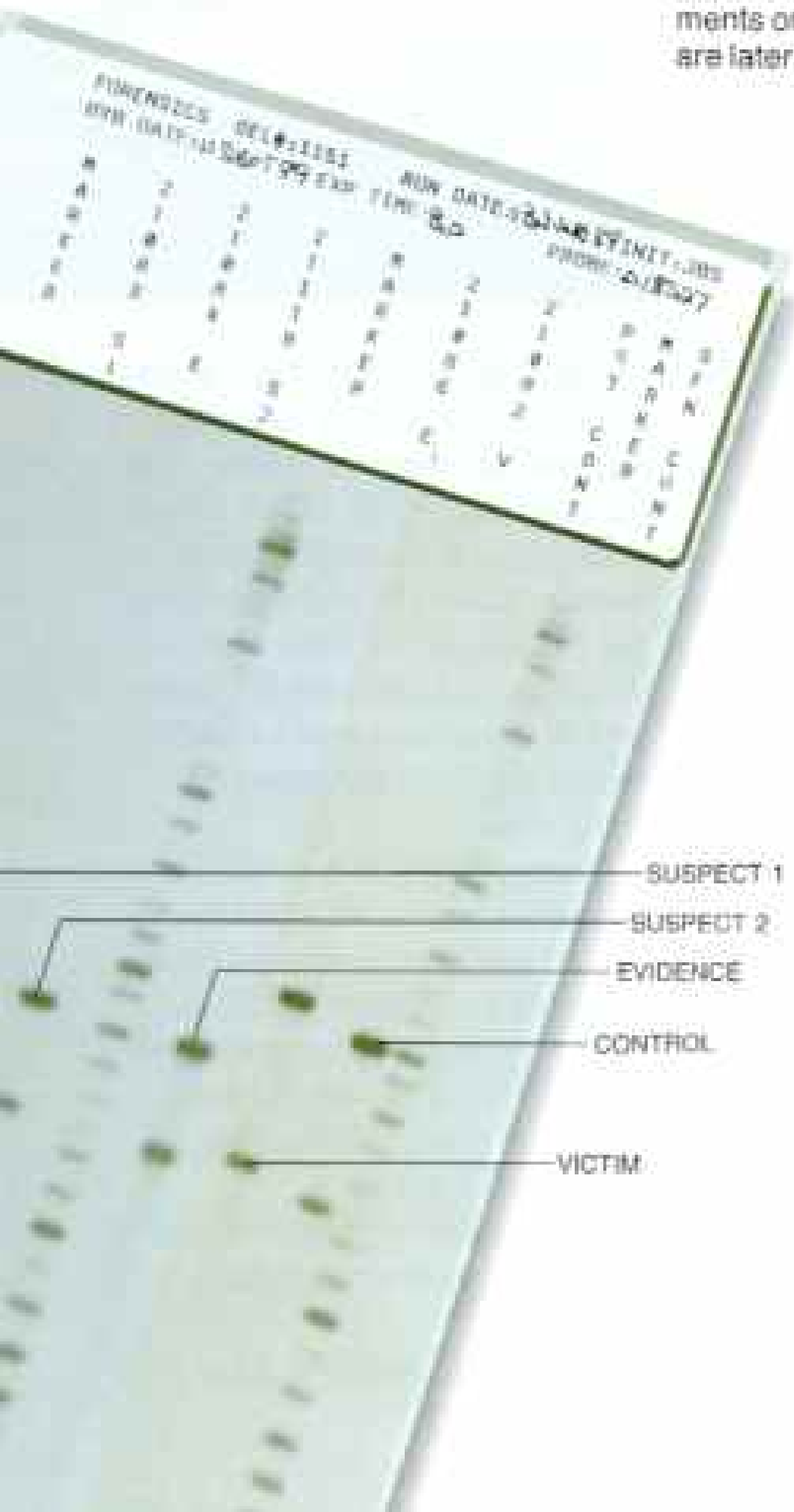
Attach radioactive probes

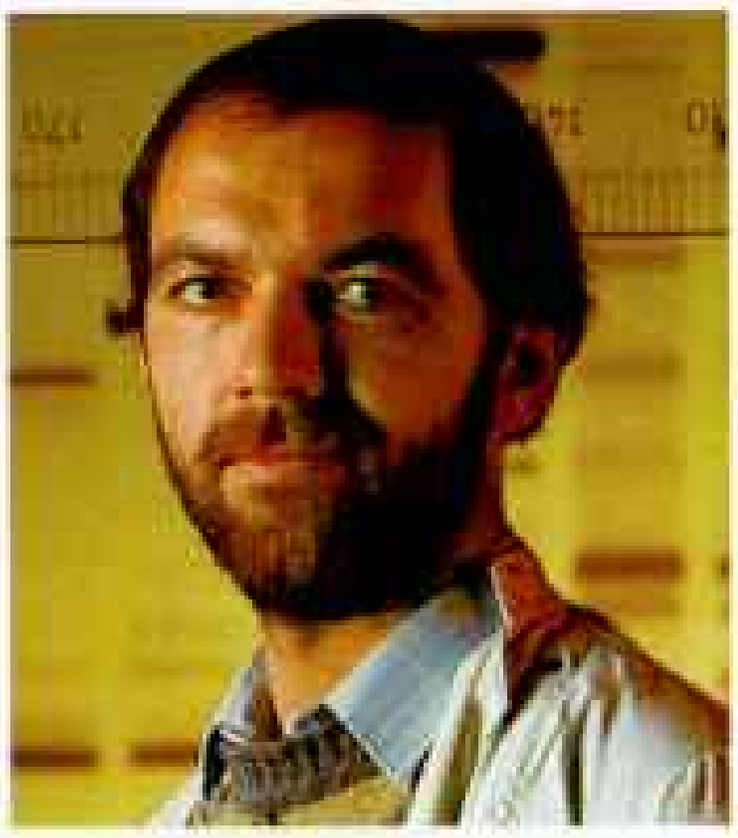
The nylon sheet is immersed in a bath, and radioactive probes—synthetic DNA segments of known sequence—are added. The probes target a specific base sequence and bond to it.

7

Make a print and analyze it

X-ray film is exposed to the nylon sheet containing the radioactive probes. Two dark bands develop at the probe sites. These are the end result, a DNA fingerprint of the evidence, which is then compared with prints of all suspects.





NEVILLE CHADWICK

CRIMES, CLUES, AND CONTROVERSY

"We bought the gold ID necklace after Lynda was killed because the name was spelled the same as hers—with a y," says Kath Eastwood (left, center). "We still keep some of her things around, like schoolbooks and clothes. It reminds us of the good times."

Kath's daughter, Lynda Mann, was 15 in 1983. Her parents were proud that she had already planned her future. But on a cold November night that year, Lynda's plans came to a halt. Bundled up against the chill, she walked from her home in the village of Narborough, in the English Midlands, to visit a friend in nearby Enderby. She never returned.

Policemen found Lynda's body the following morning next to Black Pad, a dark lane near the grounds of a mental hospital between Narborough and Enderby. She had been raped and strangled.

Eddie Eastwood, the girl's stepfather, was called to identify her. "It just knocked the wind out of me," he says. "I couldn't talk after that—for months. I just kept wondering who could do such a terrible thing."

Police scoured the villages in the region. Three years passed without a lead. Then, on a path less than a mile from where Lynda was killed, 15-year-old Dawn Ashworth was found—raped and strangled.

A week later a 17-year-old kitchen porter at the mental hospital confessed to Dawn's murder. Investigators, anxious to find out if the youth had also killed Lynda, telephoned the man local residents referred to as "that DNA bloke."

Alec Jeffreys (left, top), working at the University of Leicester, had no idea at the time that his new technique, DNA fingerprinting, would help solve a murder case. He had developed the process in the hope that it would reveal markers for inherited diseases and lead to early treatment. Murder was something else.

Comparing DNA from the porter's blood with DNA from semen samples recovered from Lynda's and Dawn's bodies, Jeffreys came to an unexpected conclusion. The semen came from one man, but that man was not the porter.

The evidence prompted police to launch an unprecedented

plan—to draw the blood of more than 4,500 young men from neighboring villages. The voluntary "blooding" began in January 1987. Government labs struggled to keep up with the demand for DNA fingerprints. Eight months later, investigators found their man.

Colin Pitchfork (left, bottom), a 27-year-old baker from Littlethorpe, had persuaded a friend to give blood in his name. The friend was later overheard boasting in a pub about the deception. Piecing together information, police arrested Pitchfork, who confessed to both murders and received two life sentences. Old-fashioned police work tracked him down, but DNA fingerprinting locked his cell door.

Recognizing the potential uses for the technique, Cellmark Diagnostics opened in June 1987 and became England's first commercial DNA-fingerprinting lab. Technicians visually analyze autoradiographs (above) for more than 3,000 immigration and paternity cases each year.

The technique has extended to the United States, but not without controversy. The assumption that people marry randomly, without regard to ethnicity or geography and, therefore, that any fingerprint's genetic bands are inherited randomly within the general population is under debate. Experts who accept this reasoning say that only one in a million persons is likely to match the fingerprint from the semen on a rape victim's clothes.

Some geneticists disagree, saying that many marry within their own ethnic group or even subgroup. Among those people some genetic traits are more common, reducing the certainty factor to perhaps one in 100,000. This statistical disagreement prompts some U. S. courts to refuse to admit DNA evidence. Jeffreys's latest DNA-typing technique, which produces a sophisticated digital code that can be stored in a computer, may influence the debate.

Renew Health, Rebuild History

Drawing strength from his daughter Katerina's embrace, a weakened Jirka Rydl (far right) prepares for the bone-marrow transplant that will save his life.

Jirka and his then wife, Tamara, foreground, were told in 1989 that a transplant was his only hope—just two years after he had been diagnosed with leukemia, a cancer of white blood cells. When a matching donor could not be found in the family, they immediately decided to search for an unrelated one.

Jirka's blood profile was entered into a computerized international registry in Minneapolis, Minnesota, in hopes of a match with one of the more than 40,000 people who had volunteered as unrelated donors. People with compatible blood and tissue types were sought. "Jirka was lucky," says Tamara. "Instead of one suitable match, we found two. That's rare."

The Rydls, immigrants from Czechoslovakia, left Eugene, Oregon, in September 1989 and moved with their two daughters to Seattle, Washington, for the month-long transplant preparation.

"Once a donor was located, we thought everything would happen right away," Tamara says. "But there were months of tests before the procedure. It was hard to be patient."

Bone marrow, which makes blood cells, is extracted from the donor's hipbone. Administered intravenously, it takes two to four weeks to produce new white blood cells in the patient. After a few months doctors can determine if a transplant has succeeded by taking a DNA fingerprint. If the transplant has worked, the blood will show the donor's fingerprint bands.

