

VOL. 184, NO. 2



AUGUST 1993

NATIONAL GEOGRAPHIC

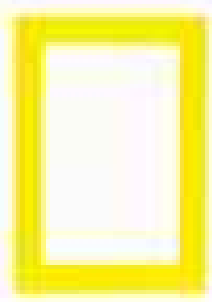
SWEDEN 2

BACTERIA 36

TIBET'S REMOTE
CHANG TANG 63

UNTAMED
TREASURE
OF THE
CUMBERLAND 123

Tragedy
Stalks
the Horn
of Africa 88



NATIONAL GEOGRAPHIC

AUGUST 1993

Sweden

*By Don Belt
Photographs by
Tomasz Tomaszewski*



Architects of a model welfare state, Swedes find their tidy world challenged by economic recession and immigrants behaving in decidedly un-Swedish ways.

2

Bacteria

*By Thomas Y. Canby
Photographs by
Charles O'Rear*



Vital to life, bacteria are the oldest, most abundant, and perhaps most useful organisms on earth. Today they star in everything from making headphones to cleaning up toxic wastes.

36

Tibet's Remote Chang Tang

*Article and photographs
by George B. Schaller*



The world's newest top-rank nature reserve is a high, stark, windswept realm, an Arizona-size land that is home to lynxes, wild yaks, and Tibetan antelope.

62

Tragedy Stalks the Horn of Africa

*Article and photographs
by Robert Caputo*



Behind the face of famine lies chronic warfare that has beset the Horn of Africa for generations. Can the beleaguered nations end the cycle of death that has already claimed millions?

88

Untamed Treasure of the Cumberland

*By Howard H. Baker, Jr.
Photographs by Pete Souza*



Twenty years ago a boisterous branch of the Cumberland River named Big South Fork inspired the creation of a 100,000-acre preserve in Tennessee and Kentucky.

123

COVER: Struggling with each step, a young woman seeks supplies at a relief center on the scorched outskirts of Baidoa, Somalia. Photograph by Robert Caputo.

Cover printed on recycled-content paper.

FOR MEMBERSHIP INFORMATION CALL 1-800-638-4077 (TDD: 1-800-548-9797)

Sweden all over, preschool teacher Christer Jonsson celebrates his country's triumph in the 1992 World Hockey Championships. Once rare in this reserved society, such nationalistic displays are on the rise as Swedes struggle with doubts about their welfare state—and themselves—brought on by hard times.



SWED

In Search of



By DON BELT ASSISTANT EDITOR

Photographs by TOMASZ TOMASZEWSKI

EN

a New Model



An ocean of snow engulfs northern Sweden in winter, when the sun clears the horizon for only a few hours a day and summer seems light-years away. Some 90 miles north of the Arctic Circle, near Sweden's border with Norway, a footbridge used in summer to cross a ravine becomes mere scenery to a passing snowmobile.







Choreographed to perfection, a cast of hundreds serves the 1992 Nobel Prize banquet at Stockholm's City Hall. Awarded each December, the prizes were endowed by industrialist Alfred Nobel, who in 1867 patented dynamite—one of many Swedish inventions, from kitchen gadgets to weapons of war, that changed the modern world.

A RAW WIND WAS SNAPPING at the streets of Stockholm, and many people had already turned off their reading lamps and gone to sleep. It was a Friday night in 1986, the last day of February—that particularly grim stretch of winter when Swedes sleep longer, and speak less to each other, than at any other time of year.

Olof Palme, their boyish 59-year-old prime minister, was still wide awake. He and his wife, Lisbeth, were bundled in their overcoats, strolling home from the movies, arm in arm. No bodyguards walked with them. This was a point of pride for Palme, who during his four terms as prime minister insisted on living as an ordinary Swede—walking to work, doing his own errands, riding the subway—as a matter of egalitarian principle. Sweden was different from other countries, he liked to say, where leaders were forced to protect themselves from their own people. Sweden, he seemed to say, was better.

It was hard to argue. Since World War II, California-size Sweden had become in many ways the envy of the world—an industrialized nation built on humane principles, sane and secure, that had fine-tuned its Swedish model of welfare-state capitalism to achieve the prosperity and social justice that other democracies aspired to.

Nestled in the bosom of Scandinavia, buffered from continental Europe by the Baltic Sea, Sweden's 8.7 million people enjoyed a standard of living as high as any in the world, ensured by the most bountiful system of social welfare on earth. Their ideals were intact, their children well educated, their environment—even their factories—remarkably clean. Police walked their beats with a smile. No one was homeless, and no one starved.

At 11:21 a "tall, dark-haired man with a limp" stole up behind the Palmes, drew a .357 magnum, and shot the prime minister in the back at point-blank range. Palme died instantly, cradled in his wife's arms. His assassin vanished into the night. Except for the two copper-tipped bullets he fired, the killer left no clues and has never been found. His motive remains unknown.

City officials moved quickly to replace the bloodstained sidewalk tiles, but it was impossible: By noon the next day thousands of Swedes had gathered there in stunned silence. Many carried a red rose, symbol of Palme's political party, the Social Democrats; by nightfall a mountain of bloodred roses marked the spot where he had died.

"I think people were grieving as much for Sweden as they were for Palme," recalled Mick Sandberg, a young professor from Göteborg. "It was clear to many of us that our innocent little world had just vanished forever."

Gray was the prevailing mood during my first visit to Sweden, which came in February 1992, six years after Olof Palme died. "Somber," I wrote in a black notebook as I drove to Stockholm from the southern port of Helsingborg, where I had arrived by ferry from Denmark. It was an impression reinforced by long, damp walks through the capital, which presides over Sweden from an inlet on the Baltic coast. Surrounded by water, laced with canals,

This coverage of Sweden by Polish free-lancer TOMASZ TOMASZEWSKI is his fifth article for the GEOGRAPHIC. His photographs have appeared in many international publications and exhibitions.



A regal bearing suits Stockholm (above). Called Venice of the North for its graceful minglings with the Baltic Sea, the city came of age during Sweden's 17th-century heyday as a European empire. Sweden later evolved into one of the most egalitarian nations on earth but preserved its monarchy. King Carl Gustaf (right) and German-born Queen Silvia celebrate Sweden's National Day, June 6, with a carriage tour through the capital.



Among the poorest of European nations a century ago, Sweden thrived when industry replaced agriculture. Led by Social Democrats, Sweden crafted its "model" welfare state to spread the wealth and recruited foreigners to work the factories spared from World War II by Swedish neutrality. Today Sweden reels from recession; its generosity is being pruned accordingly.



POPULATION: 8.7 million.

AREA: 173,732 sq mi.

RELIGION: Lutheran.

LANGUAGE: Swedish.

LITERACY: 99%. LIFE

EXPECTANCY: 78 years.

PER CAPITA INCOME: \$25,490.



Stockholm is often called Venice of the North, though in temperament this dignified, stone-faced city is more East European than Latin.

It had been an unseasonably warm winter, and much of the country was bare of spirit-lifting snow, which softens the darkness by seeming to light the world from within. Instead, Swedish night fell like a shroud over the land in midafternoon, wrapping the country in a hundred shades of gray and then in blackness so total that summer seemed as distant as a star in the night sky. But there was more to the darkness than lack of light.

"Sweden's economy is drifting toward crisis," Anders Pers, a newspaper publisher in Västerås, later told me. "Industries that

once set world standards are now struggling to survive and cutting back. For the first time I can remember, Swedes are uncertain about their future. 'How is Sweden going to come out a winner in the information age?' they ask. 'Why is there no demand for my talent?'"

As those questions were sinking in, other doubts were surfacing. Just months before in the national elections, voters turned against the Social Democrats, architects of the modern welfare state, for only the third time since 1932—choosing instead a coalition led by the Moderates, a conservative party that pledged to get Sweden out of the doldrums by pushing it into the European mainstream. They vowed to cut taxes, reform the welfare system, and promote Sweden's application to the European Community, submitted the previous July.

By the time I arrived, though, many Swedes seemed to be having second thoughts about their nation's drift to the right.

"There are a lot of un-Swedish attitudes going around right now," observed a young press officer at the Swedish Foreign Ministry. None was more ominous, she added, or more unlike them, than the growing resentment of Swedes toward the foreigners in their midst.

Overt nationalism, taboo in modern Sweden, was becoming commonplace. On the streets of Stockholm, native-born taxi drivers were advertising their "Swedishness" to customers by displaying little Swedish flags on their windshields. In towns across the country, small but



highly visible neo-Nazi groups were cropping up to taunt immigrants, scrawling “Sweden for the Swedes” on trash cans and walls. Even ordinary, decent Swedes were starting to talk openly — another broken taboo — about their distrust of the newcomers.

“Sweden is probing itself to come to terms with all this,” sighed Leif Hallberg of the National Police Board. We met in his office one slate gray afternoon, our talk illuminated, barely, by the beam of a tiny desk lamp and the light reflected off his glasses. “What kind of nation are we going to be?” he wondered. “This is the big question — the one all Swedes are asking themselves right now.”

SNOWCAPPED MOUNTAINS and a long, cool stare divide Swedes from their cousins in Norway, who descend from the same Nordic ancestors and speak a Germanic language similar to Swedish, give or take local idioms and the happy little bounce the Norwegians — who are regarded by the Swedes as hopelessly rustic — like to give the end of a sentence.

Swedes, in turn, are kidded by other Scandinavians for their starchy reserve and often made the butt of regional jokes: Two Danes, two Norwegians, two Finns, and two Swedes were shipwrecked on an island. By the time they were rescued, the Danes had formed a cooperative, the Norwegians built a fishing boat, and the Finns chopped down all the trees. The Swedes were still waiting to be introduced.

There is, it must be said, a hard edge on these jests. As an armed

Caught off guard by school-age demonstrators in the streets of Stockholm, Prime Minister Carl Bildt is jostled as he tries to explain proposed restructuring of the education system — most controversial, perhaps, of the cutbacks in services called for by Sweden’s new center-right government.

“We think it’s time for fewer state-supported solutions,” Bildt declares, citing the generous cushion of benefits that Swedes paid for with some of the world’s highest taxes.

Like him or not, most Swedes would shudder to see Bildt accosted: Former Prime Minister Olof Palme was murdered on a Stockholm street in 1986.





Man on the move, Jonas Sterner, 26, leads a busy life despite cerebral palsy, thanks to 24-hour care in a custom apartment and a \$15,000 computerized wheelchair—all provided by the government.

Comforted by a staff nurse, the late Maud Molin (left) spent her last days at a government-subsidized nursing home that charged between five and ten dollars a day. Cradle-to-grave services account for two-thirds of Sweden's annual budget.

neutral, Sweden was the only Scandinavian country to escape unscathed from World War II. In fact, Sweden saved itself by mastering what historian Franklin Scott calls "the art of the possible, frankly unheroic." Pressured by the Nazis, Sweden continued to sell Germany iron ore and components for its war machine until 1944. Sweden did earn thanks from Finland for sheltering its war refugees, including 70,000 children. But some Norwegians may never forgive the Swedes for allowing Nazi troop trains to cross their soil to attack northern Norway, or for refusing to protect King Haakon VII and his family as they fled the Nazi occupation. "It's hard to explain away our role in World War II," said Mona Pers, a literature professor in Västerås, echoing many others I spoke with.

Few natural barriers divide Swedes from one another. Apart from mountains in the west, Sweden is a relatively uniform land, dominated in the south by agricultural lowlands and elsewhere by rolling, thinly soiled hills studded with granite. What elevates this landscape from pristine to sublime are Sweden's 90,000 lakes, which were left behind by retreating glaciers 12,000 years ago and are today the Swedes' surpassing pride and joy.

Between these lakes, nearly half of Sweden is covered with a thick forest of conifers and birch, where anyone who follows the ancient rules of *allmansrätten*, or everyman's right, can wander freely—even over private property—and glory in the solitude and perfect stillness. It is this land, rather than any evocation of past empire, that Swedes talk about when they say they love their country. Rather than history, it is geography that unifies the Swedes, and silence that keeps them apart.

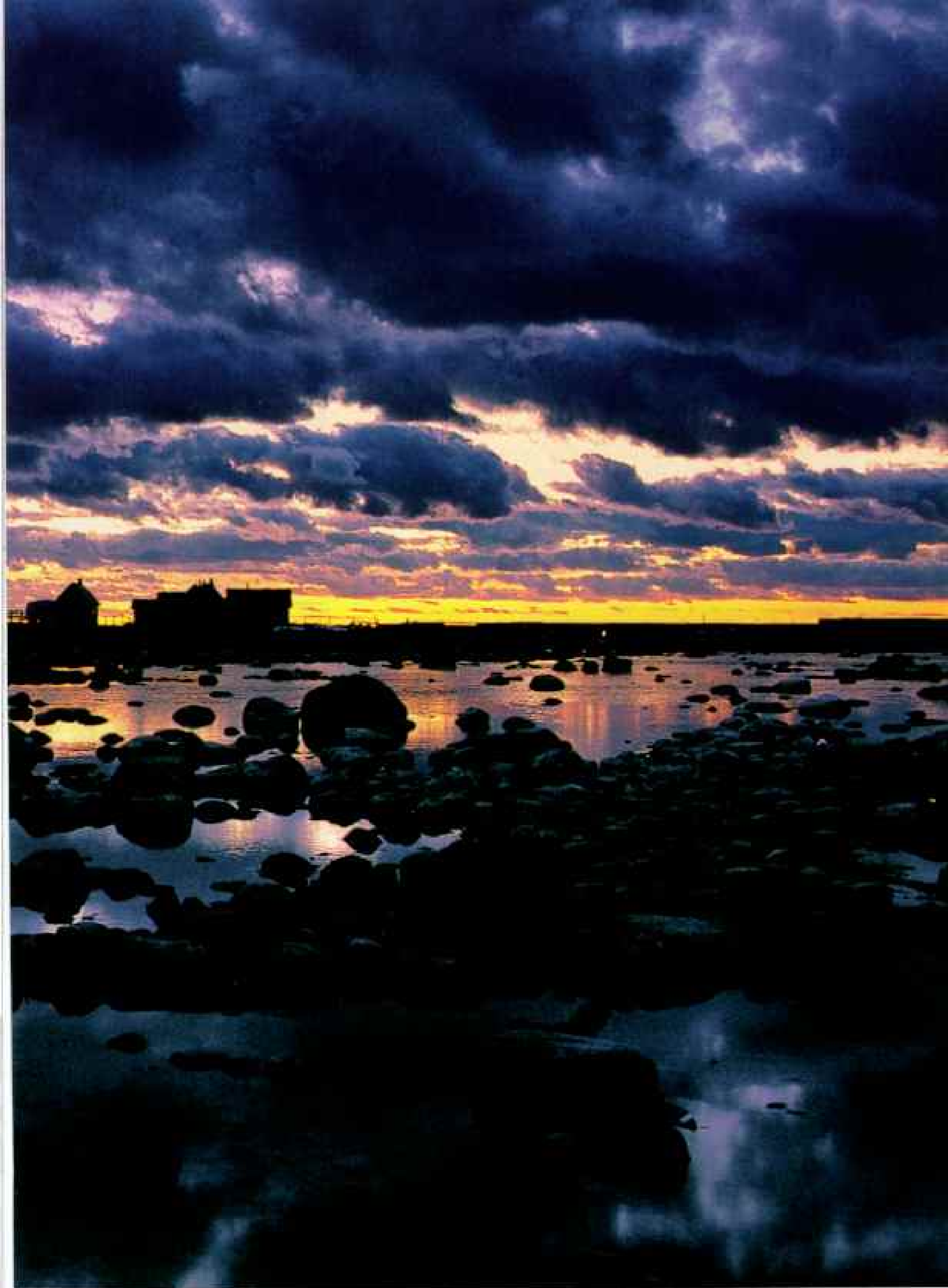
"SWEDES ARE a painfully shy people," says Åke Daun of Stockholm University, a Swedish ethnologist who compares his own society to the Japanese in its emphasis on quiet conformity. "We're taught very early not to stand out from the crowd or risk making anyone uncomfortable." To illustrate his point, he describes the Swedish businessman: "Sweat pours from him during a meeting in which he's completely silent—he's thinking of things to say the whole time and anxiously weighing the decision of whether or not to speak."

This kind of inner turmoil contributes, experts believe, to Sweden's suicide rate—15th among reporting nations—and surely figures in the alcohol-induced catatonia one comes across late at night in many Swedish cities. I'm thinking of the 4 a. m. crowd at McDonald's in Göteborg, for example—richly dressed young Swedes propped up in booths, grim faced and sad, unable to focus on the catsup-smearred table in front of them or even to stagger home.

Winters also take a toll. Bengt Kjellman of St. Görans Hospital in Stockholm has treated hundreds of Swedes suffering from



Evening settles like a song over coastal farms on Gotland, a 1,225-square-mile island in the Baltic Sea revered by Swedes for embodying their rural past. "To live as simply as a peasant in the



countryside, in a little red cabin overlooking water—this is the Swedish dream,” explains Mona Pers, a teacher in Västerås. “No good Swede would ever pass up a chance to pick berries.”

winter depression, which is probably linked to hormonal changes brought on by light deprivation. He treats his patients with two hours a day of light therapy, with 75 percent success. Others cope by traveling ("a surprising number of us go to the Canary Islands," confided one elderly woman) or by spending lots of time outdoors.

But what gets most Swedes through winter, and through life, is dreaming of where they will spend the summer: A sunlit clearing in the forest and a cabin painted dark red with white trim, overlooking water, with a Swedish flag fluttering from a pole in the yard.

Swedes call them *stugor*, these rustic cottages, and they tend them with the same muted passion they apply to all things in their world. In the loving hands of a Swedish family, that *stuga* over time is made beautiful, and more functional, and perfect to the last detail. This is the essence of Sweden, and nothing in their Lutheran experience compares with the devotion Swedes show between mid-summer and August, when they become a nation of pilgrims in Volvos, forsaking high-rise apartments in their spotless new cities for five weeks in a *stuga*, near the small farming towns where their grandparents were born.

In northern Sweden especially, they enjoy a certain lightness of being, induced by the midnight sun. There Swedes share the land with another group even closer to the elements than they—the indigenous people known as Sami (often called Lapps, to their displeasure), who in summer make pilgrimages of their own.

“HELICOPTER, HELICOPTER!” little Sofia shouted, clapping her hands. I hadn't heard any helicopter, and when I looked to her father, John Utsi, lying on his bed of reindeer skins, I could tell he hadn't either. He picked up his two-way radio and listened in on a distant conversation in crackling Swedish. "She's right," he said with a look of bemused wonder. "Five minutes."

"I remember when Sami children used to imitate reindeer noises," said John's wife, Elin, from the other side of the room as she poured coffee. "Now they imitate helicopters."

It was midnight on Lake Kutjaure, 70 miles north of the Arctic Circle and 30 minutes by air from the nearest sizable town, deep in the spectacular mountain country of northwest Sweden. It was also summer, and the Sami people of northern Scandinavia were gathering their reindeer to mark the calves, as these gentle nomads have been doing for as long as anyone can remember. But helicopters—a more efficient way for part-time herders to tend reindeer—were a wrinkle I hadn't expected. This one was coming to whisk us to a mountain rendezvous with some 1,500 reindeer under a waning midnight sun.

Like most of the 17,000 Sami living in Sweden, John and his family have another life—a more Swedish life—that they live in the town of Jokkmokk a hundred miles to the east, where John works as a journalist. But the Utsis are also among the few who still practice reindeer herding, the cornerstone of Sami history and culture. Each summer John and Elin and their three daughters move into a *goahti*, or sod-covered dwelling, and join their relatives to tend the family's reindeer as they roam the high country.

A few minutes later the helicopter arrived. John's family and I piled our gear inside, shot off into the mist, and landed ten minutes



Spirits rising, patients at St. Görans Hospital in Stockholm soak up artificial sun for two hours a day to combat depression linked to light deprivation in winter. "It looks crazy, but it sure helped me," says one patient of the therapy, which has become fashionable; doctors report a 75 percent success rate in treating such patients.



"Many of our patients say winter is harder every year," adds Bengt Kjellman of St. Görans, noting that Swedes tend to withdraw in winter and call in sick more often. Sweden's suicide rate, on the other hand, is highest in spring. Stigmatized in the 1950s as the world "suicide capital," Sweden is currently ranked 15th.

later on a cloud-draped mountainside between a snowfield and a steep ledge. The scene was like the dream sequence in a surrealist Swedish film: In the dim light I could make out dozens of other people, weary and wet, pitching tepee-like shelters in a light rain next to an enormous wire-fence corral.