In order to accept the healthy bone marrow, Jirka's immune system had to be destroyed. Plastic sheeting around his bed at the Swedish Hospital Medical Center in Seattle protected him from threatening germs.

"He was feeling very ill," Tamara says. "He had been given nearly lethal doses of chemotherapy and radiation to destroy his bone marrow, and it made him very sick. But without the transplant he would have died."

Now recovering from the transplant, Jirka struggles with the debilitating effects of chronic hepatitis contracted from a blood transfusion. People sometimes ask the couple, now divorced, where they found the

strength to handle this. "I found it in God," Tamara says, "and Jirka has a strong will to live."

Seriously ill people, like Jirka, use DNA typing for a chance at the future, but some scientists analyze DNA to trace the past.

"Biologists have always been interested in evolution," says Svante Pääbo, a biologist at the University of Munich. "Until now we've only been able to study our present-day genetic situation and make speculations about the past. Now we can go back in time, look at ancestors, and compare them with today's populations. We can, in a sense, catch evolution red-handed and follow its path."

Pääbo extracts DNA from the foot of a 2,000-year-old Egyptian mummy (left, bottom). The DNA sequences from such ancient specimens will be compared with those of present-day populations in Egypt and neighboring countries. Researchers hope to determine if different cultures from areas such as sub-Saharan Africa and Libya immigrated and influenced the Nile Valley populations.

Freed as if from a time capsule, the 8,000-year-old brain of a prehistoric Native American is removed from the skull and scrutinized for its DNA (left, top). The shrunken brain came from one of 177 bodies found preserved in a peat bog that was once a burial ground at Titusville, Florida.

Researchers were excited by the 1982 find because it proved that DNA could survive thousands of years after death. Biologists are now extracting DNA for profiles of each individual and comparing them with finds of similar age in Kentucky and Argentina. "By studying their DNA," says William Hauswirth, a molecular biologist at the University of Florida, "we will learn something about how many common ancestors they had. We also want to determine patterns of migration and the behavior of these ancient populations before the decline caused by European contact 500 years ago."

A Grandmother's Search, A Father's Resolve

Her loved ones leaning on her, Haydeé Lemos (above) is a woman who does not give up. For ten years she searched hospitals and nurseries in Argentina for a grandchild she had never seen. In 1987, through the help of genetic profiling and an organized group of protesting grandmothers, she was able to bring her granddaughter home.

María José Lavalle Lemos, at left, was turned over to her grandmother when it was shown with 99.98 percent certainty that she was the child of Mónica Lemos de Lavalle, Haydeé's daughter.

The pregnant Mónica, her husband, and their 14-month-old daughter, María, were abducted in 1977 by Argentina's military security forces.

Mónica lived long enough to give birth to María José—who was raised by a policewoman on duty at a clandestine Buenos Aires detention center where Mónica had been held.

María José's older sister, María, at right, had been returned to her grandmother much earlier, since María was found abandoned near Haydeé's home after her parents were taken. Haydeé immediately claimed the child.

For years Haydeé thought of Mónica, Mónica's husband, and their lost child as being among the ranks of the "disappeared"—an estimated 15,000 adults and children abducted and imprisoned between 1976 and 1983, during the country's repressive military rule.

"I never heard from my daughter and son-in-law again," Haydeé says. "I don't know that they are dead because I've never been given any proof, but I believe they were killed."

Persistent rumors circulated in Argentina that many children of the disappeared were being raised by people associated with their parents' killers, but the children were unaware that they were the sons and daughters of the missing ones. Then Haydeé heard that a woman was raising a little girl thought to have been born in prison—possibly Mónica's daughter.

In 1985 officials from the new democratic government, pressured by Haydeé and other grandmothers, questioned the woman, who had an eight-year-old daughter she claimed as her own. Shortly after, genetic tests proved otherwise.

Now living with their grandmother, María and María José do not discuss their parents much. "They live normal healthy lives," Haydeé says. "And I have the joy of María José. The test proved what I believed all along—that I am her true grandmother."

Other parents still wait for news of their missing children. The skeletal remains of about 300 of the disappeared were found in a mass grave on the edge of a Buenos Aires cemetery. In 1988 a team of doctors, archaeologists, and forensic anthropologists set out to identify the remains using traditional methods such as matching

teeth with dental records.

Recently the first bone samples from a victim were sent to a laboratory in England for DNA analysis. "We try to use traditional methods for identifying the remains whenever we can," says Mimi Doretti, a member of the Argentine team. "But as we run into more difficult cases, we will use more DNA profiling."

For parents like Haydeé Lemos, whose son was also abducted, the wait has been long.

Abdul Matlib (above) endured three years of Britain's slow-moving immigration process before DNA fingerprinting reunited him with his family. Here in a London hotel room he shares a midday meal with his wife, Bahar Khanum Begum, and two of their children.

Abdul came to England from East Pakistan (now Bangladesh) in the 1950s, a period when British citizenship was readily granted to people from Commonwealth countries. By the time he applied for citizenship in 1986, the laws had changed, requiring him to prove that his marriage to Bahar was legitimate and that her children, born in Bangladesh, were, in fact, his.

"Abdul's troubles affected us," Bahar says. "He was not there when some of the children were born. He only saw them for short times when he was able to return to Bangladesh."

In 1988 Abdul took his case to the United Kingdom Immigrant Advisory Service, a London agency that assists people with immigration problems and uses DNA fingerprinting to help its clients prove paternity. The agency had problems getting conclusive test results for Abdul's youngest son. The third test, however, showed that Abdul was indeed the father.

Inconsistent fingerprints can be caused by insufficient, degraded, or contaminated samples. Problems also arise when testing procedures vary. Laboratories are now standardizing techniques to prevent discrepancies.

Diagnosing Whales

Steadying his aim, Christopher Slay, a research assistant at the New England Aquarium in Boston, Massachusetts, prepares to loose a biopsy arrow into the back of a North Atlantic right whale. DNA extracted from whale skin yields fingerprints that will reveal paternity and the degree of inbreeding among these highly endangered mammals.

The animals feed and mate here off the southeast coast of Nova Scotia. Of the 150 or so female right whales in the North Atlantic, only 58 are known to have given birth since 1980.

Alarmed by the low number, researchers from four institutions will use DNA fingerprinting—together with photographic identification collected since 1980 by New England Aquarium zoologist Scott Kraus—to determine how many of the males are fathering calves.

"It will allow us to assess the reproductive health of the males," says Moira Brown, a zoologist from the University of Guelph in Ontario. "Because the females mate with several males at a time, we have no idea how successful an individual male is. Fingerprinting will eventually enable us to identify specific fathers."

Right whales, once prized for their blubber and baleen, were hunted almost to extinction by the mid-1800s. Low reproduction, perhaps from inbreeding, may be a direct result of the reduced population.

Zoologists at universities in Kingston and Hamilton, Ontario, use DNA fingerprinting to learn what percentage of DNA bands unrelated right whales have in common. This will give researchers an idea of how inbred the population is—yet one more example of how scientists learn from genetic profiling. □

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Forum

Search for Columbus

I want to express my satisfaction with the thoroughness and objectivity of Eugene Lyon's research on Columbus (January 1992). As a Portuguese American, I was particularly gratified by the emphasis on his contacts with Portuguese navigators, especially Prince Henry the Navigator, whose school at Sagres, Portugal, was the impetus for Portugal's age of discovery.

The only monument to Prince Henry outside Portugal exists in Fall River, Massachusetts. And in Newport, Rhode Island, at the sea's edge is a reproduction of the massive compass Henry used in Sagres.

ROBERT TEIXEIRA, JR.
Fall River, Massachusetts

There will soon be another monument to Prince Henry the Navigator: On June 10 a bust will be dedicated in San Juan, Puerto Rico.

Something about Columbus's signature looked strangely familiar. When I was a parochial student 35 years ago, we were encouraged to turn our attention to God during the day by reciting short, even one-word, prayers. We also put initials representing one of those prayers at the top of each worksheet above our names. I usually wrote J.M.J. for Jesus, Mary, Joseph, but I remember a possibly more desperate friend stringing initials across the entire top of her page.

KATHY CULLINAN
Columbus, Ohio

Some experts believe that Columbus used the initials above his name as mystical symbols: X may have stood for Christ, M for Mary, Y for Joseph.

Even a novice forensic document examiner knows that comparing cursive writing with hand-printing is like comparing apples with oranges. To claim they have a common source defies logic. One can guess, as Charles Hamilton does, at common authorship, but there is no scientific basis upon which to formulate such an opinion.

HOWARD A. BIRNBAUM
Forensic Document Examiner
Phoenix, Arizona

La Isabela

The distinction of being the first European town in America belongs to L'Anse aux Meadows,

Newfoundland, settled about the tenth century by Norwegians and Icelanders. As indicated by remains and artifacts, the site was inhabited for several years by both men and, importantly, women (unlike La Isabela). Iron smelting, fishing, ship repair, hunting, and the sewing of clothing and sails were carried on here. For Canadians L'Anse aux Meadows is the start of our European heritage.

MICHAEL SKRETTEBERG
Ajax, Ontario

La Isabela was formally laid out as a permanent Spanish foothold in the New World; from the start it had a mayor and its own industries. L'Anse aux Meadows served primarily as a winter base.

A note on the map (page 45) states that there were close to a million Taino Indians in 1494. My encyclopedia says there were only four million Indians in all of North America at that time. Is it possible that nearly one-fourth lived on tiny Hispaniola?

RALPH PETERS
Encinitas, California

The figure of one million came from Spanish officials attempting to count the Taino for tax purposes. Current estimates for the Indian population of the Americas as a whole range from 50 million to as many as 100 million.

U.S.S. *Macon*

I read with interest about the loss of the airship and studied the picture showing the remains of planes it had carried. I recall a conversation about 30 years ago with a retired aviation bosun mate who was a survivor of the disaster. He said when the *Macon* got into trouble, the crew was ordered to jettison the planes to lighten the ship and slow its descent. However, the nose was pitched up, and as the first plane was being positioned, it got jammed in the open hatch, trapping other planes behind it.

TAD T. RILEY
Chula Vista, California

I was a young sailor on the battleship U.S.S. *Pennsylvania* during fleet exercises on 12 February 1935. My personal log says it was a rough and stormy day. When I went topside, I saw the airship *Macon* hovering overhead. On the evening watch I happened to tune a spare transmitter to the 500 kHz international distress frequency. When the radio operator called for a 500 kHz transmitter, I signaled him to go ahead immediately.