Soon more helicopters arrived, driving the reindeer before them—a thousand frantic silhouettes fleeing the machines overhead. As the animals bolted into the corral, John and I helped pull a wire fence across behind them. "Let's get some rest while they settle down," John said. "We're going to need it."

We took shelter in my tent and spent about an hour talking and watching the rain flick at the purple nylon roof, to the rhythm of wind whipping grass and reindeer hoofs thumping against mud and rock nearby.

John is a playwright. He writes radio plays in the Sami language, a Finno-Ugric tongue closer to Hungarian than Swedish,

and draws heavily on Sami history and legend in his work.

"Sami are like the American Indian," he says, citing the parade of traders, settlers, and Lutheran missionaries who began usurping Sami lands and culture as early as the 12th century; Sweden's rush for ores, timber, and hydroelectric power practically finished the job in the early 20th. "The only difference," he said, "is the Swedes defeated us with laws instead of guns."

The Sami fought back through the courts in the late 1960s and eventually won confirmation of their ancestral rights to the land, including the freedom to hunt and fish or move reindeer herds from place to place. There was a catch: Sweden granted these aboriginal rights to only the dwindling number who herd reindeer; the other 85 percent were not given any special rights at all.

After years of Sami lobbying, the Swedish Parliament recently addressed their grievances by approving a separate parliament to represent all Sami. But at the same time it also passed a law allowing the million or so sportsmen in Sweden to hunt and fish on Sami land—a direct threat to the last of the reindeer herders.

"They give with one hand and take away with the other," John muttered, "same as they've been doing for 300 years. Trouble is, this time we haven't got room to go backward."

We heard shouts from the corral. "Let's go to work," John said, pulling on his rubber boots. He and I wriggled under the fence to join the wild scene unfolding in the corral as a hundred or so Sami with lassos—men, women, and children—began stalking the swirling river of reindeer circling the corral. Spotting the family mark on a passing cow with her calf, John and his daughters would give chase, then rope the calf, wrestle it to the ground, and use a small knife to cut the family mark—five notches in the cartilage on the calf's left ear. It was exhausting work, made miserable by the cold and rain. Yet to the people around me, I sensed, it was the most exhilarating activity on earth: Somehow, against all odds, this had survived. Thousands of summers had passed, and the Sami were still here.

The roping went on past daybreak, until all the calves were marked and accounted for. Then the corral was opened and the reindeer freed to roam the high country again, tended by full-time herders. Helicopters were called in, tents were packed, and warm Sami good-byes—"Hivas, hivas!"—passed all around. One by one, three of John's brothers, who had walked here from Vaisaluokta four miles away, shouldered their packs and set out for home. By 8:45 a.m. the clearing was empty.

We staggered toward the helicopter, completely exhausted, for the ride down the mountain to Lake Kutjaure. "Up, down, up, down—Sami life is always like this in the summer," John remarked with a bleary smile. "We don't get much rest—but for us there are more important things than sleep."

SO MUCH OF URBAN SWEDEN appears modern and freshly minted—sparkling offices and apartment complexes, highways and hotels, playgrounds, and even the Swedes themselves—that it's easy to forget Sweden is a profoundly provincial country.

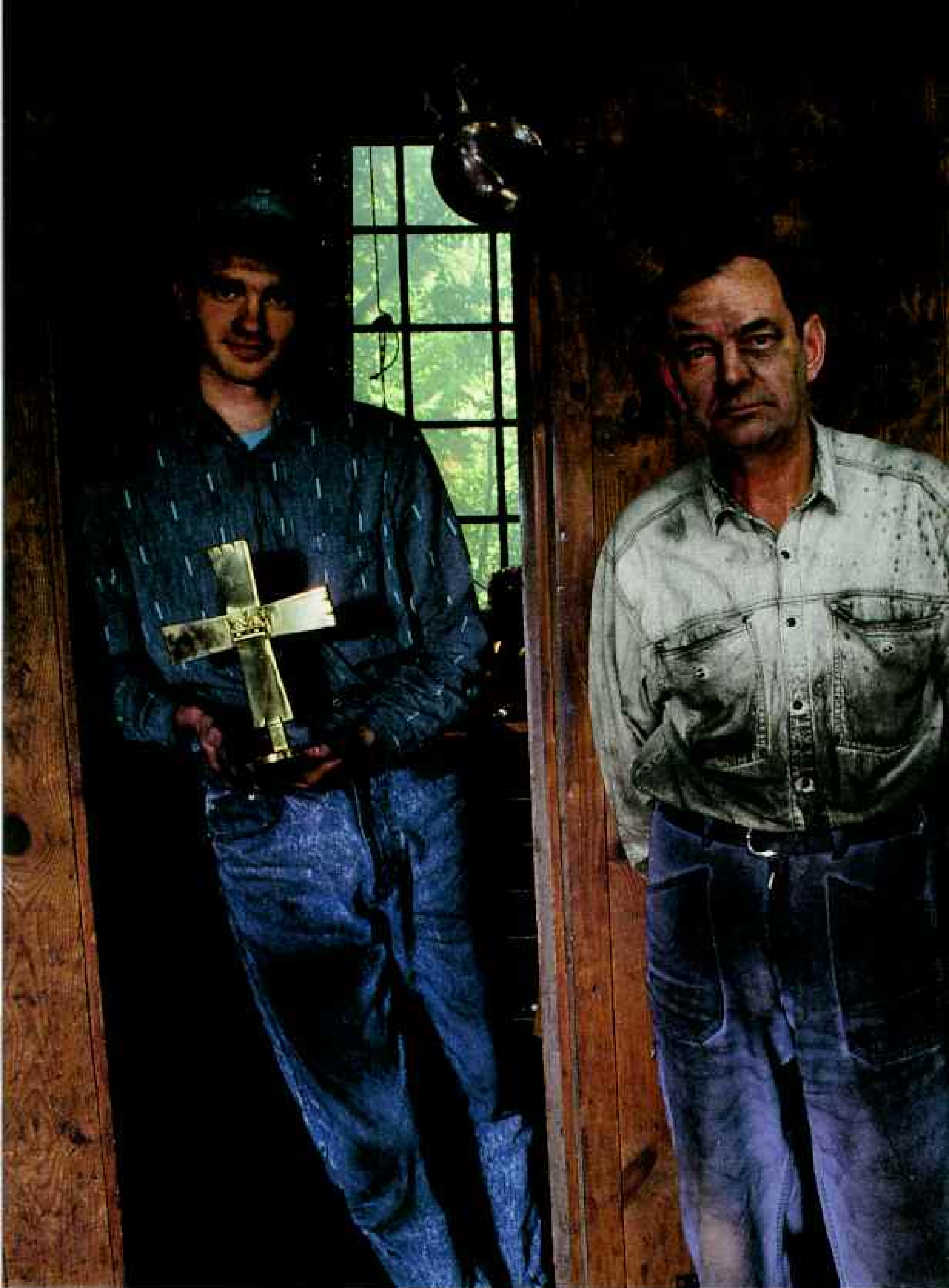
A century ago Sweden was among the poorest nations in Europe, and so short of arable farmland that a fifth of its population—more



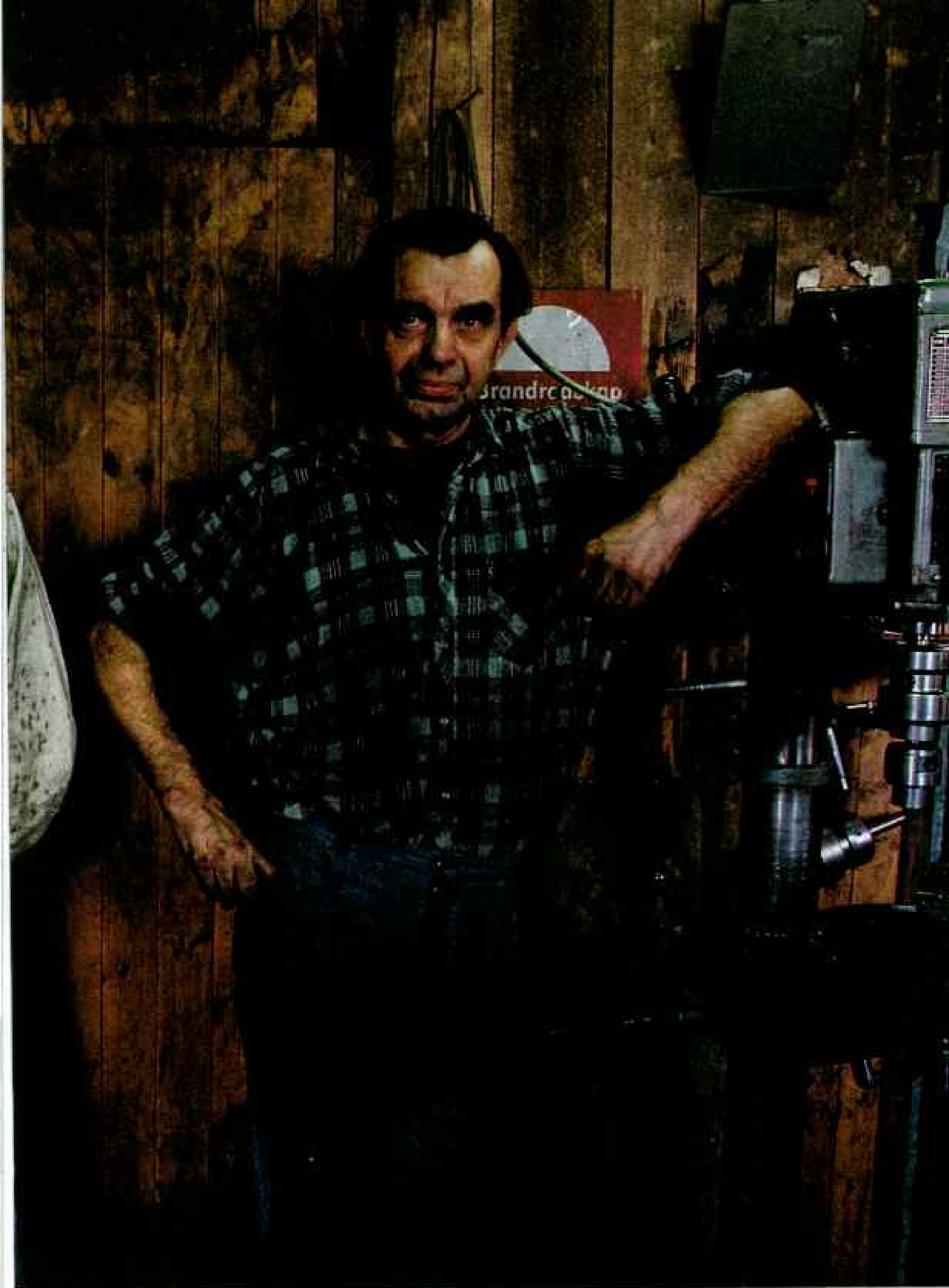
Tidying up in fall, many Swedish farmers machine-wrap their hay in airtight polyethylene (above) to preserve it through winter. Says one: "It's cheaper than building a silo."

Taking the no-tech approach, a reindeer herder in northern Sweden leads a buck to slaughter—something the Sami, or Lapps, have done each autumn for thousands of years. To manage their dwindling trade more efficiently, herders also use state-of-the-art tools—helicopters and computers—to monitor the animals.





"We're just old-fashioned Swedes," says 23-year-old Håkan Abrahamsson of Gnosjö, who joined the family business, Hyltans Metall, run by his Uncle Lars, middle, and his father, Bengt. Like



many factories in Gnosjö, Hyltans is famous for a product—in this case, the handmade copper-alloy cross displayed by Håkan. Both the Swedish royal family and Pope John Paul II own one.

than 1.3 million people—deserted it between 1850 and 1930, mainly for North America. It was also among the last in Europe to industrialize, despite vast reserves of iron and other resources; at the turn of the century 90 percent of its people still lived in the Swedish countryside, where they clung to collectivist social traditions handed down from the Middle Ages.

As Swedish industry evolved between 1900 and 1930—and soared after World War II—rural Swedes moved en masse to the cities, bringing with them the quiet pragmatism and frank peasant stare that so puzzle tourists, who come expecting to find friendly blondes and well-mannered tennis partners. In fact countryfolk migrated to these cities, where 80 percent of Swedes now live, armed with the same values that ruled life in a small Swedish town and that became the rules of modern Sweden.

They came seeking work, and through it found *trygghet*, an ancient term that conveys safety and security, consensus and predictability, and the absence of all things uncomfortable or unpleasant. Swedish industries understood *trygghet*, and they wrapped their fledgling workers in a cocoon of benefits and paternalistic concern so readily that the Swedish labor movement, which came to dominate all aspects of society, was able to find a “middle way”—acting more as partner to management than adversary.

Trygghet was also supplied by the Social Democrats, elected to power in 1932, who filled the docket with social legislation—building blocks of a welfare state they called, comfortingly, the *Folkhem*, or People's Home. Slowly, meticulously, as if society were some finely calibrated machine, they began to perfect life in Sweden and take all the guesswork out of it.

Today that welfare system consumes almost two-thirds of Sweden's 190-billion-dollar budget—even after the pruning administered by the new government. “Cradle to grave” is no exaggeration for a system that begins paying health benefits with a mother's first wave of morning sickness, continues to pay 90 percent of her or the father's salary for a year after the birth, and showers them both with allowances and subsidies and paid vacations and pensions for the rest of their lives.

IF TRYGGHET WERE THE GOAL of modern Sweden, then *lagom*, or appropriateness, became its guiding principle. The term may have originated with the Vikings, who controlled central Sweden from A.D. 800 to 1050 and drank their beer, it's said, from a common bowl: Each man would take *laget om*, or according to the law—not too much, not too little, but just the right amount. Shortened to *lagom*, the term lives on in Sweden as an all-purpose definition of what's acceptable and what's not.

“Lagom is best,” the Swedes say, meaning reasonable, in moderation, with no extremes. “To be average is good in Sweden,” explains ethnologist Åke Daun. “To be different is bad.”

This idea colors all sides of Swedish life—the home, the workplace, the schools. And while it makes for an orderly society, some Swedes fear that the *lagom* ethic, combined with an educational system that stresses uniformity, discourages the best and the brightest—the smartest kid in class, the entrepreneur, the risktaker, the artist, the inventor—in short, the very kinds of people Sweden needs now, more than ever, to succeed.



Simplicity takes center stage at IKEA headquarters in Älmhult, where studio handyman Patrik Hagelvik prepares a loop chair to be photographed for the IKEA catalog. Local entrepreneur Ingvar Kamprad turned his tiny mail-order business into a global empire. His motto —“to create a better everyday life for the majority of people” —might as well be Sweden's.



"It was a real shock," said educator Mona Pers, "to see the kids my children knew in high school—truly brilliant kids—choose the *lagom* path instead of setting their sights higher. Young people who should be doctors or scientists instead are becoming orderlies and lab technicians. This is our Achilles' heel."

Sweden's new ruling party, the Moderates, agrees. It has put educational reform at the top of its agenda, hoping that the next generation of Swedish children will prove them right.

In the meantime, perhaps Sweden could use more people like Bengt Englund—a 27-year-old engineer I got to know while exploring Göteborg, the city of 500,000 on Sweden's west coast that conducts itself like Stockholm's laid-back, worldly little sister.

Bengt lost his job in August 1991. Until then, he worked for an engineering firm that designed equipment for Volvo, the Swedish automobile giant headquartered nearby. When recession hit Volvo, Bengt's employer declared bankruptcy. At that point Bengt

could have filed for unemployment, which would have paid 90 percent of his salary for a year. Or he could have started a government job-retraining program to learn a new skill. Instead he invested his savings in an engineering business of his own.

Bengt's decision surprised everyone, including Bengt. "I remember thinking, I should feel very bad, very scared about all these new responsibilities. But it was just the opposite—I felt *great*. That's when I knew I was doing the right thing.

"My friends all acted like I was completely nuts," he went on. "My wife and I had just had a baby and moved into a new, more expensive apartment. 'What will you do if you don't get work?' everyone was asking. 'How can you be so stupid?' People in this country are so used to playing it safe that they couldn't believe somebody would ever take such a risk. That's why I think the welfare state went too far—it took away people's ambition."

So far, things have gone well for Englund Engineering, which is headquartered in a small, book-filled den next to Bengt's living room. On his drawing board the last time I visited were plans, commissioned by Volvo, for quality-control equipment on their sedan assembly lines.

"The business is really taking off," Bengt said quietly. "Although I'll never let the neighbors know it. Everybody's so jealous that it's important to keep a low profile."

"One of our neighbors sprained an ankle the other day," said his wife, Angela. "I told them to put meat on it to stop the swelling. 'I guess people who own their own business can afford to waste meat,' I was told. 'You must think you're something special.'"

"You see, you're not allowed to be too clever in Sweden," said Bengt with a wry smile.

"Just *lagom* clever," said Angela.

AT FIRST GLANCE the little town of Gnosjö doesn't look like anything special. It sits neatly and quietly in the scrub forest typical of south-central Sweden, and a tourist passing through could be forgiven for chalking Gnosjö up as one more somnolent Swedish town, distinctive only in small details—the abundance of large corrugated metal buildings, for example, or the disproportionate number of local people driving cars made by Mercedes-Benz.

But what goes on here is a dazzling repertoire of small manufacturing—some 300 industries in a region of 10,000 people, making everything from fishhooks to heavy machinery. Gnosjö and its neighboring towns illustrate what is possible when the Swedish gifts for business, technology, and collective action meet in a place where risktaking, rather than playing it safe, is encouraged.

"This is a region where people are *expected* to start their own business," explained Willis Thulin, who turned his father's backyard metalworking shop ("three employees, two cows, and a pig") into a 65-million-dollar company, Thule, which sells cartop carriers and other products worldwide. "That's the fun of it. We take risks, but we do it together and help one another, even our competitors. It works because we all know the rules and trust one another. Other people need a ten-page contract to do business. Here people say 'Charge!' and work out the details afterward."

Gnosjö's small-business explosion dates from the early 1700s,



Swedish modern is a way of life, and for most it means renting an apartment. Styles range from low-profile developments such as Tokarp in Jönköping (right) to the towers of Stockholm, where some 90 percent live in high-rise complexes.

In her two-story flat, Stockholm cellular-phone executive Sylvia Dahlgren manages her company while traveling masseur Roger Linde, who bills himself as the *Massage King*, makes a house call. "Many people hire me because of the name, like in America," says his highness. "Unlike most Swedes, I'm not shy."



when local men began trickling home from the arms factories supplying Karl XII, Sweden's young warrior-king, who had marched his armies across Europe and into Russia before being beaten by Peter the Great at the Battle of Poltava.

When these men came home to Gnosjö, they brought metal-working skills with them, and while the rest of Sweden was working in one-factory towns or bending their backs to strip-cropping, they went to work supplying Swedish merchants with clever little household gadgets—safety pins, eggbeaters, screens, hooks, plate holders—made of metal wire processed from local iron ore using stream-powered extrusion devices. Since only one suitable river runs through Gnosjö, they had to cooperate to succeed.

Thulin's friend Alf Liljehall owns Elbe, a company that supplies metal gift items to Boda, the Swedish design company. As I toured his factory one afternoon, Liljehall pulled a black candelabra from a display shelf and balanced it on his palm.

Eight local companies cooperated to produce the item, he explained, including several who compete fiercely with one another for business. Other than shipping the finished product to Boda, Elbe's main task was shuttling the item from supplier to supplier—and keeping the peace.

"This is a perfect example of how Gnosjö works," Liljehall said with a laugh. "It's all mixed up, but somehow it turns out right."

Built upon such partnerships, Gnosjö's economy has coasted through the current recession, propelled in part by Sweden's 1990 tax reform, which cut taxes from 80 to 50 percent on personal incomes above \$28,000 a year. As Sweden trims its welfare budget accordingly and prepares for life in the rough-and-tumble European Community, some believe Sweden would do well to emulate the competitive cooperators of Gnosjö.