The *Macon* had fallen into the sea, and the fleet was rushing to rescue the survivors. I went on the bridge. The whole area was illuminated by searchlights and flares. The flares ignited the fuel on the surface, adding to the problem of rescue.

I. L. MCNALLY
Sun City, California

Monk Seals

Memories flooded back of my years in Beirut, when I used to swim with a family of monk seals off

the coast of Lebanon in the late 1950s. It is my understanding that the monk seal was considered extinct in the Mediterranean; the University of Guelph in Canada gave me credit for "rediscovering" it there. I wonder how many are still around. The pup I photographed was killed; I made the mistake of making him unafraid of people.

DAVID C. PARKS
Wimberley, Texas

Severely endangered and shy of humans, Mediterranean monk seals are hard to count; their population is estimated at between 200 and 500.

Thanks to Diane Ackerman's superb writing, my husband (who is legally blind and to whom I read every word) and I could see the shining seals, hear their *baahs*, and feel concern for them.

LUCILLE C. TURNER
Frankfort, Indiana

I spent a year on Tern Island in the United States Coast Guard and witnessed firsthand the life cycles of many unusual and beautiful creatures. Once I was swimming over a reef, not realizing a seal was under it. We both cleared the edge and met face-to-face. I had to chuckle afterward, for we both panicked and sped in opposite directions.

JOHN M. NOON
Hamilton Square, New Jersey

Two years ago I received reports from the Marine Mammal Commission after an inquiry about helping manatees. In one I discovered the terrific need of the monk seals. In an attempt to get the word out I wrote to congressmen, members of the administration, and Mr. Grosvenor of NGS. I had never seen a monk seal and thought I never would see one until your article of January 1992. When I looked for an organization that took donations, my congressman suggested the National Fish and Wildlife Foundation, Suite 900, 1120 Connecticut Avenue N.W., Washington, D. C. 20036.

JAMES G. PEPPER
Dallas, Texas

Miami

I find it exhilarating that an article has been written that does not put my birthplace down. It is true that drugs and illegal aliens are big problems, but the city should not be judged by these factors only.

LAURA M. VICKERS
Conroe, Texas

You portrayed Miami as a wonderful place to visit or live. Surely you are aware of the high level of violent crimes against tourists. As victims of a strong-arm robbery at 11:30 a.m. on a major street in March 1991, my wife and I have a different view. We were advised that such crimes occur at least six times daily. I understand the authorities now pay travel expenses for victims who return to testify.

FRANK P. DOYLE
Toronto, Ontario

I am concerned that some sentences might mislead your readers into thinking Miami Beach is part of the city of Miami. It is in fact on an island, a separate municipality with its own government, police, and cultural life.

CHRISTINE DAVIDSON
Portsmouth, New Hampshire

Africa's Skeleton Coast

The Bartletts' article and photographs were as entertaining as they were cautionary and alarming. They are an urgent reminder of how very fragile life is, whether wild or human, in the Namib Desert and beyond.

EDMUND GEE
Sacramento, California

Geographica

I could not help responding to this short article on the cause of the fall of Jericho's walls. It appears that Amos Nur is trying to take credit away from the Almighty God. The biblical story does not say that God did or did not use an earthquake to achieve his purpose; likewise the Bible does not say that God used or did not use a so-called big bang to create the earth. It will take more than this to tumble the wall of faith of those who believe.

RONALD DENARDO
Kalamazoo, Michigan

Earth Almanac

The article about electric cars would make most readers think they have to wait several years to purchase one. The company where I work has been building electric cars since 1983. They travel up to a hundred miles at 65 mph and carry five passengers. At $18,000 the price is comparable to most new cars, but the total operating cost is about 25 percent less. We are the largest electric car manufacturer in the country and are currently taking orders, something large automakers can't claim.

ALEX CAMPBELL
Solar Electric Engineering
Santa Rosa, California

I have lived in the Sudbury area for 17 years and have seen it develop into a beautiful, modern city. But all you write about is the moonlike surface. Would you please come up and take pictures of the government buildings, the university, the four hospitals (including the Northeastern Ontario Regional Cancer Centre), and Lake Ramsey in the middle of downtown.

MARIE O'BRIEN
Chelmsford, Ontario

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Geographica

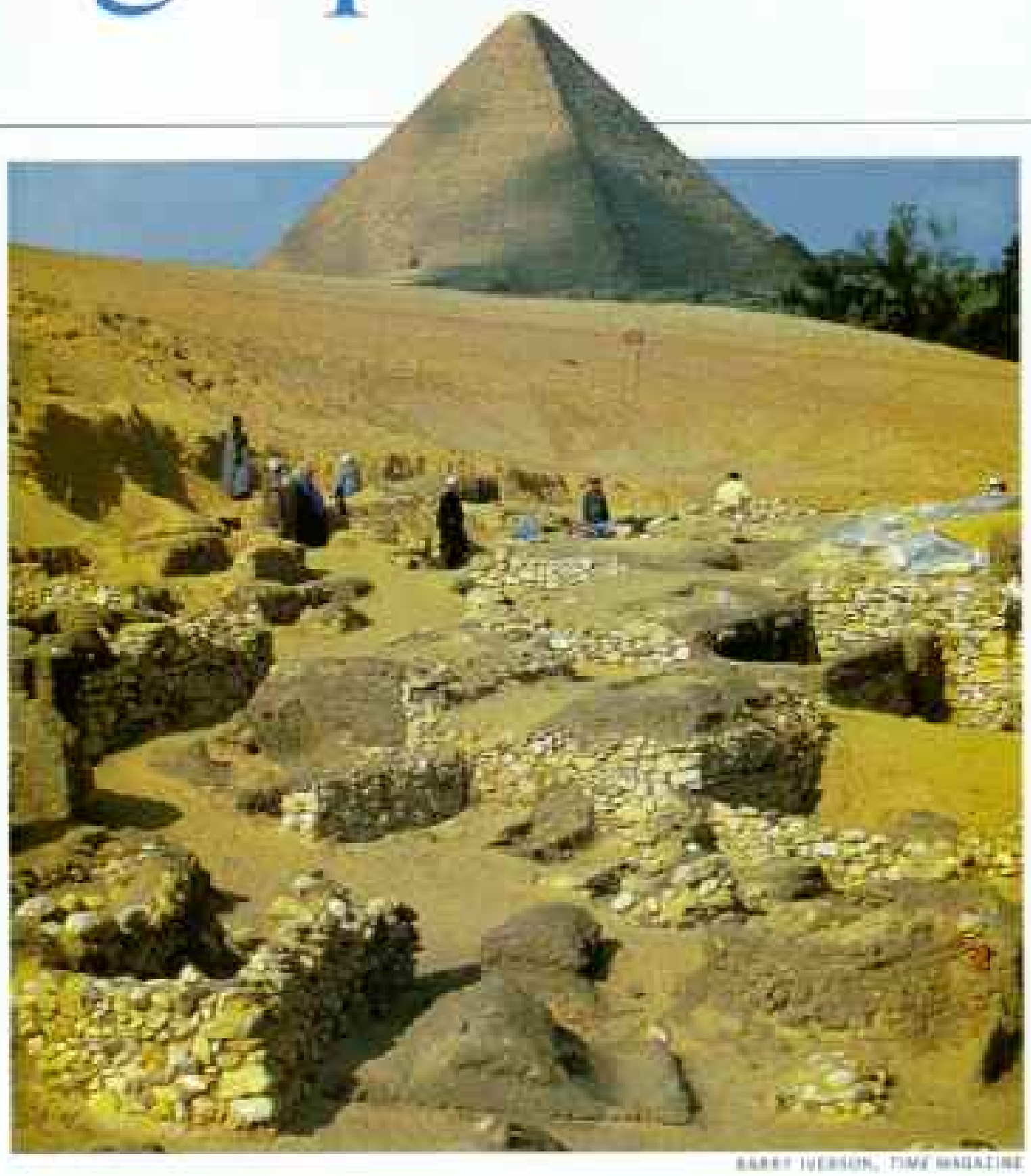
Uncovering the Lives of the Pyramid Builders

To Zahi Hawass, director general of Egypt's Giza Pyramids, the discovery of a vast buried settlement on the Giza plateau is more valuable than the tomb of Tutankhamun.

"What were found in King Tut's tomb are artifacts known throughout ancient history," says Hawass. "But we have never known anything about the people who *built* the Pyramids: how they lived, what they ate, what kinds of tombs they built for themselves."

In an open area southeast of the Sphinx (NATIONAL GEOGRAPHIC, April 1991) and beneath the nearby Cairo suburb of Nazlat as Samman, excavations led by Hawass and Mark Lehner of the University of Chicago are beginning to tell the story of the tens of thousands of Egyptians who built the Great Pyramids 4,600 years ago. Hawass and Lehner say that the laborers and artisans were not slaves but may have been conscripted workers.

So far the digs have revealed 159 tombs containing the remains of overseers and major craftsmen; a storage building, perhaps a granary; a bakery with a hearth and containers resembling egg cartons, which held the thousands of loaves of bread baked daily; and a huge wall with a 21-foot-high gateway through which workmen passed on their way to and from the Pyramids.



BARRY IVERSON, TIME MAGAZINE

To a Teacher, Home Is Where the Pupils Are

Maybe you *can* go home again.

Janice Herbranson lost her job as the only teacher in McLeod, North Dakota, in 1986, when her school found itself with only one student. After she was featured in a March 1987 GEOGRAPHIC article on North Dakota, she was offered a post teaching prekindergarten in Progreso, Texas, on the Mexican border. Her new school was much larger, with 600 pupils.

"I had 22 kids, and few spoke any English, only Spanish," she says. "It was a challenge, but I loved it."

When Herbranson visited her home, she found that things had changed in McLeod, population 40. Six children were now of school age, and a family living ten miles away wanted to send one more. The school offered Herbranson her old job back. Today she teaches six children in five grades—third grade has two.

"It's home here, you know," she says quietly.

ANNIE GRIFFITHS BELT

National Geographic, May 1992

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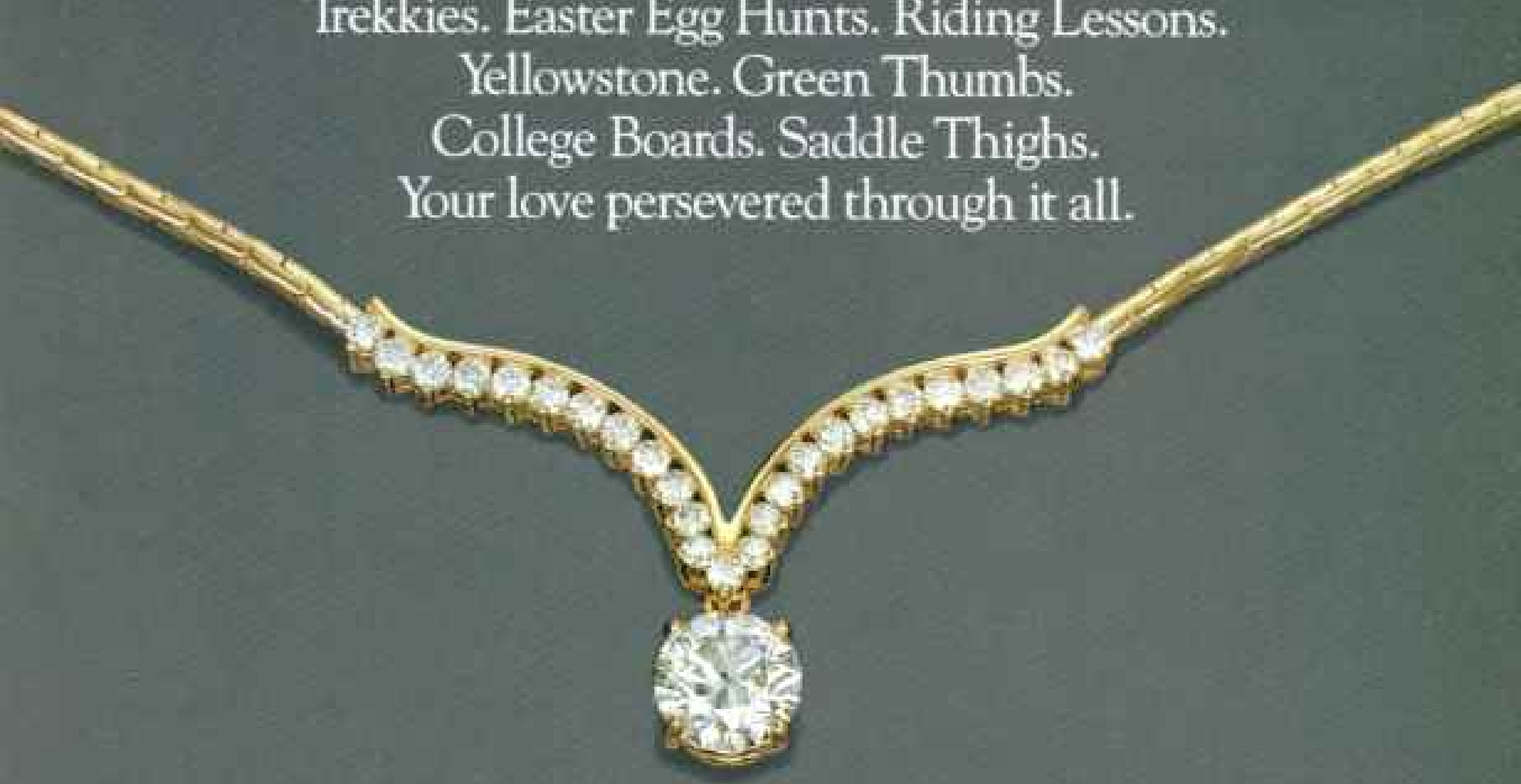

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Geographica

CHARLES KNIGHT

Why Pronghorn Play So Long and So Fast

Some animals are sprinters, able to reach high speeds for short bursts. Others are distance runners that can maintain a steady speed over time.

Then there is the pronghorn of North America, second among land animals only to the cheetah in its ability to run fast, as much as 55 miles an hour, and in a class by itself when it comes to maintaining speed while covering long distances.

To understand the unusual combination, Stan L. Lindstedt, a Northern Arizona University biologist, and several colleagues studied two pronghorn, often called antelope, trained to run on a treadmill.

"The difference between them and other animals is that they can send much more oxygen to the muscles," Lindstedt explains—five times as much oxygen, for example, as domestic goats.

"They have extra large lungs and a big heart to pump more blood—which is particularly rich in hemoglobin," he says. "Also, their muscles have more mitochondria, the little powerhouses in a cell that use oxygen to supply energy."

He believes that pronghorn may have developed the ability to run long and fast to escape their predators, coyotes and wolves, on the wide-open prairies of the West where there is no place to hide.

VICTOR R. BOSWELL, JR., NGS

Chinese Desert Fossils Locate an Ancient Sea

In far northwestern China, about as far from an ocean as any place on earth, scientists have turned up a vast array of fossils (below) of small ocean-dwelling animals that lived some 370 million years ago.

The fossils, which include new genera and new species, were found by three American paleontologists and two Chinese colleagues in Xinjiang Province.

Gary Lane of Indiana University, who joined Johnny Waters of West Georgia College and Chris Maples of the Kansas Geological Survey on the expedition, says the discovery helps locate the Asian portion of the Paleotethys Sea, which was wiped out when the continents merged into a supercontinent called Pangaea 300 million years ago. Similar fossils of the same age have been found as far away as England.

Lane, Maples, and Waters learned of the site from Chinese scientist Hou Hong-fei in 1987 and organized the expedition, funded by the National Geographic Society.

Burying Beetles Carry More Than Their Weight

If there were a weight-lifting competition for insects, the burying beetle would be the champion, hands down. Or legs up: When these beetles push a dead mouse that weighs up to 300 times as much as they do to a suitable burial spot, "they're bench-pressing with six legs" while flat on their backs, says University of New Hampshire zoologist Michelle Pellissier Scott.

The beetles bury treasure such as a mouse carcass to keep it away

HANS W. MOFFETT

from competitors. "A small dead thing is an enormous resource to other things: other beetles, flies, raccoons," says Scott.

When male and female meet around a carcass, they dig a hole and work to get the mouse into it. "Sometimes both push in the same direction," says Scott. "Other times, one digs at the nose while the other pushes it into the hole." Once they bury it, remove its fur, and roll it up into a ball, it becomes a food source for their offspring.

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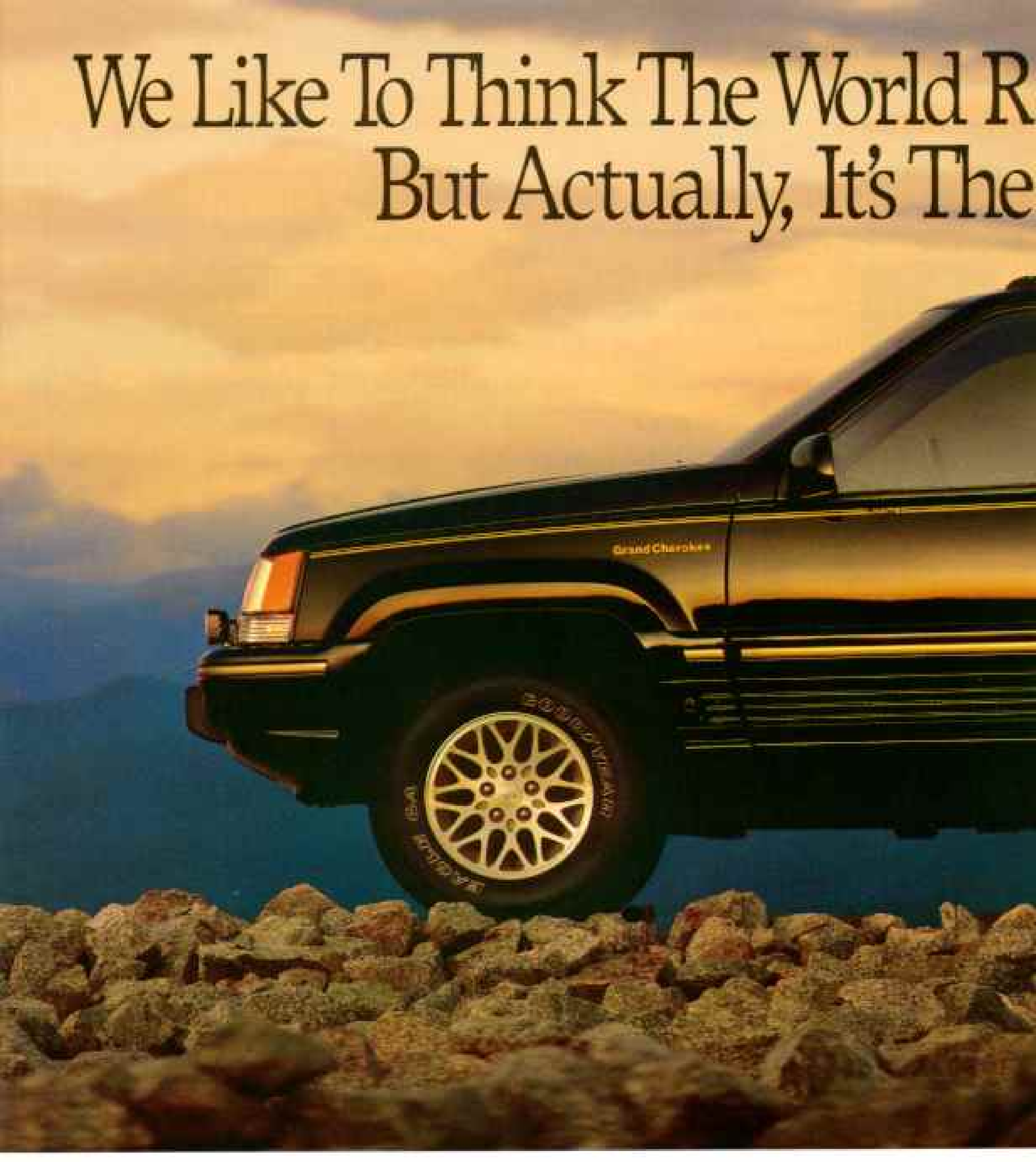

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Geographica

Babies Cry Out: Garlic, Yes; Alcohol, No

Common wisdom holds that if a nursing mother drinks beer, her baby will nurse better. Likewise, garlic should be avoided because garlic in milk makes an infant colicky.

Wrong.

At the Monell Chemical Senses Center (GEOGRAPHIC, October 1987), Julie Mennella and Gary Beauchamp tested this lore. In one study they gave mothers orange juice with a small quantity of alcohol one day, plain orange juice on another day. They found that alcohol gave milk an intense odor and that babies consumed less milk when their mothers drank the spiked juice.

In a second study the researchers gave mothers garlic tablets one day and placebos on another. "We didn't tell the mother which, but she knew pretty quickly, and everyone in the lab did too," says Beauchamp. When babies sucked garlic-laced milk, they nursed longer and consumed more than when they got "pure" milk—and none became colicky. PAINTING BY RICHARD THOMPSON

From Bronze Age Wreck, "More of Everything"

Even after eight excavation seasons, George F. Bass is still astonished by what his Institute of Nautical Archaeology team is finding at one of the world's oldest known shipwrecks, off Ulu Burun in Turkey (GEOGRAPHIC, December 1987).