Willis Thulin explains: "For years the Swedish system penalized the good worker and propped up the bad one. I think we're headed in the right direction now by giving people incentive to work hard." They'll have to, he adds, if Sweden is to compete in Europe's free market. "The EC is not going to solve all of Sweden's problems," he said. "But we have to take this step. Whether we like it or not, Sweden is part of the real world."

THE 750,000 FOREIGNERS living in Sweden today, whether foreign-born workers or political refugees, are lumped together in Swedish under the term *invandrare*, which means simply "immigrant" and is used to describe the non-Swedes one sees these days on the streets of any Swedish city or town. No matter that back home these people were Italian or Greek, Iraqi or Palestinian, Croatian or Kurd—once in Sweden, they are the *invandrare*.

While traveling in central Sweden, I stopped often in Ludvika, a little city of 29,000 at the south end of the region called Dalarna, which is much beloved by Swedes for its scenic lakes, bright-eyed fiddlers, and traditional handicrafts such as wood carving.

A century ago Ludvika was a typical Swedish factory town, full of strapping farmfolk driven from their land by drought and crop failures. Today it is again typical—a factory town in recession, grown hard in the eyes and rough around the edges—with about 2,000 *invandrare* of various nationalities in its midst.



Standing tall for Sweden—and against everyone else—are neo-Nazi skinhead groups like this one, which primed recruits with propaganda and two-dollar haircuts at a soccer tournament in Stockholm.

"Things are happening in Sweden now that would have been impossible a few years ago," sighs Gunilla Andersson,



a social worker in Rinkeby, a Stockholm suburb where a number of immigrants have been attacked recently.

Most people are shocked at the rise of such hate groups, though in private many Swedes, weary of recession and high taxes, grumble about their nation's generosity toward asylum seekers.

Immigrants are nothing new here. Hundreds came between the late 1940s and the 1960s to work for ASEA, the giant Swedish company that, like many Swedish industries, grew from a small regional company to a worldwide concern during the glory days after World War II.

In 1945 Sweden had entered the booming world market with the greatest export capacity in Europe. The Continent was war torn and destitute; Swedish factories, untouched by war, were already producing a full line of consumer and industrial products, and still growing. More workers were needed.

Encouraged by the Swedish government, these factories recruited Italians, then Finns in the 1950s, Greeks and Yugoslavs in the 1960s, and finally Turks and Chileans and laborers from a dozen other countries. By 1972, when the economy finally stalled and labor immigration was curtailed, Sweden had been receiving, and



Hundreds of human dramas passed daily through Swedish customs in 1992, as 83,200 refugees—many from the former Yugoslavia—sought asylum in a land admired worldwide for its humanitarian policies. One was Pakzab Kaizran, a 53-year-old Kurdish woman whose family was driven from Iraq by Saddam Hussein.



assimilating, as many as 70,000 immigrants in a single year.

"Those people came to work," I often heard as I traveled through Sweden—"they even learned to speak Swedish."

"Our real problem," the people of Ludvika invariably add today, "is this new crop of *invandrare*."

THEY ARE TALKING about the 1,500 refugees, many of them fleeing the war in former Yugoslavia, that the government has sent them to look after. This represents Ludvika's fair share of the more than 83,000 people now seeking political asylum in Sweden—the third highest number, after Germany and Austria, in all Europe.

Sweden has always had a steady trickle of political refugees from trouble spots around the world, attracted by its liberal interpretation of "refugee." Like the immigrant workers, these asylum seekers are given a humanitarian welcome. Sweden pays them a generous allowance, houses them in clean apartments, teaches them Swedish, educates their children, treats their ailments, fights for their rights, and monitors their happiness with an army of caseworkers—all of which costs the average Swede almost 200 dollars a year in taxes.

Having done all that, Swedes don't understand why their new immigrants can't behave more like the old ones. As many in Ludvika see it, the refugees spend most of their days loitering along the city's main walking street, Storgatan, as if Ludvika were some Adriatic farm village. Their children make too much noise and run wild through the town, while their young men slouch on park benches, speaking in a strange language to the Swedish girls passing by. All this is bringing up an unsettling racism, which seems to contradict Sweden's image of itself as a generous and decent people.

"They say they're fleeing the war, but that's just talk," declared Lena Isaksson, who lives in an apartment building where refugees are housed. "They don't seem that shock damaged. Their children run around playing with plastic guns. If they'd really been in a war, they'd be scared of a water pistol."

"They stole my neighbor's laundry right off the line," said a woman. "I feel like a minority in my own country," confided a man. "Sixteen hundred unemployed Swedes in Ludvika, and they get a free ride."

"Enough is enough."

"Send them back where they came from."

Curiously, some of the least militant people in town are the police, who despite a staggering increase in petty crime often handle the offenders by giving them a cup of coffee and a lift home.

"You can't automatically deport them because they've shoplifted or stolen a bicycle," said Roland Svensson, Ludvika's police chief, who is more concerned about the hate crimes on his books—assaults, rock-throwing incidents, firebombings, and cross burnings—than he is about stolen laundry. "You must take into account what these people went through in their own country."

By the time the young Kurdish immigrant I will call Agir had turned 16, he had seen his father languish in a Turkish prison, his mother tortured and beaten on the skull with a wooden baton, and his brother driven underground by death threats. Agir had also

"I wouldn't be complete without my car," says 24-year-old Daniel Paulin, at far left, nuzzling a beer in the style of James Dean while polishing the fender of his 1959 Chevrolet Bel Air. His is one of thousands of vintage American cars that have been cruising Swedish highways since the 1950s, when young, working-class Swedes began imitating their rebellious counterparts in America—right down to the cars they drove. By now most have grown up and joined a local chapter of the American Car Club of Sweden, which counts 11,000 members.

Paulin figures his Chevy is worth \$9,000—a tenth of what some cars fetch. He wouldn't dream of selling it, even though government cuts have cost him his job as a nurse's aide. Before that happens, he says, "I'd even go back to living with my parents."

been arrested, along with his younger sister, for the crime of declaring himself a Kurd in public.

I met Agir one evening at a vacation resort near Ludvika, where some 500 refugees are housed by the government in little red Swedish vacation cabins next to a lake.

Agir's family was sent here in 1990 to await a ruling on their request for political asylum, which was filed with customs officials

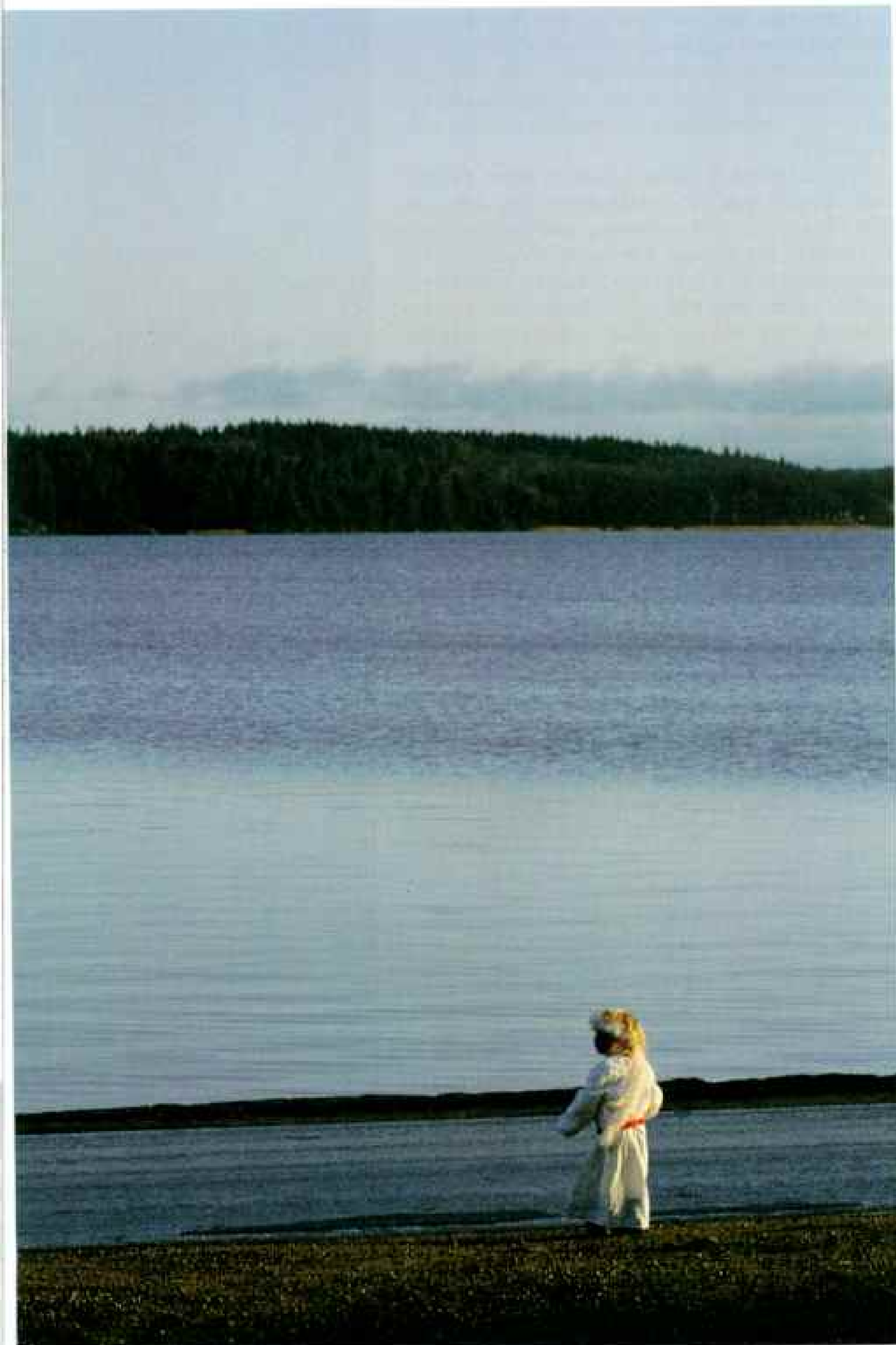


that bitter January night when they first set foot in Sweden. The family now lives in Ludvika, where Agir attends high school, but he spends much of his spare time at the refugee camp, playing chess with friends in the recreation center or watching TV news reports about the latest carnage in the Balkans. An eerie stillness settles over the room when those reports come on, he says, often followed by the sound of men weeping.

Agir is a slender young guy with liquid dark eyes and an outrageous forelock of curly black hair that he combs aggressively down to defend his forehead. He's bright and calm and awfully cocky for a 19-year-old immigrant kid from the hills of eastern Turkey who finds himself in a strange and increasingly hostile Nordic world. Since arriving, he has learned to speak good Swedish and decent MTV English. "Anything's possible," he likes to say, trying on his rock-and-roll attitude. "Noooooo problem."

I dropped by his apartment one afternoon and spent hours talking with his family, who were granted asylum in March 1992. Their residence permit allows them to work and live in Sweden





Bearing candles and Christmas cheer, Karin Eklund of Mariefred assumes the role of Lucia—the medieval saint who brings light to Swedish homes each December 13. Such vestiges of the past are cherished today, especially among parents. “Sweden really needs tradition right now,” explains Eklund. “I think we’re rather lost.”

permanently—a future they are most grateful for. But their joy vanished when our talk turned to the ugly mood outside their door.

“There are a lot of racists in Ludvika right now,” said Agir, taking off his black-leather jacket. “Look at this,” he said, fingering a gash in the jacket’s back. “A guy tried to knife me for dancing with Swedish girls in a disco.”

“They treat us like criminals,” added his older sister, Keylan. “It makes me so mad to see how they watch my mother when she enters a store. We went to the bank yesterday, and the woman in front of us in line clutched her purse as if we were thieves.”

“Sweden has been good to us, so generous,” said their mother, a strong and dignified woman who still suffers headaches from her session with the baton. “We never expected to find such hatred.”

IT WAS TO GESUNDA, a small town in Dalarna on the shores of Lake Siljan, that I came at the end. I rented a stuga at a little farmstead called Tollagården—an idyllic acre of Swedish heartland where the silence was so pure that from 30 yards away I could hear the owner, a good-natured blond woman in sweatpants named Inger, hum to herself while raising the Swedish flag each day.

I had arrived, she informed me, at the height of lingonberry season—on the cusp of raspberries and just before the peak of mushrooms—and often I would pull on a pair of green rubber boots and strike off into the sparkling air to pick them. “Keep it up,” Inger told me. “You’re starting to act like we do.”

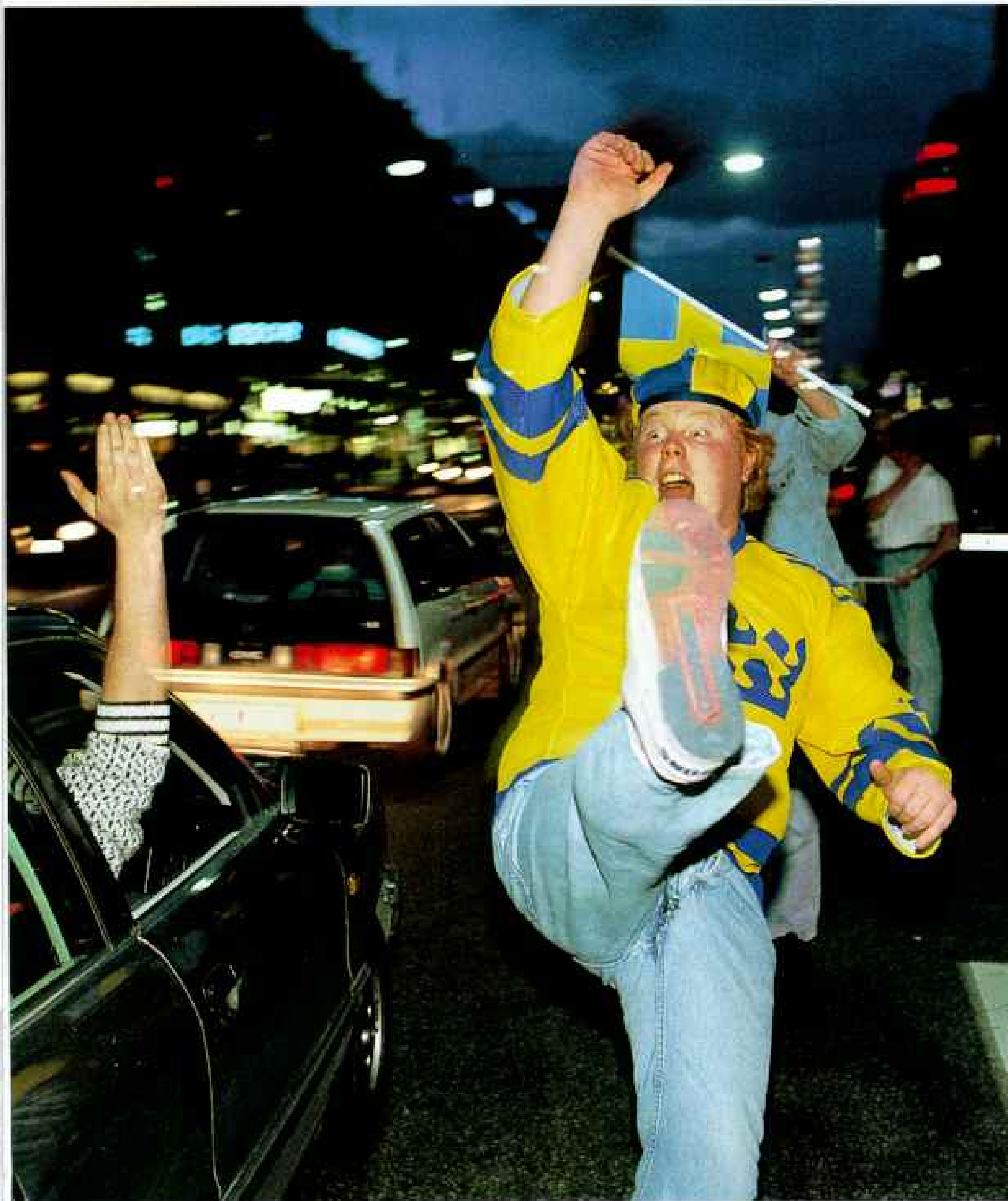
Thanks to *allemansrätten*, or everyman’s right, I was free to wander the neighborhood, and so I did. Some days I would explore the deep woods west of Tollagården, which is where I saw a moose; other days I would cut across Lars Larsson’s hay field down to Siljan, a clear and luminous lake rimmed with reeds in its shallows, and try to imagine the meteorite that punched out the lake’s basin 360 million years ago.

On a small sand beach among the reeds Larsson’s brother-in-law had built a wooden bench for his sons to use when they went swimming, and there I spent time savoring the silence like a Swede, witnessing the last precious days of summer while thinking of the hard months to come. Sitting there felt like trespassing at first, but Inger assured me that as long as I didn’t disfigure the bench, or move it, or litter, or make noise, I could sit there with a clear conscience until springtime if I chose.

It’s a beautiful custom, this *allemansrätten*, and so Swedish in its reliance on unspoken rules and consensus and the idea of freedom through obedience. No wonder Swedes cherish it as a symbol of who they are—or once were—and why, in the midst of all the issues Sweden is facing, they often focus their fears about, say, the EC, by bringing up *allemansrätten*. If Sweden becomes part of Europe, they say, everyone will just come barging in to pick berries with no regard for the rules. The country would never be the same.

“Sweden used to be like a peaceful island,” Leif Hallberg of the Swedish police had told me. “We were living ‘north of the road,’ as we say—out of the mainstream, like people wandering the countryside in a dream. We see now that this was false. Our dream disappeared, and the way things are going, we may never sleep again.” □





Swedish reserve takes a night off, as hockey fans in Stockholm kick up their heels over the 1992 world championship—a welcome relief from the burdens bearing down on Sweden. “We need to express our feelings more, good or bad,” says a Stockholm psychiatrist. “These are difficult times, and Swedes are human too.”

By THOMAS Y. CANBY

Photographs by CHARLES O'REAR

Bacteria

TEACHING OLD BUGS NEW TRICKS

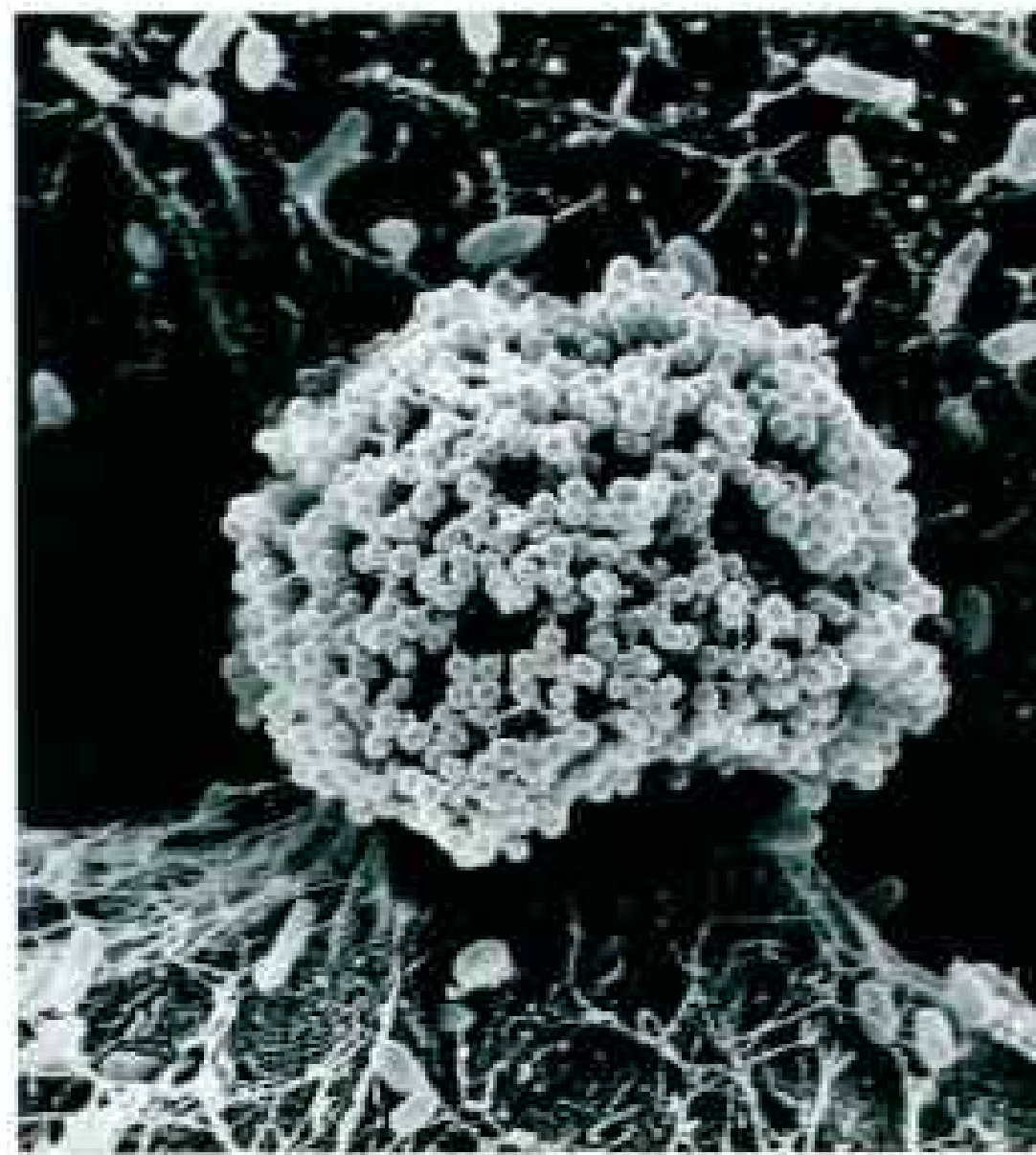
Shrouded in a metabolic mist, Californian Bob Pestoni checks the temperature of his grape compost as ravenous bacteria and fungi reduce it to fertilizer. Master chemists, bacteria are becoming an industrial force thanks to advances in biotechnology. "People are finally becoming aware of the potential," Pestoni says of the busy world of microbes.