DONALD A. FREY, INA

"We find more of this, more of that, everything is just more, more, more," says Bass.

Recent finds range from the large—copper ingots, now numbering 251 and "perhaps 100 more," according to field director Cemal Pulak—to the small, a gold ring and balance weights in the form of a lion and lioness; from the mundane, a bronze razor and a bronze saw, to the ornate, such as a ceremonial ax that, Pulak says drily, "you wouldn't use to chop wood." And there is the mysterious: Field reports call one item (above) "a most unusual stone object of unknown function."

Found by a Turkish sponge diver in 1982, the ship was a 14th-century B.C. trading vessel that held materials from at least seven cultures of the Late Bronze Age. The Institute of Nautical Archaeology team hopes to complete the excavation this summer and then to research the questions raised by the wreck, including the most basic: What was the ship's nationality, and where was she going when she sank?

It's a Plane! It's a Boat! It's a Record Holder!

The way Mark Drela tells it, he and his team have designed a small biplane, except that it flies underwater beneath a boat, and when the pilot pedals, it begins to rise out of the water, and if it's pedaled fast enough, the upper wing comes out of the water and the craft is really flying.

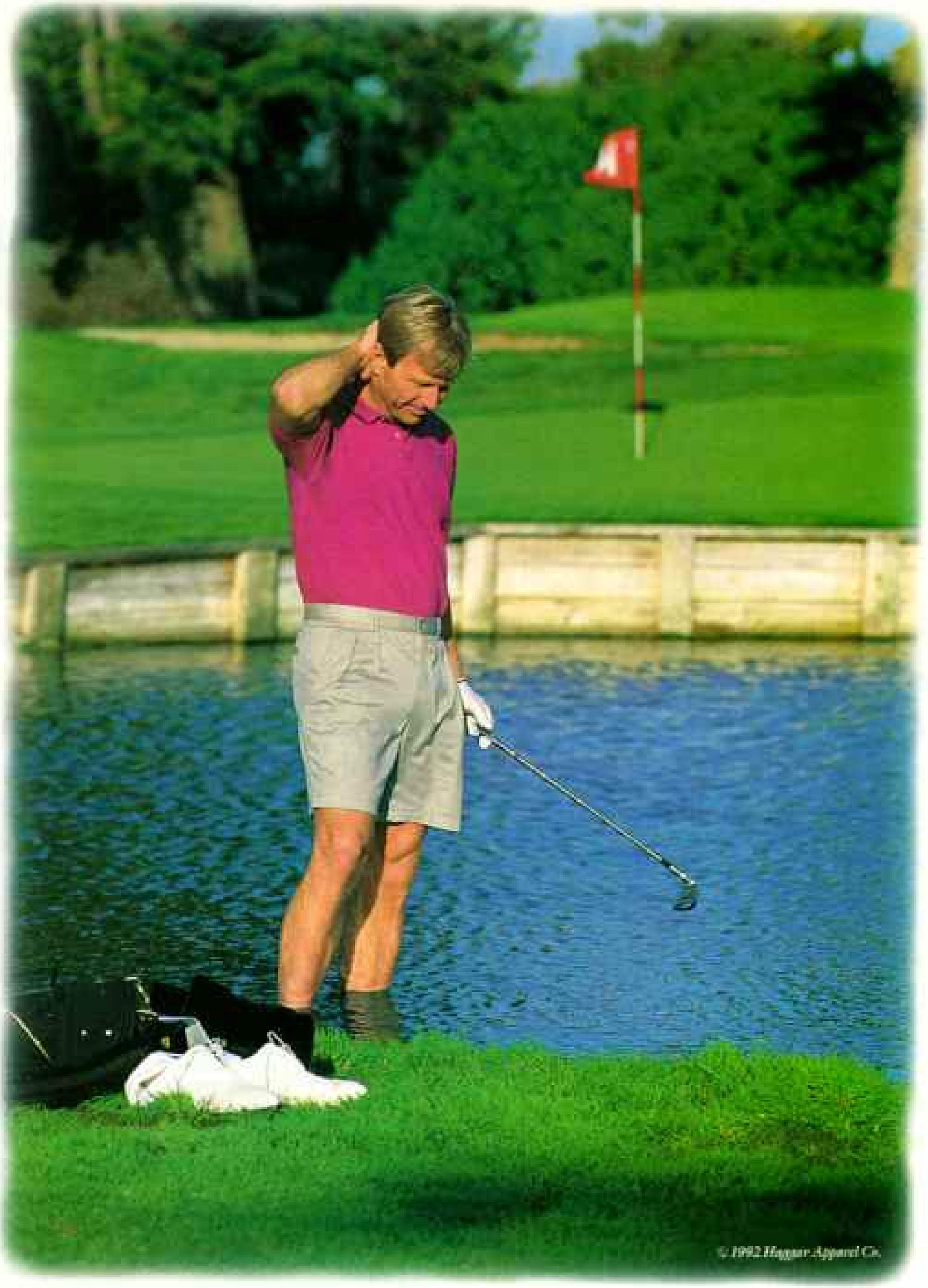
This is no ordinary boat, but then Drela is no ordinary Massachusetts Institute of Technology professor. Last fall, on the Charles River in Cambridge, he pedaled his hydrofoil to a world record human-powered speed of 18.5 knots.

Drela and his students began creating human-powered boats after he helped design *Daedalus*, which set a record for long-distance, human-powered flight (GEOGRAPHIC, August 1988). His watercraft, *Decavitator*, is the boat to beat for a $25,000 prize offered by Du Pont and the International Human-Powered Vehicle Association to the first human-powered craft to reach a speed of 20 knots or, failing that, the highest speed by year's end.

—BORIS WEINTRAUB

STEVE FINBERG

National Geographic, May 1992



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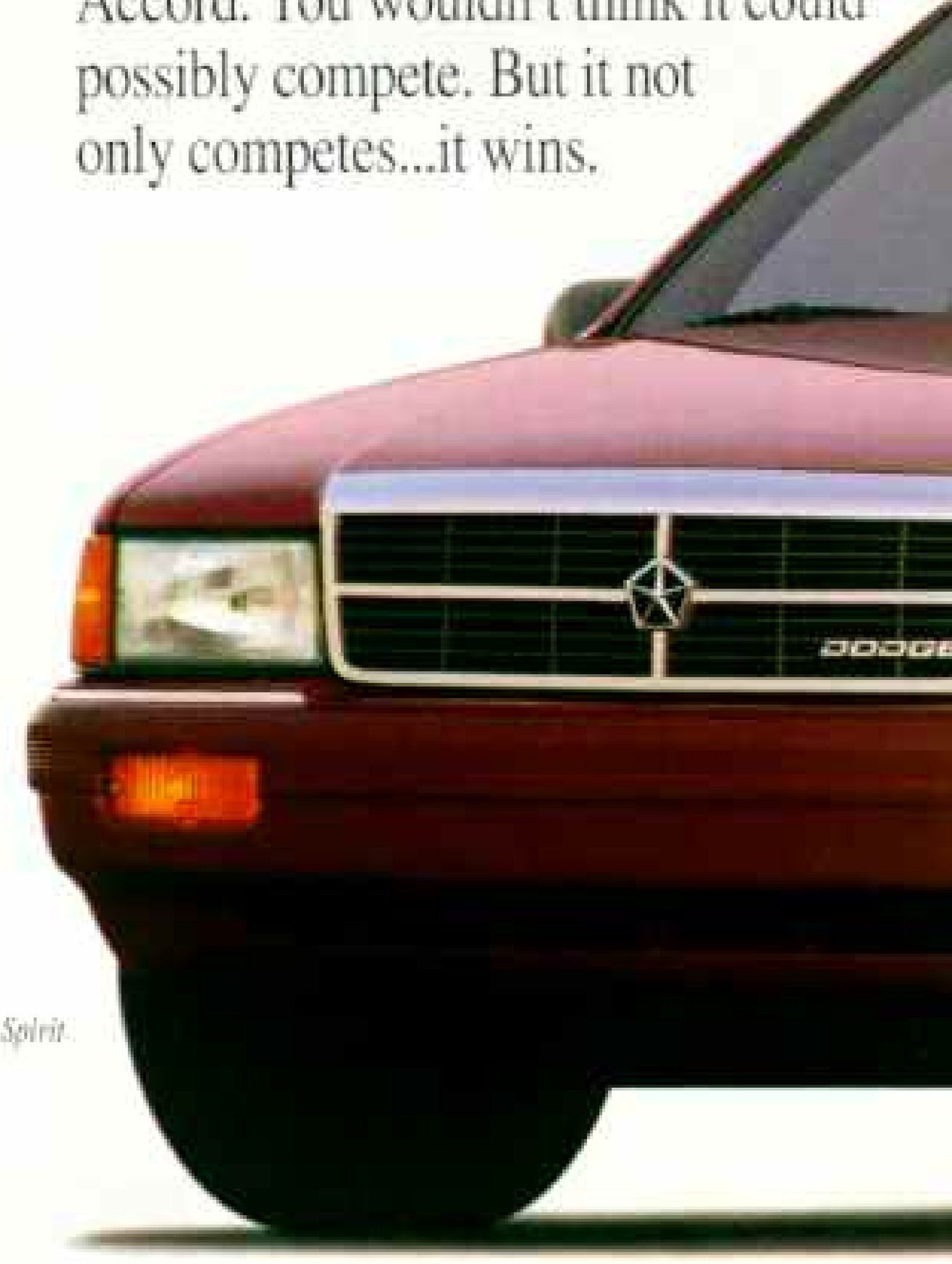

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The Peregrine Falcon: Flight to Recovery

NATIONAL GEOGRAPHIC ARTIST WILLIAM H. BOND

A peregrine falcon named Scarlett in 1978 captured the imagination of the public—and the interest of scientists striving to save her species. In the decade following, *Falco peregrinus* made a noteworthy comeback.

Researchers had released Scarlett in coastal Maryland as part of a program to bolster the U. S. population. Peregrines usually nest on cliffs, but Scarlett chose a ledge on the 33rd floor of a Baltimore office building. An excellent choice, since the great horned owl, a major predator, rarely ventures into the city, and pigeon dinners abound there.

In the West, researchers joined by ornithologist Tom Cade and his Peregrine Fund had already begun reintroducing peregrines into the wild, raising the snowy white chicks in captivity and placing them in the nests of foster parents. Meanwhile a major effort was taking place in the East, where no breeding pairs remained. Offspring of captive falcons were set out in cages to adjust to their new surroundings, a technique called hacking. The cages were placed on cliffs or man-made towers, but Scarlett inspired a new idea.