Bacterial behemoths, ten *Epulopiscium* (left) glisten on the head of a pin. A recently discovered wonder of nature, *Epulopiscium* is the largest bacterium known to science—



and an oversize example of how mystery still surrounds nature's oldest organisms. More typical microbes such as *Staphylococcus aureus*, a pathogen (above, clustered at center), would crowd the same pinhead with some five million individuals.



SECTION 1
SECTION 2
SECTION 3
SECTION 4
SECTION 5
SECTION 6
SECTION 7
SECTION 8
SECTION 9
SECTION 10
SECTION 11
SECTION 12
SECTION 13
SECTION 14
SECTION 15
SECTION 16
SECTION 17
SECTION 18
SECTION 19
SECTION 20
SECTION 21
SECTION 22
SECTION 23
SECTION 24
SECTION 25
SECTION 26
SECTION 27
SECTION 28
SECTION 29
SECTION 30
SECTION 31
SECTION 32
SECTION 33
SECTION 34
SECTION 35
SECTION 36
SECTION 37
SECTION 38
SECTION 39
SECTION 40
SECTION 41
SECTION 42
SECTION 43
SECTION 44
SECTION 45
SECTION 46
SECTION 47
SECTION 48
SECTION 49
SECTION 50
SECTION 51
SECTION 52
SECTION 53
SECTION 54
SECTION 55
SECTION 56
SECTION 57
SECTION 58
SECTION 59
SECTION 60
SECTION 61
SECTION 62
SECTION 63
SECTION 64
SECTION 65
SECTION 66
SECTION 67
SECTION 68
SECTION 69
SECTION 70
SECTION 71
SECTION 72
SECTION 73
SECTION 74
SECTION 75
SECTION 76
SECTION 77
SECTION 78
SECTION 79
SECTION 80
SECTION 81
SECTION 82
SECTION 83
SECTION 84
SECTION 85
SECTION 86
SECTION 87
SECTION 88
SECTION 89
SECTION 90
SECTION 91
SECTION 92
SECTION 93
SECTION 94
SECTION 95
SECTION 96
SECTION 97
SECTION 98
SECTION 99
SECTION 100

LIKE VENOM squirting from a fang, lethal cyanide poured daily from the Homestake Mine's gold-processing plant into South Dakota's White-wood Creek. Mercury, arsenic, and sewage thickened the toxic flow. For a hundred years the stream ran gray and sterile through the Black Hills and beyond.

"Even 30 years ago people thought it was wrong," recalls Jim Whitlock, a local resident. "But the Homestake Mine was the biggest gold producer in the Western Hemisphere. It meant money, jobs, everything."

Then time caught up with the Homestake. Citizens, state, and nation demanded action. By the late 1970s the company had largely cleaned up its ore treatment. But the question remained: How to safely rid effluent of the cyanide used for separating out the gold?

"I thought bacteria could do it," said Mr. Whitlock, today a Homestake biochemist. "I collected samples of water exposed to the poison. They held cyanide-tolerant bacteria that actually feed on the poison's carbon and nitrogen."

"We designed a bioreactor, a series of tanks in which the cyanide effluent moves slowly past feeding bacteria. It worked. We still flush the final product into White-wood Creek. Only now it's clean."

Today fishermen regularly pull trout from the once poisoned creek.

The triumph at Homestake already is legend in environmental circles. It does not stand alone. In the United States at least 50 cleanup companies apply the technology known as bioremediation, siccing microbes on everything from gasoline-soaked soil at the corner service station to EPA-designated Superfund sites strewn with the worst carcinogens.

This is a heady time to be a microbe. ("Microbe" is merely a convenient name for any of hundreds of thousands of species of microscopic organisms that flourish on earth; the most numerous are the ones we call bacteria.)

With clever coaching from microbiologists, bacteria and other "bugs" are being put to work in wondrous ways. "We've always been good at domesticating plants and animals," said Jerry Caulder of the Mycogen Corporation of San Diego. "Now we're learning to domesticate bacteria."

Some microbes serve as factories—making pharmaceuticals, pesticides, solvents, and plastics.

Some help make the snow at your ski resort. Some separate gold and copper from ores,



OF GENES AND MEN

"You can't be worried about making history—you do it because it's exciting," says Ananda Chakrabarty, who in 1972 genetically designed a bacterium that gobbles oil, thus inventing the first patented microbe in the United States. Researchers have since isolated thousands of useful microbes. The world's most diverse "bug" bank, the American Type Culture Collection (facing page) keeps 55,000 microscopic cell cultures in icy stock.



reducing the need for chemicals like cyanide.

Some rejuvenate tired oil wells.

Some make the enzymes for snipping DNA, the first step in genetic engineering.

Some are our fermenters, converting sugars into bread, beer, sauerkraut, cheese, yogurt, vinegar, wine.

And some microbes, of course, are age-old enemies, the invisible messengers of tuberculosis and cholera and other scourges. But those are relatively few. "Only one microbe in a thousand is a pathogen — what we think of as a germ," said Lenore Clesceri of Rensselaer Polytechnic Institute in Troy, New York. "The rest, neither we nor the planet could live without. They make what we want, and they get rid of what we don't want. They are the workhorses of biotechnology."

These tiny workhorses share a common characteristic: They can live as a single cell. Scoop up a teaspoon of garden soil, put it under a microscope, and you'll find several

types of microbes—three of which you know already by their deeds.

The plump spheroids you see are yeasts, the fermenters that leaven our bread and brew our beer. Perhaps a million loll in your soil sample. By happy accident, yeasts may have become our earliest domesticates when our ancestors unknowingly harvested yeasts with wild grapes and attributed the miracle of wine fermentation to their gods.

The hairy cells are molds. Your slide may hold 200,000. These fungi are master decomposers. Those hairlike filaments hold powerful chemicals whose probings decompose our compost and the litter of the forest—and can lead to crop diseases and human cancer.

The amoeba-like organism you see is a protozoan—and in fact may be an amoeba. Many protozoans prey on soil bacteria, keeping their population in check. A mere 10,000 protozoans inhabit your sample, though not the most notorious, which cause malaria.

The rest you see—all one billion of them—are bacteria. Oldest of life-forms (for two billion years the only life on earth), they are structurally the simplest, lacking the cell nucleus found in other microbes. Most reproduce by fission: They multiply by dividing.

THOMAS Y. CANBY retired as Senior Assistant Editor for Science in 1991 after 31 years on the Society's staff. This is his 21st article. Free-lance photographer CHARLES O'REAR has contributed 19 stories to the magazine, most recently "The Power of Money," in the January 1993 issue.

POLLUTION BUSTERS

Rainbow trout fill in for canaries at the Homestake gold mine in South Dakota, where live fish test the effluent from a waste-treatment plant (below) loaded with nearly 500 tons of pollutant-degrading bacteria. The mine's waterborne plume of contaminants — especially mercury — used to be detectable halfway across the state, in the Missouri River. Today, with bioremediation, only small traces of wastes leave the site. "It may not be the ideal situation, but it's a lot better than the alternative," says Homestake biochemist Jim Whitlock (left), an early convert to the use of bacteria in cleaning up everything from gasoline-tainted soils to federal Superfund sites. And the trout? "The only problem they have," Whitlock says, "is outgrowing their tanks."



Bacteria thrive as the planet's most abundant, most varied, most versatile, and most useful organisms — and among its most deadly.

These microbes dwell among us — and within us — in astronomical numbers.

At the moment you were born, all damp and wiggly, your body harbored no bacteria. But in hours they colonized this inviting ecological niche, arriving on the air, on doctors' hands, in mother's milk. Today you carry about a quarter of a pound. Billions are helping digest your last meal and, perhaps, excavating a cavity where your toothbrush fails to reach.

THE ABILITY of microbes to break down matter — both natural and man-made — helps explain why the world is looking at them anew.

"They are nature's recyclers," said John A. Glaser of EPA's risk reduction laboratory in Cincinnati. "We can use this environmental process to clean up the environment."

The process means big business for Groundwater Technology, Inc., of Norwood, Massachusetts. Specialists in treating polluted groundwater and soil, they have used the technology of bioremediation to clean up hundreds of sites around the world.

"One of the biggest problems is old gas stations," said Louis Fournier, the firm's principal scientist. "A steel tank lasts only about 15 years; in the U. S. probably hundreds of thousands have leaked gasoline.

"Gasoline percolates through the soil until it floats on the groundwater. Then it breaks down into scores of other compounds, including benzene, a confirmed carcinogen. Unfortunately benzene dissolves in water.

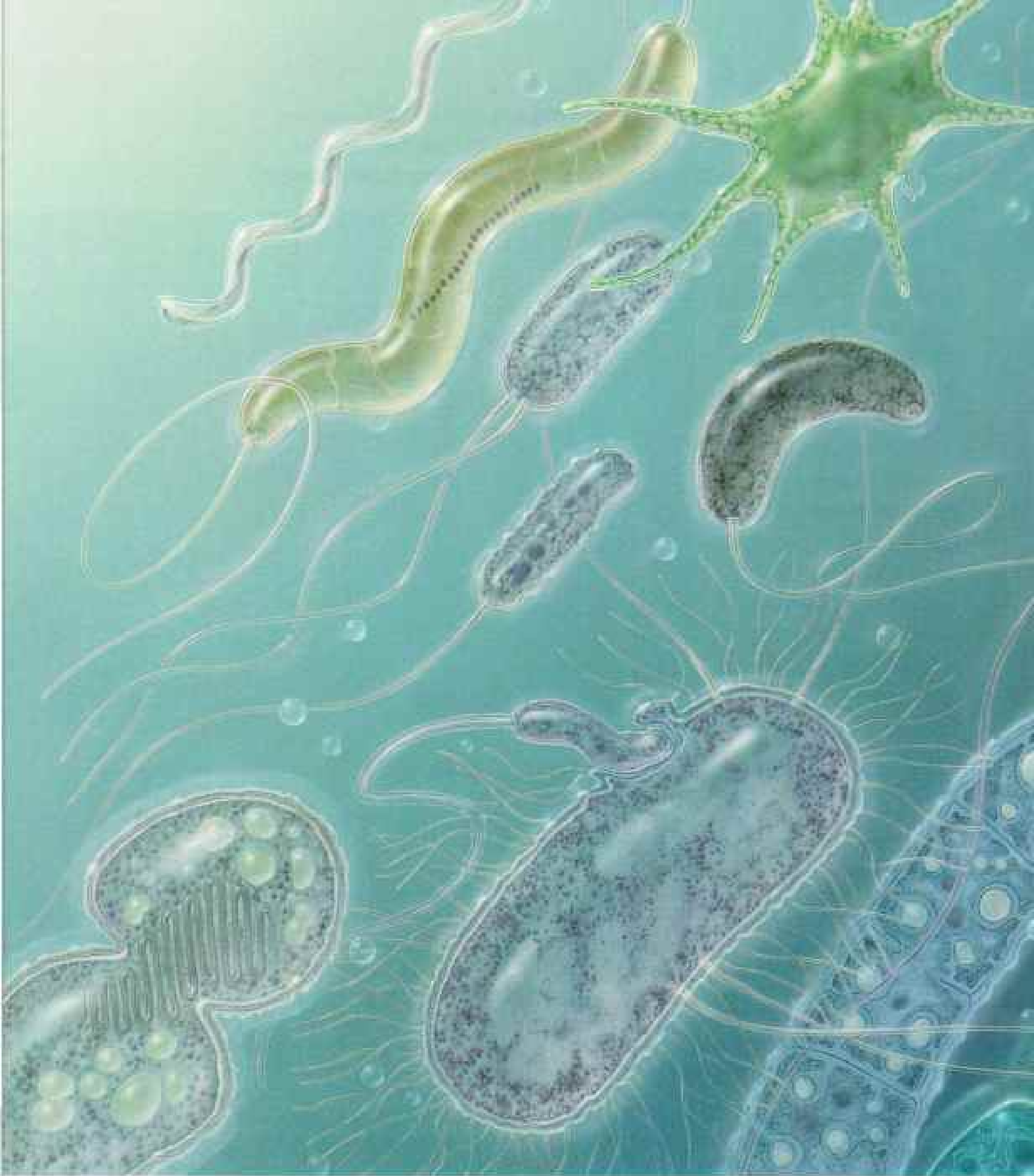
"Microbes, used in concert with other approaches, can clean all this up."

Where do they come from?

"They're already down there," said Dr. Fournier. "The soil contains thousands of species of microbes, all living off one another's excretions. Our job is to give encouragement to the right bugs — the 5 or 10 percent that will eat the contaminant. We whet their appetites with side dishes of favored nutrients — compounds of nitrogen, phosphorus, oxygen."

To see microbes in action, I sought out some sore spots among the nation's all-too-numerous waste sites. First stop: a Superfund project on the lower Mississippi, at the base of the mighty levee holding the river in check.

"The Old Inger Oil Refinery reprocessed dirty oil," said Ralph Portier of Louisiana



Menagerie in miniature

Nature's most diverse life-form, bacteria have adapted to almost every environmental niche. Some, like *Ancalochloris* (1), *Aquaspirillum* (2), and *Chromatium* (3), live in

water, where *Aquaspirillum* may use its magnetic particle chain to find food-rich sediment. *Halo-arcu-la* (4) thrives in salty places. *Pyrodictium* (5) seeks hot spots. *Rhizobium* (6) colonizes plant roots and produces a form of nitrogen vital to its host. Other types of bacteria, including *Escherichia* (7), *Streptococcus* (8), and *Treponema*

(9), can cause disease in humans.

Metabolic needs sometimes bring together disparate species. *Methylococcus* (10), an aerobic methane consumer, may be drawn to *Methanosarcina* (11), an anaerobic methane producer; *Desulfovibrio* (12), a hydrogen sulfide producer, attracts *Ancalochloris*, *Beggiatoa* (13), and *Chromatium*,

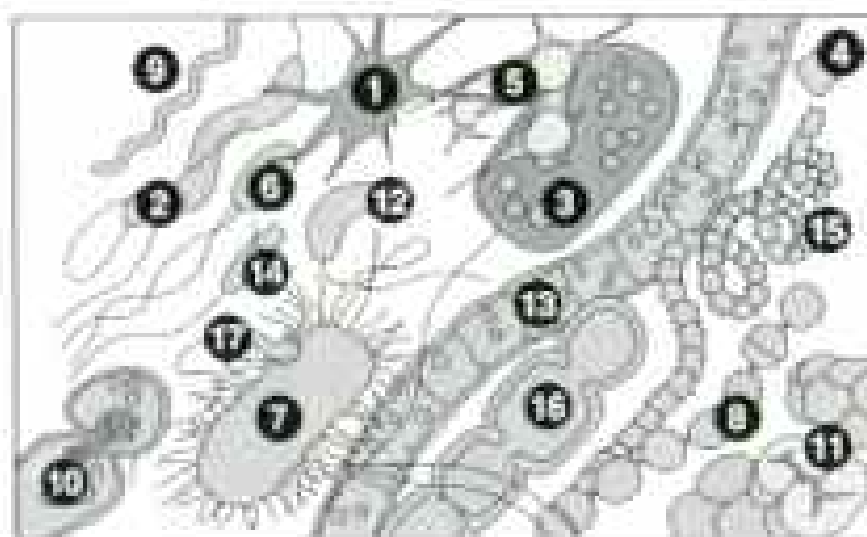


which consume that compound.

Another group of hydrogen sulfide consumers, *Thiobacillus* (14), helps leach metals like copper from ore. *Streptomyces* (15) makes antibiotics. *Anabaena* (16) produces oxygen from water during photosynthesis, while *Bdellovibrio* (17) attacks many other bacteria.

1. ANCALOCHLOPIS PERFILIEVI
2. AQUASPIRILLUM
MAGNETOTACTICUM
3. CHROMATIUM OKENII

4. HALDARICOLA MARISMORTUI
5. PYRODICTIUM OCCULTUM
6. RHIZOBIUM LESUMINOSARUM
7. ESCHERICHIA COLI
8. STREPTOCOCCUS HEMOLYTICUS
9. TREPONEMA PALLIDUM
10. METHYLOCOCCUS CAPSULATUS
11. METHANOSARCINA BARKERI
12. DESULFOVIBRIO
DESULFURICANS
13. NITROSPIRA ALBA
14. THIOBACILLUS NEAPOLITANUS
15. STREPTOMYCES VIOLACEUS
16. ANABAENA FLOS-AQUAE
17. BDELLOVIBRIO BACTERIOVORUS



PAINTING BY JANE HURD



State University. "As you can see, the soil is black with contaminants—more than 200 toxic compounds.

"One option was to truck the soil to a landfill in Texas at a cost of 25 million dollars—an engineering 'solution' that simply moved the problem. The U. S. Army Corps of Engineers demurred, because excavating would undermine the levee.

"I identified bacteria that were already eating the pollutants and encouraged them to reproduce. Then we applied them to a contaminated test site. In nine months they cleaned it up. Full cleanup will cost an estimated ten million dollars—the first Superfund site approved for bioremediation."

We drove along the river. Every few miles we passed a petrochemical plant. Near the impoverished community of St. Gabriel we stopped at the Ciba chemical plant. "This is my favorite project," said Dr. Portier.

With company officials we gathered around a pilot bioreactor—four vertical tanks the size of phone booths. "They hold granules of carbon and diatomaceous earth, for bacteria to cling to. Water from chemical processes flows past, and the bacteria eat the contaminants. The company wants to install another dye

plant, involving more chemicals. The bioreactor will solve environmental problems before they start. The new plant will create jobs, and some will go to St. Gabriel."

DESPITE SUCH SUCCESSES, bioremediation has its detractors. Established engineering still favors cleanup by excavating and incinerating. In earlier years charlatans cleaning septic tanks sold "bags of bugs" that did little—discrediting bacteria. One criticism persisted: No hard scientific data supported bioremediation's apparent results.

"We needed to clear the air," said John Wilson of the EPA research laboratory in Ada, Oklahoma. "I decided to spend taxpayers' money to research cleanup at a site using microbes—with every step monitored, every result recorded."

Traverse City, Michigan, became his proving ground.

Pollution seems out of place in this resort town, wrapped on three sides by emerald forest and fronting on Lake Michigan. Traverse is also a samaritan city, home of a U. S. Coast Guard station whose helicopters respond to the distress calls of the region's many boaters.

In the late 1970s residents adjacent to the station became concerned about their well water. "It had a funny taste and smell," recalled Irene Pickard, a retired health-care billing clerk. "It grew brownish and began to foam in the glass."