Scientists set four chicks in a nest atop the Interior Department in Washington, D. C. Office workers soon thrilled to the sight of the birds wheeling over the city. The first urban release program was a success.

The magnificent raptor had plunged dangerously close to extinction in the lower 48 states by the 1960s, when scientists detected DDT by-products in unusually fragile eggshells and dead birds. The use of the pesticide was virtually banned in the U. S., but peregrines continued to feed on birds that wintered in South and Central America, where it was not banned.

The cosmopolitan peregrine, a favorite of falconers, breeds on every continent except Antarctica, producing a clutch of three or four eggs annually. Hatching after four weeks, the young begin flying and hunting at six weeks. An adult peregrine can achieve 60 miles an hour in flight speed but cuts the most impressive figure in direct pursuit of prey. Wings folded, it drops toward a victim at 200 miles an hour. Hurtling downward, the falcon stuns or kills its target with a blow of its talons and circles back to recover the prey in mid-air or from the ground. Pairs may hunt together, one chasing an unwitting bird into the path of the other.

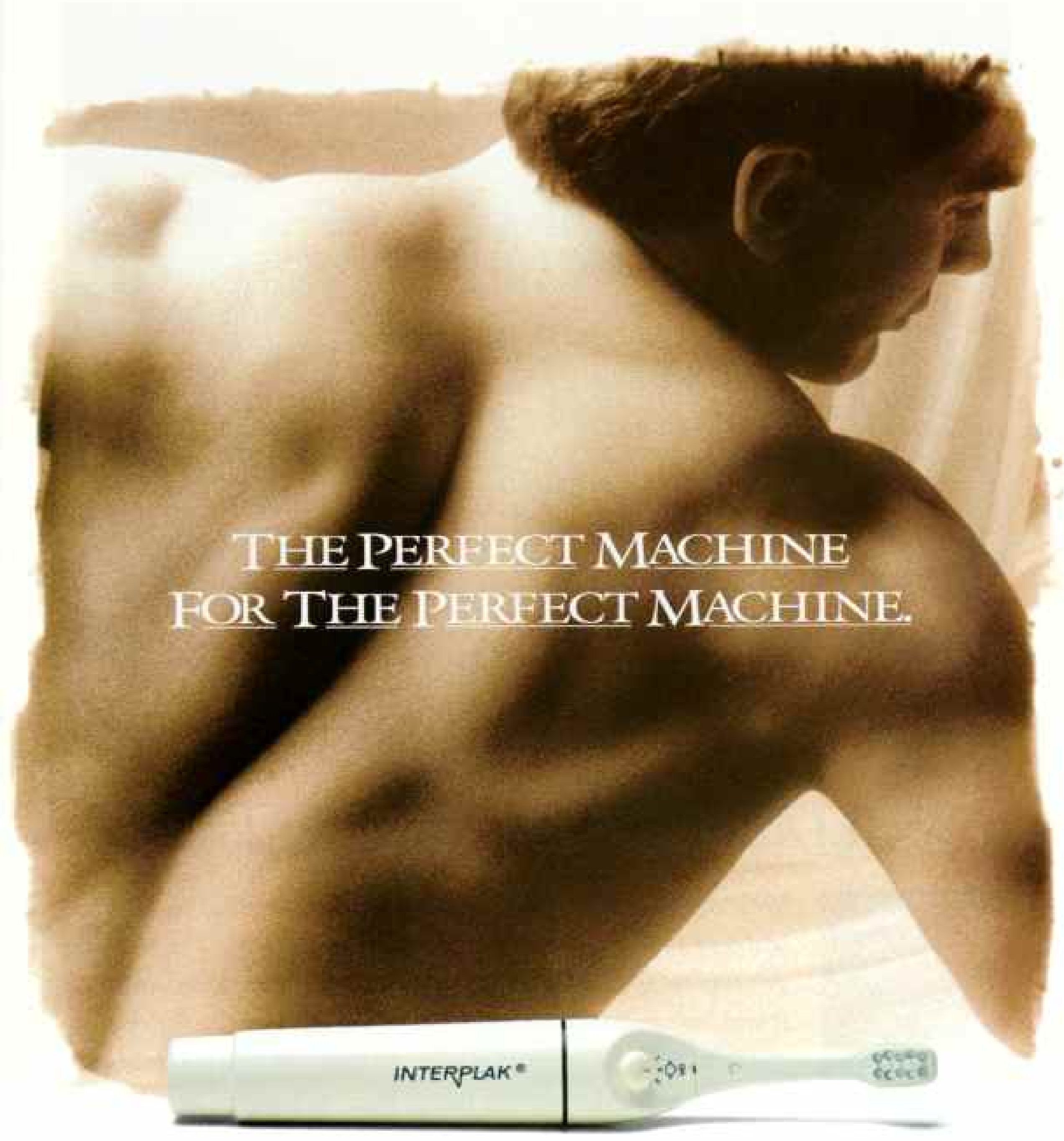
Though the peregrine is still endangered in the lower 48, the fund reports that more than 4,000 peregrines have been released, and some 700 nesting pairs are known today—up from 60 pairs in 1975 (see "Falcon Recovery" in the April 1991 GEOGRAPHIC). In many regions the peregrine population has become self-sustaining.

Scarlett raised 22 chicks, four from her own eggs, and will remain a symbol of successful wildlife conservation. □

WILDLIFE AS CANON SEES IT

Saunder's Gull
Genus: *Larus*
Species: *saundersi*
Adult size: Length, 32.5 cm
Adult weight: 200–250 g
Habitat: Nests in salt marshes in China; winters in China, Taiwan, Korea and Japan
Surviving number: Estimated at 2,000
Photographed by Mark A. Brazil

With two eggs still to hatch, a Saunder's gull remains on the nest, while its firstborn chick snuggles up close to sleep. The breeding grounds for this bird were unknown for more than a century since it was first discovered in 1871. Requiring salt marshes for nesting, the Saunder's gull survives in only two main colonies in China, both of which are under serious threat from reclamation projects. To save endangered species, it is essential to protect their habitats and understand the vital role of each species within the earth's ecosystems. Color images, with their unique ability to reach people, can help promote a greater awareness and understanding of the Saunder's gull and our entire wildlife heritage.



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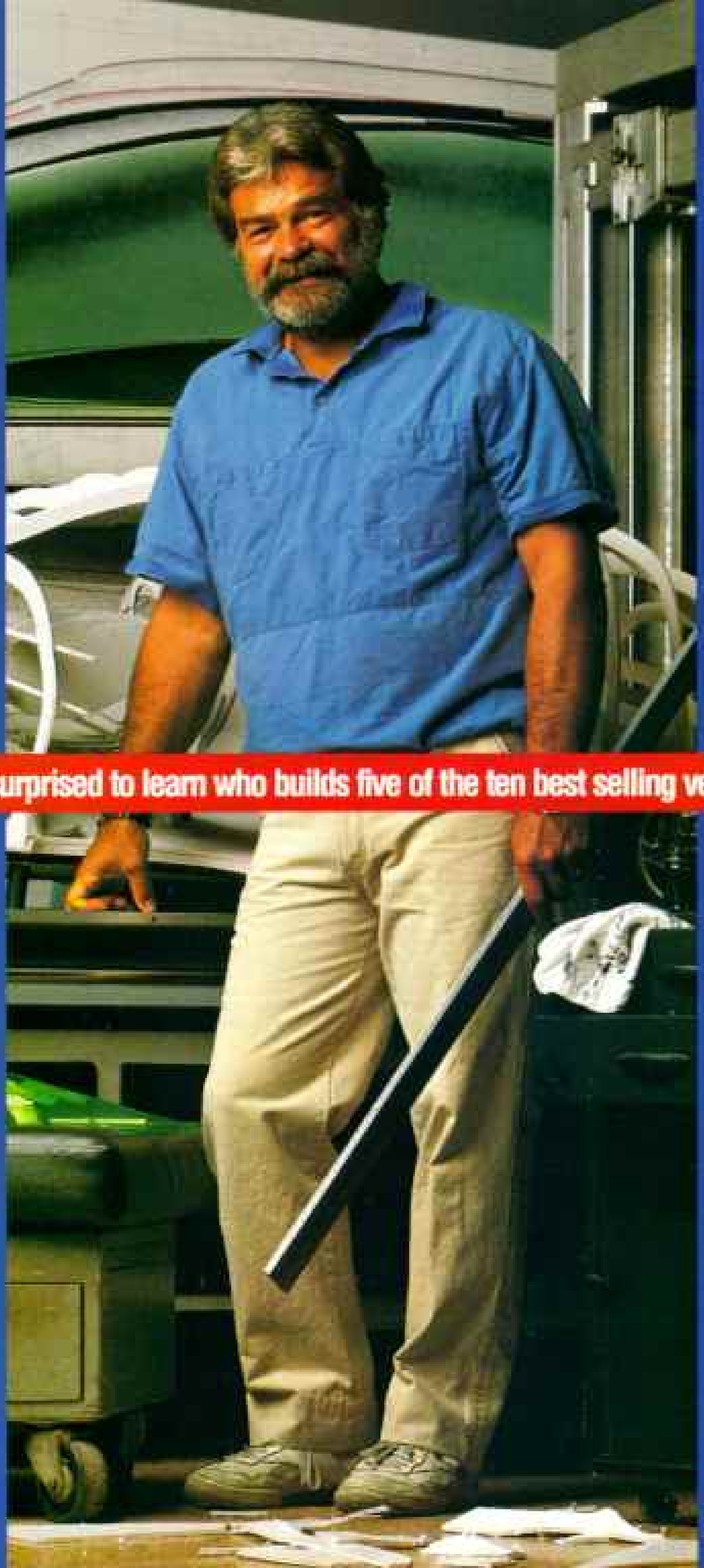

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Call 1-800-GO-TOYOTA for a brochure and location of your nearest dealer. *1992 EPA estimated figures shown for the Corolla LE Sedan with 4-speed automatic overdrive transmission. †Based on worldwide sales 1966–1991. Get More From Life...Buckle Up. © 1991 Toyota Motor Sales, U.S.A., Inc.

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(nitroglycerin)
TRANSDERMAL DELIVERY SYSTEM

BRIEF SUMMARY

INDICATIONS AND USAGE

This drug product has been conditionally approved by the FDA for the prevention of angina pectoris due to coronary artery disease. Tolerance to the anti-anginal effects of nitrates (measured by exercise stress testing) has been shown to be a major factor limiting efficacy when transdermal nitrates are used continuously for longer than 12 hours each day. The development of tolerance can be altered (prevented or attenuated) by use of a noncontinuous (intermittent) dosing schedule with a nitrate-free interval of 10–12 hours.