Investigation revealed that aviation fuel had been leaking from the station's underground tanks, maybe for decades. Its invisible plume had moved a mile with the groundwater, beneath the Pickard family's house and beyond. In 1984 the Coast Guard hired Traverse Group, Inc., a bioremediation firm.

TGI drilled interdiction wells to pump out the fuel at the station boundary. "The effect on the plume was astonishing," said William Korreck, then site manager for TGI. "With the spread of the spill halted, the indigenous soil microbes quickly did their work, and the plume collapsed on itself. After 18 months we could find no trace of it beyond the station."

The concentration under the station became the focus of three experiments. Dr. Wilson's team at EPA set up to monitor. Interest was riveted on a dramatic new technology known as bioventing, pioneered by Robert Hinchee of Battelle Memorial Institute in Columbus,



Ohio, among others. With John Armstrong, TGI's founder, I strolled the grassy test area above the spill. Every few feet white plastic well pipes thrust above the green like cemetery markers. Some carried air down to the polluted aquifer. Shorter ones drew air up through the soil—the key to bioventing.

"Air pumped down to the groundwater picks up the contaminants," said Dr. Armstrong. "Then vacuum pumps draw the dirtied air back up. As the contaminants filter through the soil they are eaten by the native bacteria, which we encourage with nutrients.

"Air analyzed at the surface is clean. The microbes turn the soil itself into a bioreactor."

"Bioventing is slow but cheap," said Dr. Wilson. "It can reach under buildings and other surface obstructions. It should be the technology of the future."

Like fuels from leaking tanks, other pollutants are woefully common. Microbes find growing roles with each.

- **Paint-stripping sites:** Kelly Air Force Base in San Antonio, Texas, strips old paint from C-5s—half a million pounds of pollutants a year that few landfills will accept. Other military bases and commercial aircraft contribute similar noxious debris.

HIGH-TECH TUNES

Microbes make the music in a set of \$4,000 headphones designed by Sony Corporation, which molds bacteria-produced cellulose (facing page) into speaker diaphragms that boast superb acoustic qualities. Tireless biological factories, bacteria are also capable of churning out medicines, vitamins, and even plastics that biodegrade in landfills.

Could microbes star as strippers? Their show hit the road at a laboratory in Utah.

"Two bacteria and a fungus remove the paint," said Gail Bowers-Irons of Technical Research Associates in Salt Lake City. "We found them at an old paint landfill." She showed me a bottle holding liquid and a chunk of painted metal. The microbes were loosening paint from the metal as if peeling a banana.

"Once the paint is removed, we have a bacterium that eats it," said Mrs. Bowers-Irons. "The bacterium came from a junk pile. We look for helpful bugs wherever equipment is falling apart." A pilot plant for consuming paint is scheduled to be built at Kelly Air Force Base next year.



By sorting 20,000 mutants of a single strain of bacteria, Malcolm Shields of the University of West Florida in Pensacola isolated the most effective form of a bug known to degrade TCE, or trichloroethylene. This ubiquitous contaminant, found in solvents for removing grease and paint, pollutes soil and groundwater at thousands of sites.

- **Wood-preserved sites:** At hundreds of locations across the country, companies treat telephone poles and railroad ties. They use some of the harshest chemicals known. Creosote, the old standby—now tightly controlled—reeks of polyaromatic hydrocarbons, PAHs, many of which are carcinogens.

"Many operations also tend to be marginal, unable to meet environmental costs," said EPA's John Glaser. "They go bankrupt and walk away from their mess."

Digging through preservative sites in Florida, James Mueller of SBP Technologies, Inc., discovered a bacterium that degrades the carcinogenic PAHs. Now patented, it has been successfully tested in bioreactors at

Pensacola, where the now-defunct American Creosote Works contaminated an aquifer and soil with thousands of gallons of creosote and pentachlorophenols.

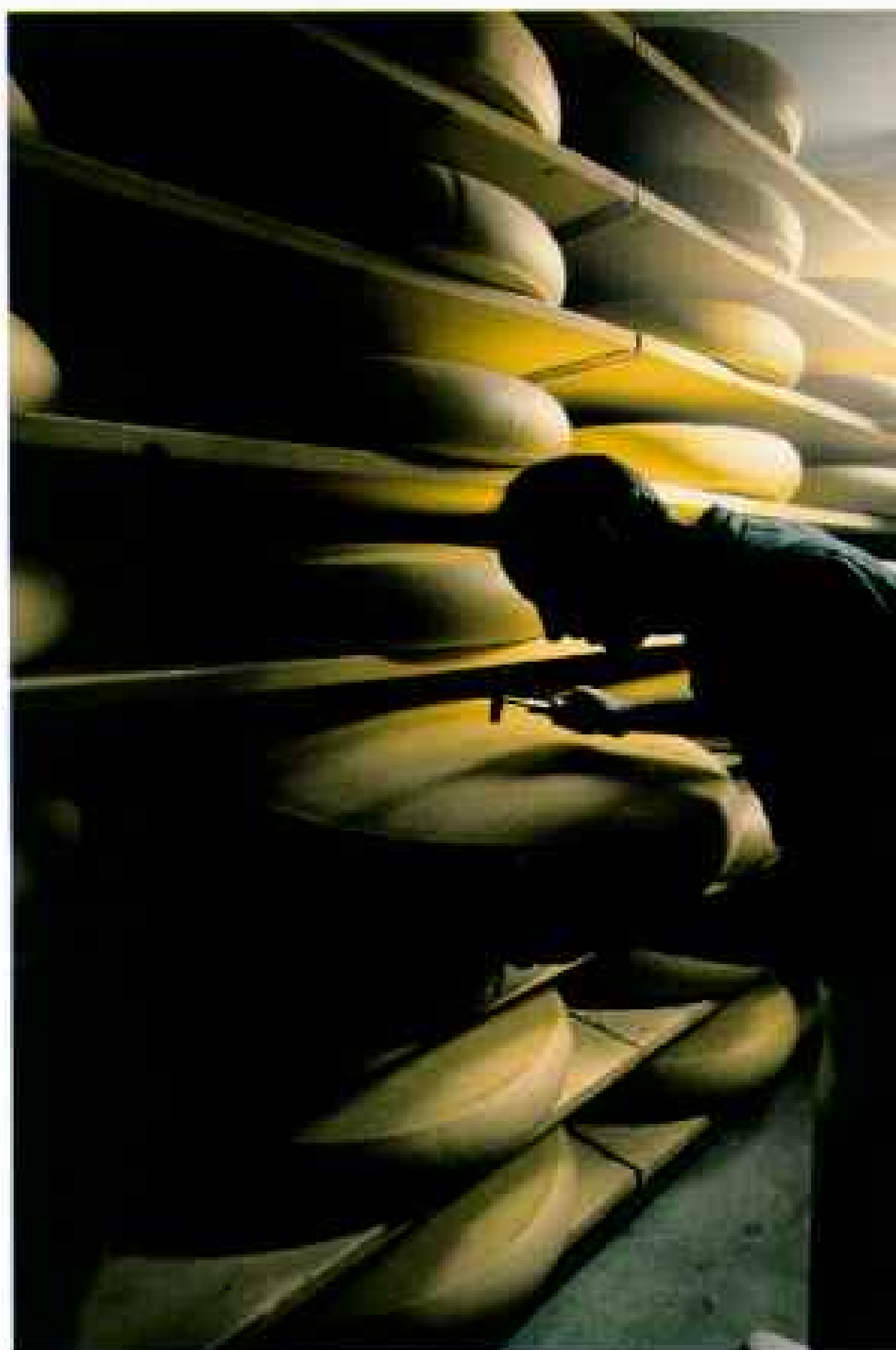
- **Coal-gas sites:** At the turn of the century many cities illuminated streets and homes with "town gas" made from coal. An estimated 1,500 plants were once active, many on what is now prime real estate in the East.

"The contaminants—PAHs, creosote, coal tar—glue the soil together, making it hard to get nutrients, pollutants, and bacteria to interact," said Kennedy Gauger of the Radian Corporation in Austin, Texas. "We're working on slurring the soil, making it more accessible."

WHAT ABOUT OIL SPILLS? Can we help native bacteria clean them up? The 1989 *Exxon Valdez* spill in Alaska provided promising results. "We marked out plots on contaminated beach," said Hap Pritchard of the EPA research center in Gulf Breeze, Florida. "We designated some for treatment with

CHEESE WIZ

"Nobody comes down from heaven and teaches you cheese making," says Swiss dairyman Hans Moser, 73, hoisting a vial of enzymes used to curdle milk (left). Old masters of an ancient biotechnology, Swiss cheese makers use high-quality strains of bacteria to ferment their delectable product. Tradition still guides most aspects of their art: Their cheese's famous holes, made when bacteria emit carbon dioxide during fermentation, ideally should be no larger than cherries. Cheese-maker Rudolph Klötzli (right), hammering ripe cheeses to test for hole size, explains the inexplicable to untrained ears: "The holes have to sound clean."



fertilizers and some as controls with no treatment. In tests conducted over two summers, oil in the treated plots degraded two to four times as fast as that left to natural processes."

Can we *apply* microbes to a spill, instead of simply stimulating those already in the soil or water? The merits are hotly argued; skeptics claim that introduced bacteria can't compete with hardy natives. EPA is currently developing standards for evaluating such methods.

Meanwhile an aggressive Texas firm, Alpha Environmental, has built a worldwide business applying its oil-eating microbes to petroleum-polluted sites. Alpha claims that a proprietary catalyst speeds reproduction of microbes and helps sustain the bugs as well.

Microbiologists happily capitalize on a phenomenon they don't fully understand: Bacteria break down chemicals from which they derive no nourishment or other clear benefit.

Some of these chemicals are tough. PCBs, TCE, and the like were designed to endure: Their molecules resist microbial attack. Yet in nature bacteria crack them. This odd behavior

is called co-metabolism. The General Electric Company has demonstrated co-metabolism of PCB contaminants that it had discharged into the Hudson River years ago.

"Our job," said Dr. Pritchard of EPA, "is to understand co-metabolism so we can encourage it in bioremediation."

Recently scientists discovered another of nature's defenses against contaminants: the broad presence of microbes that have previously adapted to environmental change existing in a state of suspended animation.

"In times of stress," said David L. Lewis of EPA's Athens, Georgia, research lab, "such as climatic change or the appearance of chemical pollutants, the quiescent microbes are activated. They impart a 'memory' to ecosystems, allowing them to cope with new stresses."

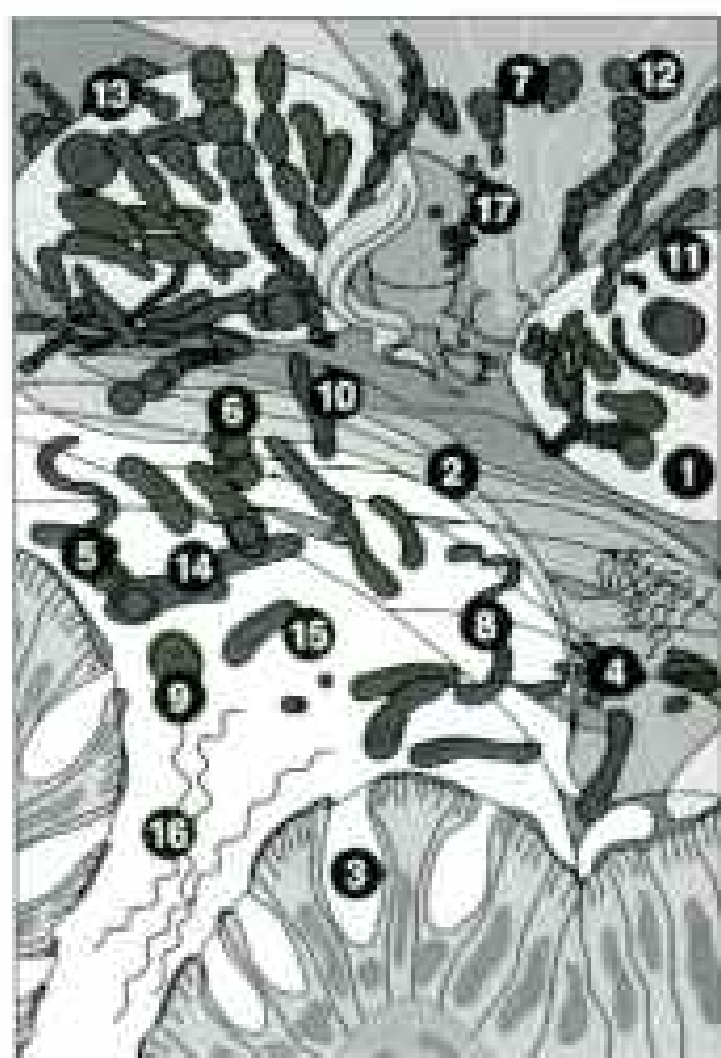
To work their magic, microbes secrete enzymes. All of us produce these remarkable proteins; they serve as catalysts for the chemical processes that take place every second in our bodies. Microbes evolved enzymes first, billions of years ago. The enzymes in turn



A BELLYFUL OF BACTERIA

Even as we harness the bacteria around us, we benefit from the many living inside us. In the large intestine alone, a diverse community of a hundred trillion bacterial cells acts as a barrier against pathogens. These cells also produce nutrients that the intestinal wall absorbs, derived from food the small intestine cannot digest (1), mucous gel (2) secreted by goblet cells (3), and other bodily substances.

Making up some 70 percent of the bacterial volume, *Bacteroides* (4) and *Eubacterium* (5) break down the complex carbohydrates from whole grains, fruits, and vegetables. Other bacteria such as *Acidaminococcus* (6), *Bifidobacterium* (7), *Butyrivibrio* (8), *Coprococcus* (9), *Fusobacterium* (10), *Lactobacillus* (11), *Peptostreptococcus* (12), and *Ruminococcus* (13) complete the breakdown of food. Certain strains of *Clostridium* (14) and *Escherichia* (15) are also normal residents of the intestinal ecosystem, but others can cause diarrhea. We know very little about the roles, as workers or pathogens, of many bacteria, including spirochetes (16). Prominent upper respiratory residents such as *Staphylococcus* (17) may be just passing through.



PAINTING BY JANE HURD

gave rise to the ancient art of fermentation.

The master fermenters, many authorities agree, are the Japanese. Using enzymes produced by fungi and bacteria, they ferment their esteemed sake and beer, their *miso*, their malodorous bean dish, *natto*. And, of course, that most essential condiment, soy sauce.

The Japanese began producing soy sauce five centuries ago. At the Kikkoman Corporation in Tokyo, I saw the simple ingredients of the sauce: soybeans, wheat, salt, and the mold *Aspergillus*.

"The mold is one of our treasures," said an employee. Alluding to the Japanese reverence for forefathers, he added: "The production workers call *Aspergillus* 'ancestor.'"

From Japan I brought home a box of detergent and gave it to my wife, Susan, prettily gift wrapped. "Romantic," she muttered. But she relented with the first wash using microbe-made *Atakku* (Attack). Unavailable in the U. S., it has captured half of Japan's two-billion-dollar market.

Attack joined a flow of innovations that emerged from the laboratory of Koki Horikoshi and his celebrated Superbugs Project. He unearthed scores of bacteria intriguing to science and beneficial to Japanese industry.

"My fascination is bacteria that thrive in extreme environments," said Dr. Horikoshi. "I discovered the Attack bacterium in a rice field; it survives alkalinity that is lethal to most microbes. It produces an enzyme that penetrates the dirt-holding niches in cotton fabrics—how, we still don't know."

"A JUG OF WINE, a Loaf of Bread. . . ." Poet Omar Khayyám could have been a microbiologist, so neatly did he link these products of fermentation.

"Both use the yeast *Saccharomyces*," said Gary Sanderson of Universal Foods Corporation in Milwaukee. "The yeast converts sugars in the grain or grapes to carbon dioxide and alcohol. In the bread the carbon dioxide bubbles become trapped by the dough, causing the bread to rise. The alcohol boils off during baking but leaves a sweetness. Wine is the reverse—you retain the alcohol and permit the carbon dioxide to escape."

A thunderous new dawn for microbes as workers broke in California in 1973. Scientists Stanley Cohen and Herbert Boyer spliced the gene of a toad into the genes of a bacterium. This remarkable feat signaled the birth of



modern biotechnology. Now microbes could be tailored to create medical and other products. These strains could then be mass-produced in large tanks.

Bacteria had been groomed for the task. "They have been intensely studied, particularly in medical research," said Paul Schendel of the Genetics Institute in Cambridge, Massachusetts. "We know more about them than about any other living system."

Much of this research focused on *Escherichia coli*, found by the millions in our large intestines. When gene splicing went commercial, *E. coli* became the bacterium of choice for cloning and mass-producing new materials. The first product brought security to more than four million diabetics across the United States. It flowed from Eli Lilly and Company in Indianapolis.

The pharmaceutical giant was erecting a new facility when I visited. "It will process Humulin, our trade name for human insulin," explained Andrew Russell as we trooped through the present overtaxed plant. Tanks rose three stories high; inside, trillions of genetically engineered *E. coli* were manufacturing the vital drug.

"Before we learned to make insulin," said Dr. Russell, "the only sources were cattle and swine pancreases. There was fear that the demands of an increasing population would exceed supply. Then Genentech, Inc., of San Francisco, managed to transfer the insulin-making gene to bacteria. Lilly developed the difficult technology of producing the bacteria in large tanks and isolating and purifying the drug. The crisis was avoided."

(Ironically, a particularly virulent strain of the *E. coli* bacteria was responsible for several deaths after children ate contaminated hamburger meat in fast-food restaurants in the Pacific Northwest this year. That strain causes illnesses that can lead to anemia, kidney failure, and strokes.)

Microbial factories could spread beyond medicine into products of other industries. There are, for example, microbes whose tiny bodies bulge with plastics.

"We think of plastics as new materials," said R. Clinton Fuller of the University of Massachusetts at Amherst. "But bacteria have been making them for 3.5 billion years.

"Many species make polyesters almost identical to those used in synthetic fibers. But

there's an all-important difference between biological plastics and the chemical synthetics. Bioplastic is biodegradable; synthetics have a mirror-image molecular chain that inhibits biodegradation."

Is the world responding to the prospect of bioplastics?

ICI, the British chemical giant, produced 150 tons last year, said Professor Fuller, and environmentally minded German "greens" gladly pay more for biodegradable bottles made from it. Japan, critically short of landfill space, could be first to plunge into large-scale bioplastic production.

TWO BACTERIA loom large in the struggle to provide humankind with food and fiber. They are *Agrobacterium* and *Bacillus thuringiensis*, known as *B.t.* to gardeners and farmers. Among their benefits, the two could lessen agriculture's dependence on chemicals used in pesticides.

B.t. produces a miraculous natural insecticide, best known for its effect on caterpillars. The bacterium, which contains a tiny protein crystal that burns through the insect's gut, exists in countless strains, each fatal to a specific insect. Applied as dust or spray, the product causes few environmental side effects.

B.t.'s precision, however, is a handicap in the marketplace, where it must compete with chemical insecticides that can kill many insects. Because sunlight destroys the protein crystal, the insecticide also has a brief life, and gardeners must reapply it every week or so.

This limitation has been overcome by the Mycogen Corporation. "We transfer *B.t.*'s crystal-forming gene to a *Pseudomonas* bacterium that has a tough, double-layer cell wall," said Thomas Larsen. "The cell walls encapsulate the crystal against sunlight, giving it greater field life. We call it the CellCap System." Applied as a spray of dead *Pseudomonas*, a product using CellCap was the first genetically engineered pesticide to win EPA approval for release.

In 1976 Israeli entomologist Yoel Margalith was surveying a mosquito-infested area of the Negev desert. On a puddle he spotted a mass of dead larvae. Laboratory analysis showed they had been killed by an unknown strain of *B.t.*, now labeled *B.t.i.*, for *israelensis*.