Controlled clinical trial data suggest that the intermittent use of nitrates is associated with decreased exercise tolerance, in comparison to placebo, during the last part of the nitrate-free interval; the clinical relevance of this observation is unknown, but the possibility of increased frequency or severity of angina during the nitrate-free interval should be considered. Further investigations of the tolerance phenomenon and best regimen are ongoing. A final evaluation of the effectiveness of the product will be announced by the FDA.

CONTRAINDICATIONS: Allergic reactions to organic nitrates are extremely rare, but they do occur. Nitroglycerin is contraindicated in patients who are allergic to it. Allergy to the adhesives used in nitroglycerin patches has also been reported, and it similarly constitutes a contraindication to the use of this product. **WARNINGS:** The benefits of transdermal nitroglycerin in patients with acute myocardial infarction or congestive heart failure have not been established. If one elects to use nitroglycerin in these conditions, careful clinical or hemodynamic monitoring must be used to avoid the hazards of hypotension and tachycardia. A cardioverter defibrillator should not be discharged through a paddle electrode that overlies a MINITRAN patch. The arcing that may be seen in this situation is harmless in itself, but it may be associated with local current concentration that can cause damage to the paddles and burns to the patient. **PRECAUTIONS:** General: Severe hypotension, particularly with upright posture, may occur with even small doses of nitroglycerin. This drug should therefore be used with caution in patients who may be volume depleted or who, for whatever reason, are already hypotensive. Hypotension induced by nitroglycerin may be accompanied by paradoxical bradycardia and increased angina pectoris. Nitrate therapy may aggravate the angina caused by hypertrophic cardiomyopathy. As tolerance to other forms of nitroglycerin develops, the effect of sublingual nitroglycerin on exercise tolerance, although still observable, is somewhat blunted. In industrial workers who have had long-term exposure to unknown (presumably high) doses of organic nitrates, tolerance clearly occurs. Chest pain, acute myocardial infarction, and even sudden death have occurred during temporary withdrawal of nitrates from these workers, demonstrating the existence of true physical dependence. Several clinical trials in patients with angina pectoris have evaluated nitroglycerin regimens which incorporated a 10–12 hour nitrate-free interval. In some of these trials, an increase in the frequency of anginal attacks during the nitrate-free interval was observed in a small number of patients. In one trial, patients demonstrated decreased exercise tolerance at the end of the nitrate-free interval. Hemodynamic rebound has been observed only rarely; on the other hand, few studies were so designed that rebound, if it had occurred, would have been detected. The importance of these observations to the routine, clinical use of transdermal nitroglycerin is unknown. **Information for Patients:** Daily headaches sometimes accompany treatment with nitroglycerin. In patients who get these headaches, the headache may be a marker of the activity of the drug. Patients should resist the temptation to avoid headaches by altering the schedule of their treatment with nitroglycerin, since loss of headache may be associated with simultaneous loss of anti-anginal efficacy. Treatment with nitroglycerin may be associated with lightheadedness on standing, especially just after rising from a recumbent or seated position. This effect may be more frequent in patients who have also consumed alcohol. After normal use, there is enough residual nitroglycerin in discarded patches that they are a potential hazard to children and pets. A patient leaflet is supplied with the systems. **Drug Interactions:** The vasodilating effects of nitroglycerin may be additive with those of other vasodilators. Alcohol, in particular, has been found to exhibit additive effects of this variety. **Carcinogenesis, Mutagenesis, and Impairment of Fertility:** No long-term animal studies have examined the carcinogenic or mutagenic potential of nitroglycerin. Nitroglycerin's effect upon reproductive capacity is similarly unknown. **Pregnancy Category C:** Animal reproduction studies have not been conducted on nitroglycerin. It is also not known whether nitroglycerin can cause fetal harm when administered to a pregnant woman or whether it can affect reproductive capacity. Nitroglycerin should be given to a pregnant woman only if clearly needed. **Nursing Mothers:** It is not known whether nitroglycerin is excreted in human milk. Because many drugs are excreted in human milk, caution should be exercised when nitroglycerin is administered to a nursing woman. **Pediatric Use:** Safety and effectiveness in children have not been established. **ADVERSE REACTIONS:** Adverse reactions to nitroglycerin are generally dose-related, and almost all of these reactions are the result of nitroglycerin's activity as a vasodilator. Headache, which may be severe, is the most commonly reported side effect. Headache may be recurrent with each daily dose, especially at higher doses. Transient episodes of lightheadedness, occasionally related to blood pressure changes, may also occur. Hypotension occurs infrequently, but in some patients it may be severe enough to warrant discontinuation of therapy. Syncope, crescendo angina, and rebound hypertension have been reported but are uncommon. Extremely rarely, ordinary doses of organic nitrates have caused methemoglobinemia in normal-seeming patients. Methemoglobinemia is so infrequent at these doses that further discussion of its diagnosis and treatment is deferred (see **Overdosage**). Application-site irritation may occur but is rarely severe. In two placebo-controlled trials of intermittent therapy with nitroglycerin patches at 0.2 to 0.8 mg/hr, the most frequent adverse reactions among 307 subjects were as follows:

	placebo	patch		placebo	patch
headache	18%	63%	hypotension and/or syncope	0%	4%
lightheadedness	4%	6%	increased angina	2%	2%

OVERDOSAGE: Hemodynamic Effects: The ill effects of nitroglycerin overdose are generally the results of nitroglycerin's capacity to induce vasodilatation, venous pooling, reduced cardiac output, and hypotension. These hemodynamic changes may have protean manifestations, including increased intracranial pressure, with any or all of persistent throbbing headache, confusion, and moderate fever; vertigo; palpitations; visual disturbances; nausea and vomiting (possibly with colic and even bloody diarrhea); syncope (especially in the upright posture); air hunger and dyspnea, later followed by reduced ventilatory effort; diaphoresis, with the skin either flushed or cold and clammy; heart block and bradycardia; paralysis; coma; seizures; and death. Laboratory determinations of serum levels of nitroglycerin and its metabolites are not widely available, and such determinations have, in any event, no established role in the management of nitroglycerin overdose. No data are available to suggest physiological maneuvers (e.g., maneuvers to change the pH of the urine) that might accelerate elimination of nitroglycerin and its active metabolites. Similarly, it is not known which – if any – of these substances can usefully be removed from the body by hemodialysis. No specific antagonist to the vasodilator effects of nitroglycerin is known, and no intervention has been subject to controlled study as a therapy of nitroglycerin overdose. Because the hypotension associated with nitroglycerin overdose is the result of vasodilatation and arterial hypovolemia, prudent therapy in this situation should be directed toward increase in central fluid volume. Passive elevation of the patient's legs may be sufficient, but intravenous infusion of normal saline or similar fluid may also be necessary. The use of epinephrine or other arterial vasoconstrictors in this setting is likely to do more harm than good. In patients with renal disease or congestive heart failure, therapy resulting in central volume expansion is not without hazard. Treatment of nitroglycerin overdose in these patients may be subtle and difficult, and invasive monitoring may be required. **Methemoglobinemia:** Nitrate ions liberated during metabolism of nitroglycerin can oxidize hemoglobin into methemoglobin. Even in patients totally without cytochrome b_5 reductase activity, however, and even assuming that nitrate moieties of nitroglycerin are quantitatively applied to oxidation of hemoglobin, about 1 mg/kg of nitroglycerin should be required before any of these patients manifests clinically significant (≥ 10%) methemoglobinemia. In patients with normal reductase function, significant production of methemoglobin should require even larger doses of nitroglycerin. In one study in which 36 patients received 2–4 weeks of continuous nitroglycerin therapy at 3.1 to 4.4 mg/hr, the average methemoglobin level measured was 0.2%; this was comparable to that observed in parallel patients who received placebo. Notwithstanding these observations, there are case reports of significant methemoglobinemia in association with moderate overdoses of organic nitrates. None of the affected patients had been thought to be unusually susceptible. Methemoglobin levels are available from most clinical laboratories. The diagnosis should be suspected in patients who exhibit signs of impaired oxygen delivery despite adequate cardiac output and adequate arterial pO_2. Classically, methemoglobinemic blood is described as chocolate brown, without color change on exposure to air. When methemoglobinemia is diagnosed, the treatment of choice is methylene blue, 1–2 mg/kg intravenously. **DOSAGE AND ADMINISTRATION:** The suggested starting dose is between 0.2 mg/hr* and 0.4 mg/hr*. Doses between 0.4 mg/hr* and 0.8 mg/hr* have shown continued effectiveness for 10–12 hours daily for at least one month (the longest period studied) of intermittent administration. Although the minimum nitrate-free interval has not been defined, data show that a nitrate-free interval of 10–12 hours is sufficient (see **Clinical Pharmacology**). Thus, an appropriate dosing schedule for nitroglycerin patches would include a daily patch-on period of 12–14 hours and a daily patch-off period of 10–12 hours. Although some well-controlled clinical trials using exercise tolerance testing have shown maintenance of effectiveness when patches are worn continuously, the large majority of such controlled trials have shown the development of tolerance (i.e., complete loss of effect) within the first 24 hours after therapy was initiated. Dose adjustment, even to levels much higher than generally used, did not restore efficacy. **STORAGE CONDITIONS:** Store at controlled room temperature 15°–30°C (59°–86°F). Extremes of temperature and/or humidity should be avoided. **CAUTION:** Federal law prohibits dispensing without prescription.

*Release rates were formerly described in terms of drug delivered per 24 hours. In these terms, the supplied MINITRAN systems would be rated at 2.5 mg/24 hours (0.1 mg/hr), 5 mg/24 hours (0.2 mg/hr), 10 mg/24 hours (0.4 mg/hr), and 15 mg/24 hours (0.6 mg/hr).