The discovery marks a humanitarian milestone. The World Health Organization and others spray *B.t.i.* on vast areas in Africa,



ENZYME POWER

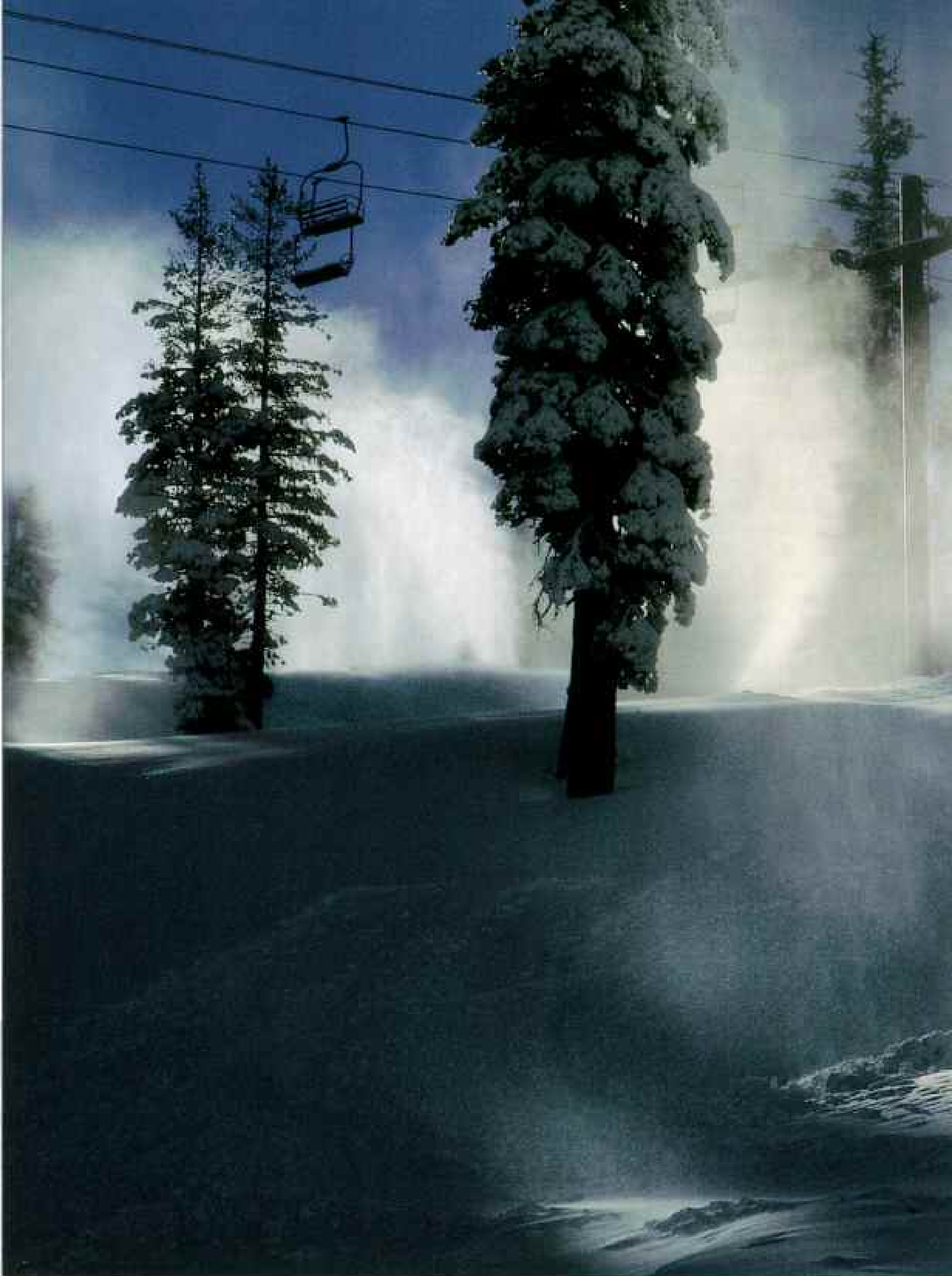
"It takes away all the dirt — that's how it's different," declares Tokyo resident Megumi Ishikawa of Attack, a Japanese detergent that uses bacterial enzymes to digest stains. The grime-fighting bugs were found in a rice field. Hot springs in Yellowstone National Park (facing page) yield bacteria with heat-resistant enzymes crucial to DNA research.

Asia, and South America to control malaria-bearing mosquitoes. *B.t.i.* also kills black-flies, the carriers of river blindness, and spraying campaigns are eradicating the menace in fertile river valleys of West Africa.

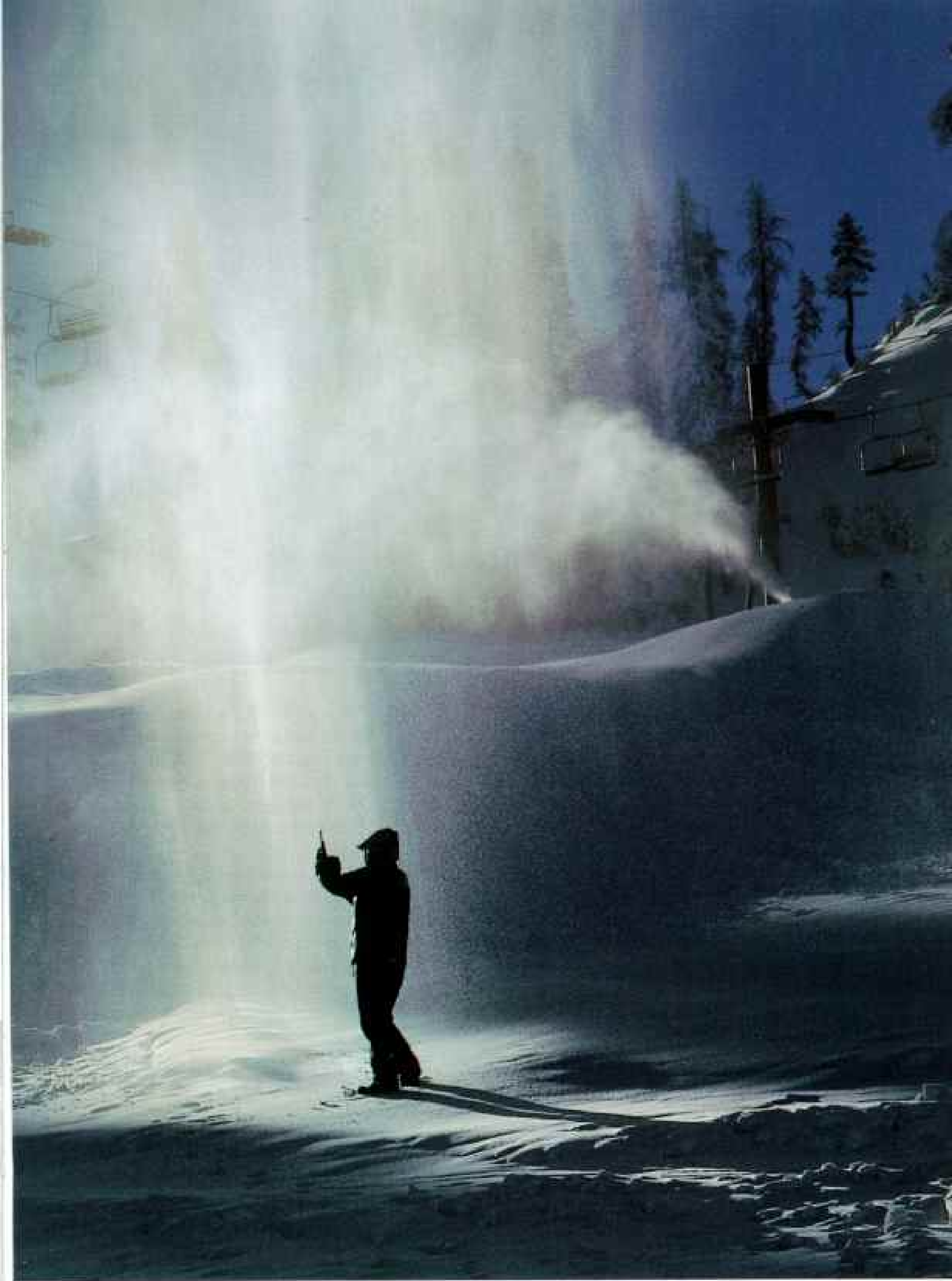
A novel idea arose from *B.t.*'s success: Why not insert its crystal-growing gene directly into a plant? The plant itself would then combat pests, reducing the need for spraying. And the insect-killing trait would pass to ensuing generations of plants through the seeds.

But how do you insert a bug's gene into a plant? The answer lay in yet another bug, the remarkable *Agrobacterium tumefaciens*.

"It's known as the crown gall bacterium,"



Winter gets a bacteriological boost at a ski resort near Lake Tahoe, California, where a technician monitors snowmaking operations made possible by proteins extracted from dead *Pseudomonas syringae*. When mixed with water, the proteins align water molecules so they



crystallize at temperatures roughly 9°F warmer than the water's freezing point — an advantage exploited by some 300 ski areas worldwide. Though costlier than its chemical competitors, ice-forming *P. syringae* is also used for cloud seeding.



said Johnie Jenkins of the U. S. Department of Agriculture Research Service in Starkville, Mississippi. "We believe *Agrobacterium* makes an enzyme that enables it to snip a plant's chromosome and insert its own gene. The gene causes the plant to produce tumors, or galls. These form food for the bacterium.

"To change a plant's genetic structure, we remove the tumor-inducing gene from *Agrobacterium* and replace it with the gene we want for the plant—one that produces, say, a *B.t.* crystal. *Agrobacterium* then inserts it into the plant's chromosome."

Agrobacterium's performance in Starkville could alter the future of agriculture.

There and at a dozen other sites, Monsanto is testing cotton plants implanted with the *B.t.* gene for killing caterpillars. The tests aim at reducing the frequent drenchings with chemicals required to protect the 14 million acres of cotton in the U. S.—a staggering 35 percent of all insecticides used on major crops.

Slipping in mud from an overnight rain, Dr. Jenkins and I surveyed his cotton patch. The engineered plants were easy to spot—bent over by the weight of their healthy bolls. Unaltered plants stood erect, most of their bolls destroyed by worms. "The difference is a

single gene," he said. "Monsanto hopes to commercialize the advance through seed companies in the mid to late 1990s."

Critics argue that the target pests will soon evolve genetic resistance to *B.t.* Another uncertainty lurks in the shadows. Will a public outcry scuttle the project?

Americans have shown concern about the introduction of genetically engineered organisms into the environment. True, the Mycogen release of CellCap products won approval, but those introduced microbes were dead.

Mindful of public feeling, Monsanto and groups cooperating in the cotton experiment—EPA, USDA, Mississippi State University, and the state of Mississippi—have maintained rigid safety precautions. Public hearings preceded planting the first cotton.

Dr. Jenkins breathes optimism. "The alternative to our work is continued, massive pesticide use. I think we're on the side of history."

Agrobacterium opens many doors for biotech companies. The DNA Plant Technology (DNAP) lab in Oakland, California, is aiming an introduced gene at fungi that cause rot in supermarket vegetables. Other DNAP genes prolong the sweetness of peas and change the color of roses and chrysanthemums.

AN APPETITE FOR OIL

"There were cracks so big you'd find everything from beer cans to mice nests in them," marvels technician Andy Anderson (left), who helped rebuild an eight-mile stretch of Kansas highway ruined by temperature extremes. Asphalt-eating microbes in the soil are also thought to play a role. Natural bacteria that dine on petroleum products are being groomed as new weapons against oil spills. Researcher Tom Worthington (right) helped devise a cleanup system using powdered white clay to capture slicks (middle), forming edible islands for the bacteria to attack (bottom). The bugs, cultured from undersea oil seeps, are diligent: His experiments show that 70 percent of the test spills are gone in five weeks. "It'd take mother nature 55 years to do what we do in 36 days," claims Worthington. "You get these floating dinner plates of oil, and the bacteria just love 'em."

MICROBES have joined the work force in other areas:

- **Biomining:** "Spanish miners knew in the 1700s that by running water on piles of copper ore, they caused free copper to seep out," explained Henry Ehrlich of Rensselaer Polytech. "Unknown to them, the moisture stimulated bacteria to oxidize the sulfur binding the copper in the ore."

Today perhaps a quarter of all U. S. copper is processed by bioleaching. In Brazil, Australia, and South Africa, gold mines use microbes to treat the raw ore before final processing with cyanide.

- **Biosensors:** When a herbicide spilled into California's Sacramento River in 1991, state authorities quickly applied a classic test for toxicity, immersing rainbow trout and watching to see if they lived or died. Today authorities are switching to a bacterial device developed by Microbics Corporation of Carlsbad, California. The size of a small typewriter, this sensor capitalizes on the trait of many bacteria to luminesce, like lightning bugs. The bacteria do so less brightly when in contact with harmful material.

Enzymes made by bacteria integrate with

Bacteria: Teaching Old Bugs New Tricks





electronics in sophisticated sensors developed by biotechnologist Isao Karube of the University of Tokyo, Dr. Karube's enzymes measure the alcohol content of wine and beer and the freshness of sushi. Placed in hospital toilets, the sensors monitor the health of patients, as indicated by minerals deposited with urine.

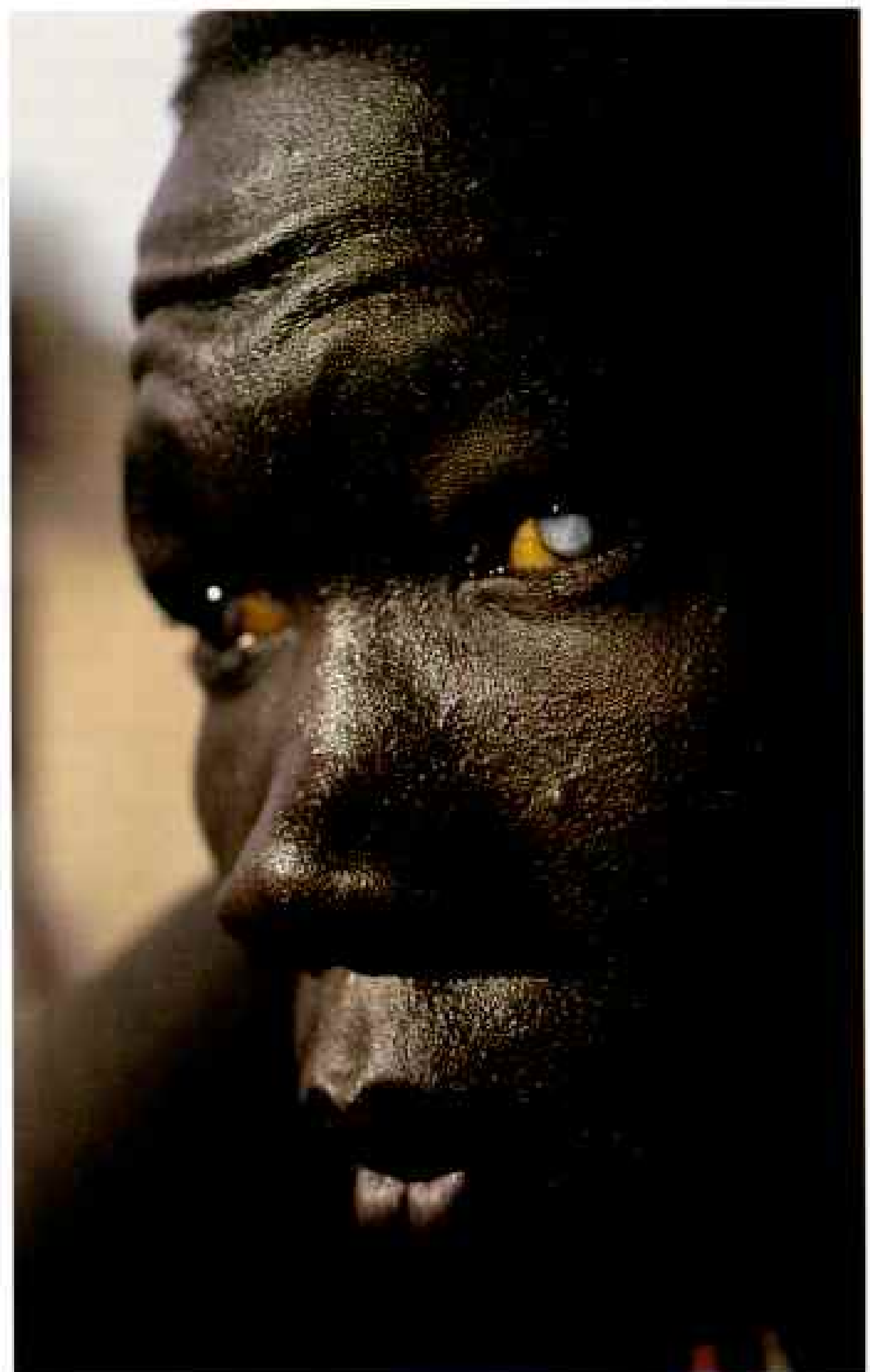
• **Enhanced oil recovery:** Microbes play a growing role in wringing oil from faltering wells. The opportunity is enormous. In U. S. oil fields an estimated 50 billion barrels await improved recovery techniques.

"Hundreds of wells are stimulated yearly using microbes," said Thomas E. Burchfield of the National Institute for Petroleum and Energy Research in Bartlesville, Oklahoma. "For example, bacteria remove clogging paraffins. A company can inject microbes down a well or simply stimulate the bugs already there with nutrients — most often molasses."

• **Coal desulfurization:** The acid rain that threatens lakes and forests in North America traces in large measure to sulfur from coal combustion. Bacteria show promise of removing much of that sulfur before the coal is burned. Research is under way at the Institute of Gas Technology in Chicago and DOE's Idaho National Engineering Laboratory.

• **Nitrogen fixation:** French chemist Louis Pasteur recognized in the 1800s that soil microbes are essential to life; they are the primary force for fracturing tough molecules of atmospheric nitrogen and making it available for plants. These bacteria, often of the genus *Rhizobium*, live in the roots of plants, principally legumes.

Agriculturists have sought to extend this process to other crops and thus reduce our dependence on chemical fertilizers that pollute the environment. It has proved a challenge.



PARASITE PATROL

Taking the cure to a land stricken with onchocerciasis — river blindness — a World Health Organization helicopter sprays a mixture taken from *Bacillus thuringiensis israelensis* on an infected river in Guinea. The biodegradable toxins target the larvae of the blackfly, which carries the disease. A pesticide supply depot (top right) attests to the scale of the operation. Though help has come too late for a victim in Mali (right), experts hope to banish the illness from West Africa by the year 2000.

"Soil teems with *Rhizobium* strains," explained Jo Handelsman of the University of Wisconsin at Madison, "but most of them are poor nitrogen fixers, even though they are well adapted to their niches. We can find efficient nitrogen-fixing *Rhizobium* strains, but it's difficult for them to compete. We're trying to make them more competitive by manipulating their genes."

• **Making snow, stopping frost:** In 1975 Steven Lindow of the University of Wisconsin discovered that bacteria living on plant leaves encourage the formation of frost. He traced the phenomenon to *Pseudomonas syringae*, whose cell wall contains a protein that causes water molecules to align so that they form ice crystals.

Picking up the ball, colleague Trevor Suslow developed Snomax, a snow-making powder formulated from dead *P. syringae*. Today the product, licensed by Genencor International, Inc., is mixed with water and sprayed on ski slopes around the world to generate snow.

If bacteria induce frost, could damaging frost be prevented by ridding crops of the bacteria? Each year U. S. farmers spend millions of dollars fending off frost with wind machines and water sprinklers.

Drs. Lindow and Suslow pursued the idea, adopting the name Frostban. They removed *P. syringae*'s ice-nucleating gene and grew the frost-free bugs in tanks. Sprayed on leaves, the altered bacteria crowd out the frost inducers.

During the 1980s the scientists sought to release the altered bacteria on California potatoes and strawberries. Their efforts stirred tumult from environmental activists. Jeremy Rifkin of the Foundation on Economic Trends and others sued to halt field tests in 1983. Volleys of new test applications met fresh volleys of objections. Finally in 1987 Dr. Suslow obtained permission to test the bacteria on strawberries, Dr. Lindow on potatoes. They succeeded in completing their tests, although in both experiments vandals ripped up plants.

Results showed substantial frost reduction. But the industry lost momentum for introducing altered bacteria.

"During that time," said Dr. Suslow, now with DNAP in Oakland, "we were also able to identify naturally occurring bacteria that can crowd out the frost inducers." In 1992 EPA registered several of these naturally occurring strains for field use.

MICROBE THERAPY

Japanese spa goers loll in invigorating "enzyme baths," where wood chips are heated by the fermenting zeal of *Bacillus subtilis*. Whether easing our pains or tackling our wastes, new technologies are proving that unexpectedly good things can come from nature's small packages — bacteria.