3M Pharmaceuticals
Northridge, CA 91324

NTR-6BS JUNE 1991

REFERENCES: 1. Hougham AJ, Hawkinson RW, Crowley JK, et al. *Clin Ther.* 1989;11(1):15–31. 2. Pharmaceutical Data Services: Scottsdale, AZ: Jan 1992.
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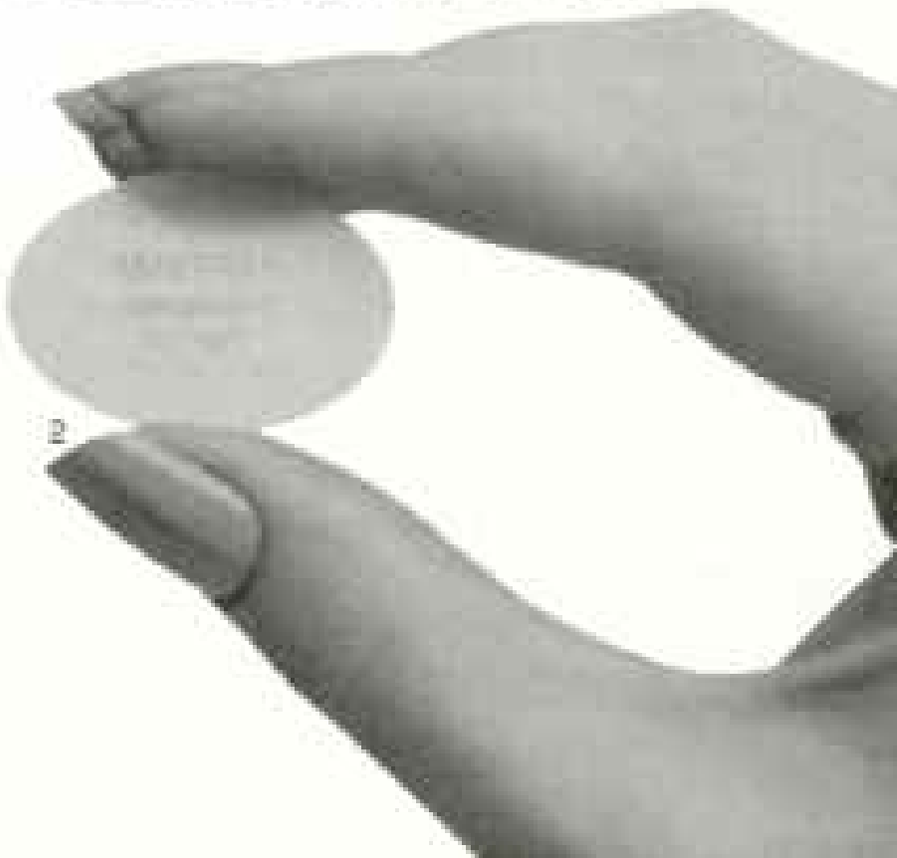

On Television

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NASA

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Earth is the focus of many ISY activities, as scientists use space technology to study global threats to our environment. Such studies owe much to a viewpoint new in human experience—the sight of a small blue ball turning in the void. As Al Reinert says, "The pictures Apollo sent back of our planet, our home, gave earthbound millions their first truly global perspective." We went to the moon and discovered earth.

"For All Mankind" is a May selection of the National Geographic Video Club. Call 1-800-447-0647

NEIL A. ARMSTRONG, NASA

Ballooning Over Mount Everest

It seems a serene pastime, but not if your ambition is to be the first to soar by hot-air balloon over Mount Everest. On October 21, 1991, Australian Chris Dewhirst and Britons Leo Dickinson, Eric Jones, and Andy Elson braved the turbulence swirling about the world's highest peak.

Choosing the method that first put humans aloft in 1783, the four balloonists confronted 65-mile-an-hour winds in the jet stream, a vortex that could suck them into the face of the mountain, unpredictable gusts near the ground, and temperatures 69° below zero F.

"I thought ballooning rated low on the adrenaline scale," said Dickinson, veteran of 2,500 skydives. "I was wrong."

"The Great Everest Balloon Race" will air May 10 on Explorer, cable network TBS, 9 P.M. ET

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Logic would seem to dictate that when you pay thousands of dollars more for a car, you should get a lot more car. Apparently, in the case of the Cadillac Sedan DeVille versus the Chrysler Fifth Avenue, logic does not apply. Both cars provide ample room for six, air-conditioning, automatic transmission, automatic load leveling, stereo sound system, fully reclining seats, all as standard equipment. Both offer safety and performance. A driver's air bag is standard on the Chrysler Fifth Avenue, as is a powerful fuel-injected, 3.3-liter V-6. Anti-lock brakes are also available. Here, however, is where logic totally falls apart. The restyled Chrysler Fifth Avenue costs thousands less, yet it has more rear legroom than the largest Cadillac.* And it offers a better warranty: bumper-to-bumper protection for 5 years or 50,000 miles† So if you're looking for a great luxury car, defy logic. Pay less, get more.

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*Standard equipment levels vary. Legroom comparison to Cadillac Brougham. †Excludes normal maintenance adjustments and certain wear items. See limited warranty at dealer. Some restrictions apply.

Earth Almanac

An Epic Eclipse for Southern California

The moon made a pass at the sun last January 4 and set off celestial fireworks. Southern Californians, who booked seaside tables and climbed to overlooks, watched as the moon partly blocked the setting sun. Encircling the lunar disk, blazing edges of sunlight sank into the Pacific in a rarely seen annular eclipse.

In the July 1991 total eclipse (pages 30-51) the moon was close enough to earth to block the sun completely. But for January's eclipse the moon was too far from earth to totally obscure the sun. Thus the brilliant halo of sunlight escaped: the term "annular" derives from the Latin word for ring.

"People were oohing and aahing," said Bernard V. Jackson, a solar physicist who viewed the spectacle from a San Diego hilltop with two dozen other onlookers. The best seats were there and in parts of Orange County; overcast skies blocked the view in Los Angeles.

ROGER N. REDMEYER, STARLIGHT

Spinning Spiders: Pioneers of the Wheel

Down the slope of a sand dune comes a hurtling blur (sequence below), gaining speed on the steep dune face, rolling madly over the sand, skittering for hundreds of feet toward the horizon. Is it a lizard? A dust devil? No—it's superspider!

Actually, it's the golden wheel spider, one of several spiders in Africa's Namib Desert that escape predators by turning themselves into disks and rolling away. They illustrate the first confirmed use of the wheel by an animal.

The spiders make their burrows in dunes. There they are hunted by pompilid wasps, which try to sting the spiders and lay an egg on the immobilized victim—food for the developing wasp.

Smart spiders live near the dune tops. When a wasp attacks, the spider flips sideways and does continuous cartwheels down the dune slope out of danger. Namibian zoologist Johannes Henschel says the spiders spin at an incredible rate—as many as 44 revolutions a second, equivalent to the wheel rotation of a car traveling at 200 miles an hour. They roll until the slope flattens out—as far as a hundred yards. Spiders living near the base of the dune can't roll far and are soon punctured by the wasps.

CARMICHAEL KURZEJESKA; J. H. HENSCHEL, ANTHONY BANNISTER PHOTO LIBRARY

National Geographic, May 1992

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Crusader for Earth Also Fights a Personal Battle

"Chlorofluorocarbons," a word that would tongue-tie most 11-year-olds, comes easily to Caralynn Fejka. So do "ozone" and "global warming," which Cara explains to her younger sister Stefanie's classmates in Coraopolis, Pennsylvania.

"I recommend that you check your refrigerators, air conditioners, and dehumidifiers," she counsels, "because leaks from old appliances can destroy our ozone."

Cara battles both environmental dangers and a personal threat—lymphoma, a form of cancer that has responded favorably to treatment.

Last November she took her message to Washington, D. C., thanks to the Make-A-Wish Foundation, which helps make dreams come true for children with life-threatening diseases. She visited Vice President Dan Quayle and several congressmen and stopped by National Geographic for a chat with President Gil Grosvenor and Editor Bill Graves.

As Cara told the class, "Maybe all these problems sound scary to you. I decided not to be afraid. And you can make a difference."

MICHAEL LUTZKY, NGS

Red Wolves Return to Smoky Mountains

After decades of silence the howl of the red wolf has returned to Great Smoky Mountains National Park. Last November this pup (below), a sibling, and their zoo-bred parents were released into the park as an experiment prior to full reintroduction.

GREAT SMOKY MOUNTAINS NATIONAL PARK

Throughout the Southeast, habitat loss and the toll of hunters reduced these small, shy wolves to fewer than a hundred by 1970. Before they became extinct in the wild, several dozen were captured to start a breeding program. In 1987 the first were freed in North Carolina. With the release of four in the Smokies, about 30 roam the wild again.

But a genetics study raises a new question: Is the red wolf a separate species, protected under the Endangered Species Act, or a hybrid, a cross between the coyote and the gray wolf? The red wolf has interbred with both.

"In our view it is a distinct species," says biologist Chris Lucash of the U. S. Fish and Wildlife Service. "It predates the gray wolf in North America."

Meet the Cuttlefish—Master of Camouflage

A trick called countershading helps fish and other marine dwellers fool predators.

Because sunlight comes from above, an animal's upper surface tends to look brighter than its underparts when viewed from the side. Some creatures have overcome this by evolving dark tops and pale undersides. The minimized contrast makes them much harder to see.

Countershading is usually fixed and works only if the animal maintains its normal orientation. But coloration can be changed by cuttlefish (below), squid, and octopus, report biologists Graham Ferguson of the Stazione Zoologica in Naples and John Messenger of the University of Sheffield. It is known that pigment sacs in the skin of these cephalopods can expand or shrink to change color patterns. The researchers found that a cuttlefish turned upside down instantly expands the sacs on its belly and constricts those on top to reverse its countershading.

JOHN FORSYTHE, MARINE BIOMEDICAL INSTITUTE

—John L. Eliot

National Geographic, May 1992

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On Assignment

ROGER H. RESSMEYER, STARLIGHT

A trip to Hawaii was no day at the beach for ROGER RESSMEYER, who led the GEOGRAPHIC team photographing the solar eclipse for this issue. Along with his wife, Jain, and Joe Stancampiano, the Society's senior photographic equipment expert, Roger made several dry runs atop frigid Mauna Kea during the two weeks before the eclipse. Roger, who first scouted the site for the best shots back in 1987, positioned 23 cameras, set the exposures, and orchestrated the team at totality.

Pictured on Mauna Kea are, from left, text editor Tom Canby and, for pictures, Senior Assistant Editor Mary Smith; Ressmeyer; GEOGRAPHIC Editor Bill Graves; Stancampiano; and Jain Ressmeyer.

Covering the war-torn, newly declared Republic of Georgia, photographer TOMASZ TOMASZEWSKI (right, at left) needed his own support team. Two armed Soviet soldiers rode with him in a military vehicle as he traveled between warring factions. "Otherwise, I would have been shot," says Tomasz. He was struck in the head by a rock at a riot in the capital, Tbilisi, and, along with author ANGUS ROXBURGH, was stranded in a car for nine hours by a spring blizzard.

Tomasz's luck nearly ran out when his helicopter hit power lines and crashed. Luckily, electricity had been cut two days before by an earthquake. Tomasz walked away, but he says, "Of eight people on board, I think two died. There was no official report."

Based in Warsaw, Tomasz photographed Poland's last Jews and the final days of communism in Eastern Europe for the magazine. "Georgia was exciting," he admits, "but it was the kind of adventure you don't really want to remember!"

ANTONIO RIBEIRO, GAMMA-LIAISON

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