HOW SAFE are microbial releases? Scientists acknowledge that in the early days, guidelines for control of bacterial releases were lacking. They believe safeguards now exist, through both legal requirements and adherence to time-tested research standards.

"I can't see the Australian rabbit problem happening," said Lenore Clesceri of Rensselaer, alluding to public fears of runaway bacteria strains.

"We've experimented with engineered bacteria for decades," declared Robert Stevenson, director emeritus of the nation's bacterial bloodlines at the American Type Culture Collection in Rockville, Maryland. "We've had no trouble, partly because of the earlier concerns."

Before quitting my coverage, I visited bacteria paradise — a sewage-treatment facility. I chose a key one: Maryland's Back River plant, main line of defense between Baltimore's torrent of human and industrial wastes and the effluent-burdened Chesapeake Bay.

"We screen the wastes, settle them out, and use a pinch of chemicals," explained manager Gerry Slattery, "but the bugs are the heart of it. The wastes feed more than four million pounds of bacteria. Sometimes I wonder who's working for whom."

We visited the secondary treatment area — great troughs aflow with dark liquid. "For every pound of sewage that arrives, we unleash ten pounds of bacteria. They're lean, they're hungry, and they grab."

We went to the outfall, where the final effluent enters the bay. Minnows schooled beside a long concrete pier, and fishermen pulled up white perch. "The treated effluent," said Mr. Slattery, "is much cleaner than the regular bay water."

I get your message, Mr. Slattery: We look after the bugs, and they will help us look after planet Earth. □





TIBET'S REMOTE CHANG TANG

In a High and Sacred Realm

Adrift in a sea of grass, a Tibetan nomad guides his flock over the Chang Tang, or "northern plain," home to one of the world's newest—and most immense—wilderness reserves.

*Article and photographs by
GEORGE B. SCHALLER*



N

EARLY 2,000 TIBETAN ANTELOPE flowed over the curve of a hill. Pale and insubstantial in the heat waves, they streamed toward me, the murmur of their soft grunts filling the air. There were only females and young. Whenever a mother briefly halted to forage, her month-old offspring suckled quickly or bedded down, exhausted.

In June the pregnant females had hurried north, moving silently over shimmering plains and past snow-swept mountains, following an ancient migration route to some mysterious place to give birth. It is a place so remote that even nomadic herders do not venture near it. It is so bleak that the animals find little more than the dry leaves of a sharp-tipped sedge to eat. We had tried to follow the herds, but severe blizzards stopped us at Heishi Beihu, "blackrock northlake," so named for its black lava flows. Now, in early



OFFERING MEALS ON THE MOVE, A TIBETAN ANTELOPE SUCKLES HER MONTH-OLD OFFSPRING. BY THE THOUSANDS, ANTELOPE STILL SWEEP FREELY ACROSS THE WILD HEART OF TIBET.





A HERD OF TIBETAN ANTELOPE ETCHES TRAILS OF HUNGER THROUGH A SNOWSCAPE AS BRIGHT AS A SUNLIT CLOUD.



*Barbed but beautiful,
a blue poppy embodies
both the delicacy and
harshness of life on
Tibet's northern plain.
With an average eleva-
tion of 16,000 feet,
annual rainfall as mea-
ger as two inches, and
a brief three-month
growing season, no trees
break the raw horizon
in a grassland almost
as big as Texas.*

"...a truly wild

August, the antelope were a hundred miles south on their return migration.

As the animals approached, I became a motionless mound, my face tucked among cushions of edelweiss, yellow-flowered cinquefoil, and tufts of spear grass. We were at 16,500 feet. Behind me glacier-flanked peaks of the Aru Range rose abruptly, several over 20,000 feet in elevation, and on my left was Luotuo Hu, "camel lake," turquoise and tranquil among brown, rumpled

hills. The antelope, normally so shy, surrounded me, some at less than a hundred feet, as they leisurely headed down valley. Another herd came, and another. Only about half the females had young at heel, as compared with two-thirds with young at this season two years before. The June blizzards had probably killed many newborns.

I felt becalmed in time and space. In 1903 the British explorer Capt. C. G. Rawling had also witnessed this great migration: "Almost from my feet away to the north and east, as far as the eye could reach, were thousands upon thousands of doe antelope with their young. . . there could not have been less than 15,000 or 20,000 visible at one time."

Rawling was the last Westerner to observe this spectacle until my wife, Kay, and I visited the Aru area in 1988 and again in 1990 and 1992. There are fewer antelope now, and the groups we observed belong to the largest of the four known migratory populations in the Chang Tang, Tibetan for "northern plain." These unhampered migrations indicate that the Chang Tang harbors a rare treasure, an undamaged ecosystem, a truly wild land not yet controlled by humankind.

THE TIBETAN PLATEAU is about 950,000 square miles in size, and about 70 percent of this area consists of high pastures (map, pages 72-3). The highest of these is the Chang Tang; it spreads over much of the western and northern parts of the Tibet Autonomous Region of the People's Republic of China and also extends east into the neighboring Qinghai Province and north into the Xinjiang Autonomous Region as far as the Kunlun mountains, which trace the northern rim of the Tibetan Plateau. Pastoralists have long settled the good grazing lands of the Chang Tang. But the desolate northern area, north of about 32° N latitude, has remained either uninhabited or only sparsely populated. This section covers some 200,000 square miles, an area larger than California or Germany, and most lies between 15,000 and 17,000 feet in elevation. It is a harsh landscape of forbidding grandeur and infinite horizons. Winds rage, their force broken by neither trees nor shrubs. Winter temperatures drop to minus 40°F, and even in summer the night temperatures hover around freezing.

GEORGE B. SCHALLER, director of science at the Wildlife Conservation Society in New York City, has reported on lions, snow leopards, and pandas for NATIONAL GEOGRAPHIC. His latest book, *The Last Panda*, was published in April by the University of Chicago Press.

land not yet controlled by humankind"

At the turn of the century the Swedish explorer Sven Hedin traveled for 55 days across the Chang Tang without seeing another person. He wrote: "Roads! There are no other paths there than those beaten out by wild yaks. . . ." As a boy I had read Hedin's accounts. The Chang Tang became to me a fabled land of dreams and adventures. And later, after I became a naturalist, the area retained its sense of unknown possibilities, its fauna of Tibetan wild asses, known locally as kiangs, of wild yaks, of huge-horned Tibetan argali sheep, and other species all still unstudied. Here one can step beyond the known world back in time to explore where no outsider has ever trod.

Another antelope herd passed by me, and then the slopes were silent. I climbed uphill toward my waiting car, almost afloat in the hard, bright light. Overhead a flock of sand grouse and a few white clouds were on the wing, and the sky was as blue as a poppy. Nine kiangs, elegant in their russet-and-white coats, ascended a slope opposite me, a stallion at the rear. Many stallions are solitary during the summer rut, hoping that a herd of mares will wander into their territory. The belly of one mare bulged; she would give birth within days. Four wild yak bulls grazed on a far hillside, looking huge and rugged even at a distance.

Ahead of me, stretching to the south, was the Aru basin, about 700 square miles in extent. The Chang Tang consists mostly of lake basins without outlets, separated by bald ridges and mountain chains. No great rivers have carved through this terrain except at the eastern margin, where the Yangtze River has its source. As glaciers melted after the last ice age, vast lakes filled the basins. The land became increasingly drier and lakes grew smaller, some disappearing. Old beach lines can be seen as much as 600 feet above present lake levels. Today the region is a high-altitude desert with only about five to ten inches of precipitation a year, most as snow and hail in the summer. With a drop in lake levels, minerals were concentrated, making most water brackish or saline, undrinkable. Once one large lake filled the Aru basin; now it is divided into two smaller lakes, Aru Co—*co* means lake in Tibetan—and Memar Co, near which we had our camp.

Our expedition leader, Gu Bin-yuan of the Tibet Plateau Institute of Biology in Lhasa, waited for me by the car. Distances in the Chang Tang are so vast and the terrain is so remote that it is best to use four-wheel-drive vehicles. Most areas are accessible, especially in winter, when the soil is dry and streams are frozen. But I preferred to walk: One

A RESEARCH
PROJECT
SUPPORTED
IN PART
BY YOUR
SOCIETY

Ears at attention, a Tibetan woolly hare—endemic to the region—wavers between curiosity and flight. Hunting wild hare is taboo among some nomadic herders; Tibetan Buddhism holds all life inviolate. For Tibetans even peaks and lakes can be holy. The Chang Tang, a stark and desolate wilderness, is home to innumerable deities.



A world stripped to its rocky soul surrounds the author's camp along a glacial wash in the Aru basin. The monumental Chang Tang has discouraged human intrusion for millennia. Even today its windswept valleys and nameless peaks remain largely the domain of gazelles, wild asses, and yaks. Nomads inhabit mostly its southern and western fringes.

can only make intimate contact with an area on foot, roofless, exposed to the raw bite of wind. Besides, the animals of the Chang Tang are not innocent of cars. Wild yaks may travel for miles and Tibetan antelope seek the horizon with dazzling speed when they perceive a vehicle, obviously aware that death can follow.

Once when walking far north of the Aru basin, we met a lynx in a desolate place where the plains are as gray and corrugated as a yak chip. The land was empty, with little grass and few animals; an occasional gray-rumped Tibetan woolly hare—a species unique to the plateau—huddled in a shallow scrape. No humans came to this isolated spot. But the lynx had settled here. At rest on a cliff, he apparently thought us inconsequential; there was not even fire in his eyes as he gazed in our direction.

In the Aru basin a Tibetan gazelle, a lone female, fled from our car with stiff-legged bounds, her white rump patch flashing like a heliograph. Perhaps she had her offspring cached nearby. Weighing only about 30 pounds, these delicate and swift animals are the most widespread of the wild ungulates on the grass steppes; they are usually seen in small herds of up to a dozen individuals. Farther on, the plains suddenly rippled, and dust rose as if swept by wind. My scope revealed a herd of male Tibetan antelope, about 350 of them, racing several abreast, their horns as erect as the lances of a company of knights. Perhaps they had scented a wolf—two packs roamed the basin—or perhaps they merely feared the car. Males, unlike females, do not troop as far as 200 miles to the barren north in spring. Instead most migrate only part way and loiter the summer away alone or in herds. By November they will have rejoined the females in preparation for the rut.

I had come to the Chang Tang to chronicle the obscure lives of the plateau's large predators (snow leopard, wolf, lynx, Tibetan brown bear) and six wild ungulates (wild yak, kiang, blue sheep, Tibetan argali, gazelle, and antelope). I was interested in their status and distribution, birth and death rates, food habits, movements. The Tibetan antelope became my special focus. Just as the seasonal wanderings of the wildebeest define the ecosystem of the Serengeti in Tanzania, so do the travels





of Tibetan antelope in the Chang Tang. Between 1985 and 1987, before beginning work in Tibet, I had surveyed wildlife in those parts of the Chang Tang that extend into Qinghai and Xinjiang. Large tracts had little or no wildlife, and those animals that survived seemed living elegies for a past that was rapidly vanishing. Would the mystery, solitude, and inspiration of the Chang Tang be marred by the extermination of its noble animals and the construction of roads, mining camps, and other development? The 17,300-square-mile Arjin Shan Reserve had recently been established in Xinjiang at the northern edge of the Chang Tang, a notable action by China, but it was not enough. I was reminded of the last words of Milarepa, a Tibetan hermit who died in 1123:

*Do if you like that which may seem sinful
But help living beings,
Because that is truly pious work.*

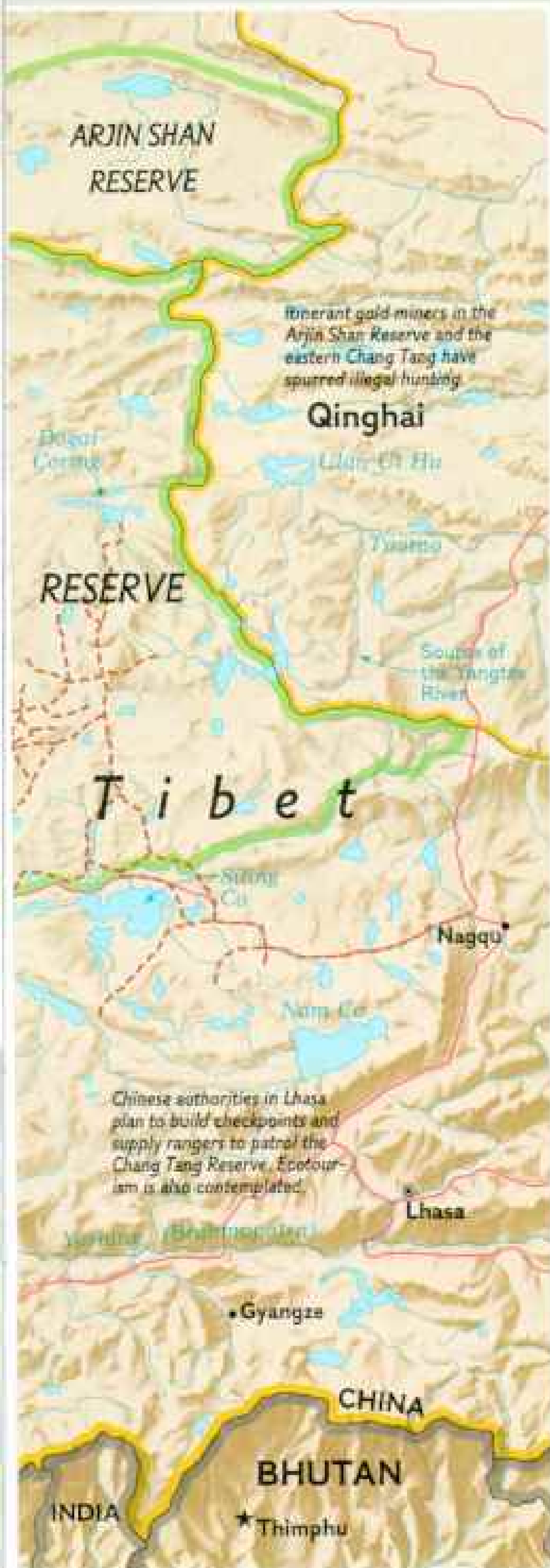
Conservation initiatives are too often made after wildlife has been decimated and habitat modified; I was determined to help the Chang



Tibet's Empty Quarter

"No spectacle could be more sublime," explorer Sven Hedin wrote of a trek through the northern Chang Tang at the turn of the century. "Every day's march, every league brings discoveries of unimagined beauty." Satellite images offered Western scientists their only glimpses of Tibet's remote outback between Hedin's visit and 1988—when China allowed author George B. Schaller into the Chang Tang's desolate northern sector. He and his Chinese and

Tibetan colleagues have since logged thousands of miles by car and camel (facing page), laying groundwork for the world's largest nature reserve after Greenland National Park. The 115,500-square-mile reserve—Arizona would fit inside its boundaries—was established by China this year. The park promises a wealth of new biological data, and more. A wilderness on the roof of the world has been set aside for posterity.





*"Here one
can step...
where no
outsider
has ever
trod."*

Tang endure as part of Tibet's natural heritage. By 1992, while we were in the Aru basin, a responsive Tibet Autonomous Region government was in the final stages of establishing a Chang Tang Reserve. China subsequently made it a national reserve. Approximately 115,500 square miles in size—600 miles at its widest and 300 miles at its longest—the Chang Tang Reserve is the second largest in the world, exceeded only by Greenland National Park, which consists mostly of ice cap.

Our camp—a cook tent, four small sleeping tents, and the vehicles drawn close as windbreaks—was tucked against a hill beside a glacial stream. On our return, I told Kay jubilantly about my day with the antelope. And she showed me plants she had pressed for identification, a tiny polygonum, a purple-flowered legume, a matlike composite—inconspicuous or procumbent, as if reticent about facing the harsh environment.

Black-lipped pikas—small, tailless relatives of rabbits—had burrows within a few feet of our tent. Kay had been observing their nose-to-nose greetings and playful boxing, and she kept notes on their behavior. Pikas are an essential link in the food chain of the Chang Tang. Upland hawks,



saker falcons, and sand foxes subsist on them, brown bears dig them from their burrows, and wolves snatch them up when larger prey is unavailable. On the lush pastures of eastern Qinghai each pika family—a male, female, and their offspring—lives in an extensive burrow system. But here on the spartan uplands, where most of the ground is bare and food widely dispersed, pikas use scattered simple burrows, each six to ten feet long, and scuttle between them.

Hume's ground jays, small tan birds with curved bills, were feeding nestlings in an abandoned pika burrow near our tent. "Three adults have been bringing insects to the nest all day," Kay said. This nest had not just a pair of adults but a third adult helper, probably a fledgling from the previous year.

Chi Doa, a Tibetan who was second in command on our trip, called *chi fan*—dinner. We sat on boxes and water cans outside the cook tent, each of us with a bowl of noodles and canned peas spiced with red pepper. Yak chips smoldered, heating water for tea.

The Aru Range glowed in sunset hues of sepia and gunmetal gray. Dawa, one of our drivers, enthusiastically told us that he had spotted a large herd of wild yaks in the nearby foothills earlier that day. Perhaps we could find them again tomorrow.

The cold hit hard as soon as the sun vanished behind the ranges. Kay and I retreated to our mountain tent, where, tucked into our sleeping bag, we read a little by flashlight. Before going to sleep, I looked outside. There were stars close and bright but also a cloud bank that spoke of snow. Later snow came, rustling as soft as moth wings on our tent.

MILLIONS OF DOMESTIC YAKS inhabit Central Asia. Essential to the lives of many people, yaks provide meat, wool, and milk rich in butterfat, as well as fuel and transport. But to have a true image of the yak, one must meet a wild bull in unrestricted freedom. A ton of power with imposing 30-inch horns, the wind whipping his long mantle of hair, he takes possession of the landscape. Wild yaks were once

"A noisier, cheerier lot I have never seen," an early European visitor remarked of Tibetan nomads, pastoralists who still brazen out winter temperatures of minus 40°F in yak-hair tents. Dependent on herds of sheep and oxlike domestic yaks for survival, nomads have shared their remote pastures with wildlife for generations—a tolerant tradition imperiled by the illegal wildlife trade.

abundant on the Tibetan Plateau. During his travels in eastern Qinghai in 1889, William Rockhill found hills "literally black with yak; they could be seen by the thousands."

Those plains are now empty of yaks, killed off for meat since the 1950s, when a new road made the area accessible to hunters. This species of wild cattle is now largely confined to the most remote parts of the Chang Tang, and even there it is becoming increasingly scarce. Herds of 20 or 30 or even a hundred wild yaks can still be seen, as can bulls, singly and in small groups. In one uninhabited area of 3,200 square miles we found just 73 yaks during an intensive survey. The Aru basin and area surrounding it was exceptional in that it had, to my knowledge, the largest remaining concentration of wild yaks in Tibet, about one thousand.

The next day we found the herd that Dawa had reported. The yaks rested on dun slopes the sun had already freed of snow. From a great distance I could count over 200 black dots speckling the hillside—and two golden dots. Wild yaks are typically a lustrous black except for a flush of gray on the muzzle. But in the Aru region a startling mutation has occurred: One to two percent of the yaks are completely golden. A black female may have a golden calf or a golden female a black calf.

Most of the yaks drowsed in ponderous ease. At the edge of the herd a bull trailed a cow closely, guarding her from other bulls; the rut had begun, and she would give birth eight and a half months later.

A short distance from the others a herd of 40 yaks grazed placidly on the plain. Suddenly the animals bunched and bolted. Five lanky wolves surged around and through the herd. After a headlong rush the yaks halted, then stood indecisively. Occasionally a wolf swept closely past the herd or a yak made a token rush with lowered horns. It was a standoff. The wolves apparently were searching for calves, but there were none. Soon the pack bounded off to join a sixth wolf on a nearby rise; the yaks lingered before drifting toward the hills.

After observing the yaks awhile, I too wandered off. As usual I remained alert for brown bears. The Tibetan brown bear, a subspecies found only on the plateau and now the rarest large mammal there, has black legs, a broad, white collar, shaggy ears, and an irascible temper. Near here a bear had rushed from a depression with her head threateningly low, hair bristling, and with utter fury she pursued the car in which Kay was traveling. The animal revealed its wildness, and Kay was suitably impressed.

"I have never, ever, seen such an angry animal," she told me later. It was a female accompanied by two cubs.

If this account tarries so long in the Aru basin, it is because wild hoofed animals are almost always in view, because no area of the Chang Tang has so imprinted itself on my memory. With its ecological wholeness and stark beauty, its mysterious horizons and unfettered freedom,

Unfazed by humans, a lynx (facing page) stares fearlessly from its perch in a northern corner of the reserve, a hinterland devoid of people. Wildlife here is so unstudied that the behavior, population, and distribution of major species are only now being documented. One novelty: golden wild yaks (below), a rare mutation in the normally black-haired species.



the Aru basin is a place where both body and mind can travel; it represents to me the spiritual essence of Tibet.

In 1891 Hamilton Bower, an officer in the British Army, visited Aru Co and wrote afterward: "In every direction antelope and yak in incredible numbers were seen, some grazing, some lying down. No trees, no signs of man, and this peaceful-looking lake, never before seen by a European eye, seemingly given over as a happy grazing ground to the wild animals." Now, a century later, wildlife is still abundant here, more so than in any other place I saw in the Chang Tang.

The Aru Range provides fresh water and with it good grazing. But the growing season is short, a mere three months, and for most of the year the herbivores are forced to feed on dry, dead plants that are not very nutritious. Only some 30 plant species provide most of their forage. Yet the animals have divided their sparse resources with harmony and simplicity. For instance, blue sheep favor the vicinity of cliffs, wild yaks and argali sheep the foothills and high rolling terrain, and others the plains. Kiangs are partial to eating spear grass, whereas Tibetan antelope sample a wide variety of plants, from coarse sedges to succulent legumes.

MY CHINESE AND TIBETAN co-workers were mostly from the Tibet Plateau Institute of Biology and the Tibet Forest Bureau. Over a period of several years we made five journeys through the Chang Tang Reserve, each lasting one to three months. Our work was made possible by these two Tibetan organizations, the Wildlife Conservation Society, and the National Geographic Society. Driving cross-country, the land expanded before us, scoured by wind, immense and vital in its solitude, our vehicles providing the only human measure. We usually traveled with two cars plus a truck that carried fuel and food. One car would lead, selecting a route over hills, through ravines, around soft ground, and the heavily laden truck brought up the rear. If we misjudged the terrain, we or the truck often got stuck axle deep in mud. This could require a day or more of digging, excellent exercise at 16,000 feet. Permafrost underlies much of the northern Chang Tang at a depth of two to three feet, but the surface could be so sodden after days of summer storms that we could not travel. I would have preferred pack animals to vehicles. There is atavistic pleasure in traversing these uplands in the simple fashion of another age. We did this only once, for three weeks, riding on Bactrian camels at the leisurely pace determined by the animals themselves. But time was short, our mission urgent.

A mere dozen or so Western expeditions had penetrated what is now the Chang Tang Reserve before we began our collaborative work there. We sometimes crossed the routes of these early travelers. Prince Henry of Orléans and Gabriel Bonvalot were the first to cross the area north to south in 1889, and Hamilton Bower first went west to east in 1891. St. George Littledale's caravan in 1895 included his wife and terrier. Sven Hedin made three journeys, the last one from 1906 to 1908, and with it





the period of foreign exploration there came to an end. Most of these expeditions were attempting to reach Lhasa, the holy sanctuary of Tibetan Buddhism, by entering forbidden Tibet through the uninhabited Chang Tang. All failed. Tibetan soldiers posted near Siling Co and other places turned the expeditions aside.

The area saw no more foreigners until 1950. In that year Frank Bessac, an American Fulbright scholar; Douglas Mackiernan, the American consul in Xinjiang's capital, Urumqi; and three White Russians fled the civil war in Xinjiang and tried to reach India by crossing the Tibetan Plateau. They had struggled almost across the Chang Tang when nervous Tibetan border guards shot Mackiernan and two of the White Russians. But Bessac and one companion survived to be safely escorted to Lhasa and on to India.

Since the 1960s a number of Chinese scientific expeditions have conducted research in the region, but until recent years the accounts of early Western travelers provided our only information about the wildlife.

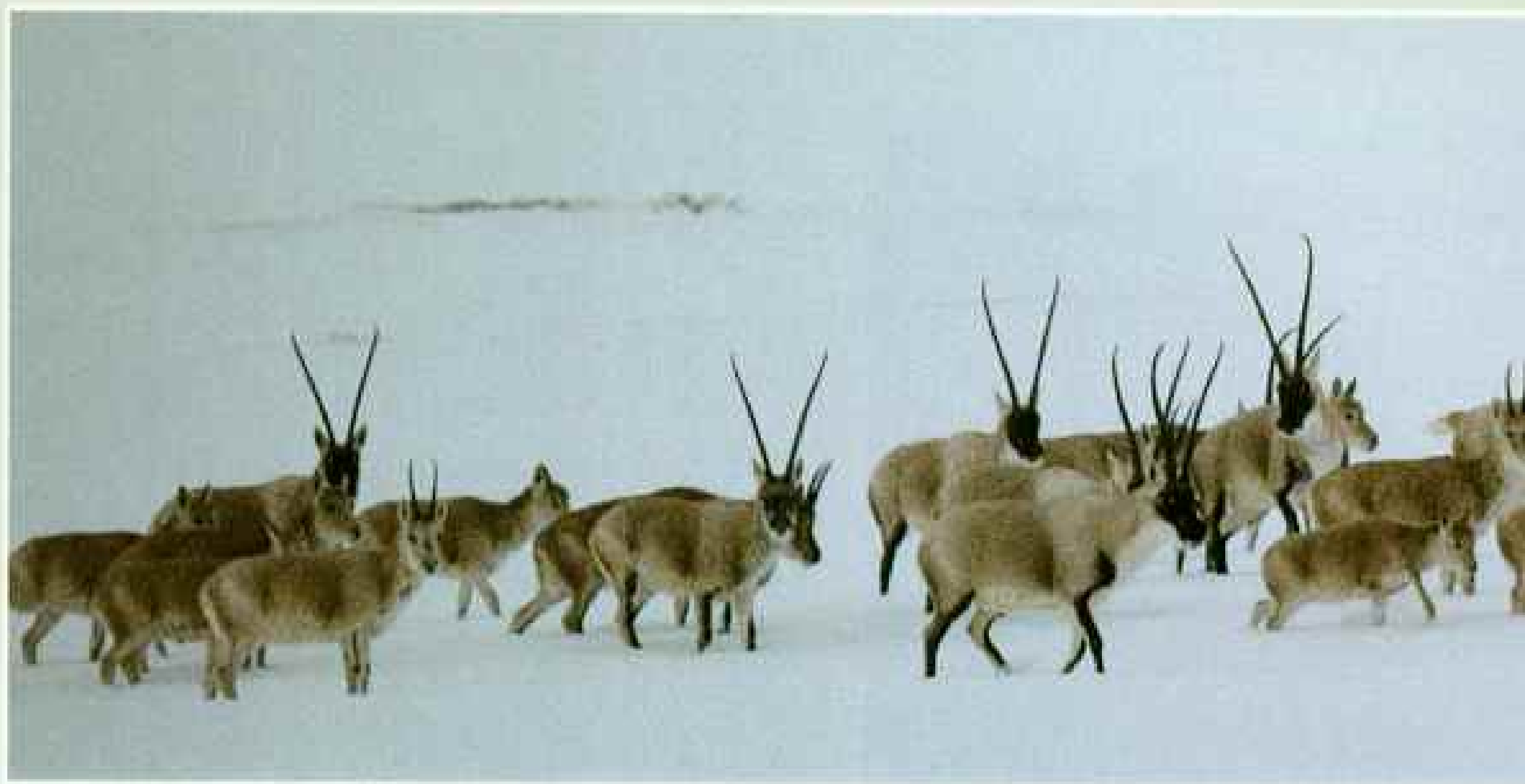


Antelope carcasses lie frozen at a camp in the Chang Tang, where hunters roamed with stone knives and scrapers (below) in Neolithic times. Today profit, not subsistence, drives much of the killing: Antelope wool is spun into fine scarves coveted in India and Europe. With every sale, the empty plains of Tibet grow emptier still.



Some wrote perceptively; others viewed animals in terms of recipes or provided erroneous insights, as when the British wanderer Henry Savage Landor wrote about the kiangs: "Their apparent tameness is often deceptive, enabling them to draw quite close to the unwary traveler, and then with a sudden dash seize him by the stomach."

Like some early travelers, we found that wildlife was not evenly distributed throughout the Chang Tang. For miles we might see nothing except perhaps a lone kiang on a ridge, his tail blowing, the sky to himself, or perhaps a glint of gazelles. Then suddenly in the empty land we would come upon an aggregation of animals where grazing was especially good. Overall the average density was less than one animal per square mile. The northern half of the reserve is desolate, with gazelles almost absent, argalis as rare there as elsewhere, antelope seasonal, and the other animals few and scattered. The region remains unpopulated because livestock cannot easily subsist there. By contrast the southern half of the reserve with its grass steppes is critical to the survival of the



“The land
expanded
before us,
scoured
by wind,
immense
and vital
in its
solitude....”

wildlife. Here the antelope gather by the thousands for the winter; here the kiangs may still roam in herds of one hundred or even twice that. But almost gone from the south is the totem of the Chang Tang, the wild yak.

Once only a few pastoralists used these grasslands seasonally, if at all. They herded their sheep and goats and yaks, and they hunted for subsistence. In 1906, for example, Sven Hedin came across a tent inhabited by a woman with three children. “She had arrived from Gertse [Gerze] 17 days before with her two husbands, who had returned to Gertse after they had filled her tent for her with wild-ass meat. She owned a few yaks and a small flock of sheep and would live for the next three months on game—yaks, kiangs, and antelopes.” Tibetan pastoralists hunted wolves, lynx, foxes, and bears for their pelts and to protect livestock. And a small amount of antelope wool was traded to India, where it was marketed as *shahtoosh*, the king of wool, because none finer exists. Such subsistence hunting by a few herdsman with muzzle-loaders and traps had no measurable impact on the wildlife.

Indeed, hunters have been part of the Chang Tang for thousands of years. One day as I meandered far from camp along the beach of an ancient lake, its waters long ago transformed to dry steppe, I spied at my feet a sliver of stone, a piece of chert. Its charcoal color contrasted with the pale sand and pebbles around it. I picked it up. It was a stone tool, a flake with one edge chipped to make a cutting blade. Hunters had once camped here, perhaps 5,000 years ago, perhaps 10,000 years.

All the way home I held the stone tool tightly in my hand, making human contact over the millennia with those who had also walked these unbounded uplands. And now that I had learned to see, I found stone tools in several localities, all good campsites, such as at the mouth of valleys and at hot springs. Most tools were scrapers or knives or microblades, tiny sharp flakes that can be hafted as arrowheads. The tool kit of a hunter.

Stone-tool sites extend far north into areas of the Chang Tang that are not inhabited today. Pollen analysis of lake sediment by researchers Huang Cixuan and Liang Yulian of the Chinese Academy of Sciences shows that about 5,000 to 13,000 years ago the region was warmer and wetter than today. Then as now most of the Chang Tang consisted of



steppe, but there were also stands of pine and fir and thickets of tamarisk, willow, and alder. Lakes were then much larger, and mountains bristled with glaciers. People and tents would have been part of that landscape as well, and I now viewed it with a sense of times past.

During recent decades the economy of pastoralists has changed. Once families made long annual treks by yak caravan to trade wool, butter, and other products for such basic supplies as *tsampa*, the roasted ground barley that is a Tibetan staple. But now trucks reach almost all tent camps, even those of pastoralists who have moved north into the Chang Tang to the limit of good grazing. The traditional system of pastoralism that shifts livestock seasonally has maintained the grasslands well; I saw no serious overgrazing in the reserve. Wildlife and livestock can obviously continue to coexist. However, with a ready access to markets, some pastoralists are now less tolerant of wild animals, especially of kiangs, which are thought to compete with livestock for food. Others still find quiet pleasure in their natural heritage. As one herdsman told me, "I like to see wild animals around."

WITH THE ADVENT of a cash economy, commercial hunting has been added to subsistence hunting. Wild yaks, with so much meat, were the first to be killed in great numbers. Officials from one town ventured far to the north into uninhabited terrain each autumn to shoot wild yaks by the truckload. We found yak heads littering the most remote areas. In 1988, in the small town of Gerze, I saw herdsman plucking wool from antelope hides to sell to local dealers. In the courtyard of one such dealer were sacks of wool ready for smuggling into western Nepal and from there to Kashmir, where the wool is woven into scarves and shawls.

Since the mid-1980s the trade in woven goods has become so lucrative that it has sharply driven up the price of antelope wool. In 1992 a herdsman received the equivalent of about \$50 for a hide (the price of four sheep). But in Europe a small shawl sells for as much as \$3,000 and a large one for \$8,500.

In the winter of 1991 we visited a hunting camp, one of four in a small area. There were three men, wrapped in sheepskin cloaks, from Gerze,

Elegant as figures in an Oriental screen painting, antelope struggle through a heavy snowfall that starved hundreds of animals. Life is on the edge in the Chang Tang. Studies suggest that the plateau's sparse vegetation has forced grazers to specialize—wild yaks and argali sheep favor the hills; antelope and gazelles prefer the flatlands.

more than 130 miles away. They had traveled here by yak caravan, leaving their other livestock and families behind. During the previous ten days they had trapped 22 antelope. The hides were stacked in their tent, the frozen bodies outside; they had also saved the heads of males because the horns are widely used in traditional medicine and find a ready market in Lhasa and Beijing.

To catch antelope, the men used an ingenious circular foot trap with small pointed sticks projecting toward the center. The trap is placed on a trail over a hollow, concealed, and tied to a stake. When an antelope or gazelle steps into the trap and tries to withdraw its leg, the sticks dig into the skin, holding the animal.

Wild yaks and Tibetan antelope are fully protected in China, and the Tibet Forest Bureau has tried to curtail the illegal wool trade. One truck driver, for example, was taken to court for killing 300 antelope. However, control is extremely difficult, in part because officials, instead of upholding the laws, themselves often hunt. Most hunting is done by herdsmen, not usually by the capable ones whose flocks thrive but by those who have somehow failed, whose existence has become marginal. It is a difficult social problem that must be resolved.

In the past the Aru basin was used by pastoralists only seasonally, usually for two to three months between May and September. To my consternation, five families with about 40 people moved permanently into the basin in 1991, for one purpose only: to hunt antelope. One day we drove to the tent in which the headman of these families lived with his wife. We sat on a rug by the central stone-and-clay stove. He offered us salted tea; we bargained with him for a sheep, wanting to add fresh meat to our diet of rice and noodles and tsampa. I gave him a card, as I do to all herdsmen during these travels. On one side it has a drawing of Buddha amid peaceful animals and of a kneeling hunter who has laid down his arms: a sword, a bow, a quiver of arrows. On the other side is one of Buddha's sayings in Tibetan script:

*All beings tremble at punishment,
To all life is dear.
Comparing others to oneself,
One should neither kill nor cause to kill.*

The herdsman reverently touched the card to his head and then placed it on the family shrine with its butter lamps and picture of the Dalai Lama. He told us, with Duwa translating into Chinese, that he was 68 years old. His father and grandfather had lived in this region before him. The five families here owned a total of only about 600 sheep and goats and 45 yaks—and a truck.

How could they afford to buy a truck when they owned so little livestock? By kill-

ing antelope. And now more must be killed to buy gasoline for the truck. According to this man, vehicles with officials had come here from Gerze on two occasions the previous winter to hunt yaks and antelope with modern weapons.

"If the officials obey the law and stop hunting, we will too," he said.

The pastoralists in the reserve should be allowed to continue their traditional lives. But if unrestricted commercial hunting continues, the wild yaks, Tibetan antelope, and others will within a few years be reduced to

Species sale: A Lhasa trader (facing page) peddles skins—including that of an endangered Indian tiger. Demand for everything from antelope horns to otter pelts fuels poaching in Tibet, where the swiftest denizens of the wild plains are no match for high-powered bullets, carried in elaborately decorated cartridge cases (below).



tragic remnants. The fate of the bison on the American plains comes to mind.

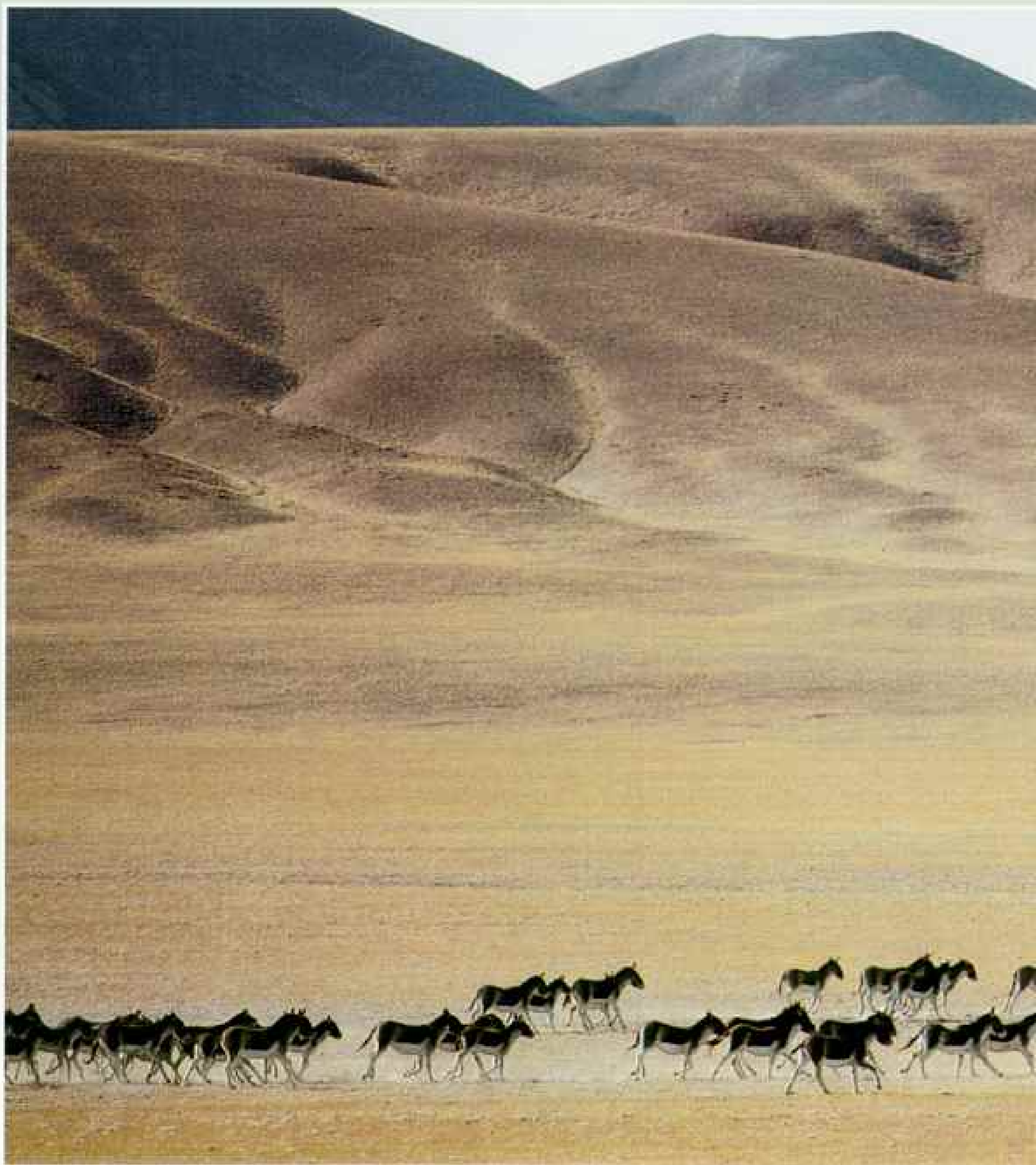
Om Mani Padme Hum. This is the Tibetan invocation for the salvation of all living creatures. To Tibetans life is holy, and the Chang Tang is a sacred realm. When the last wild yak has died and roads have been pushed to the rim of that remote world, Tibet will have been denatured, it will have lost something vital.

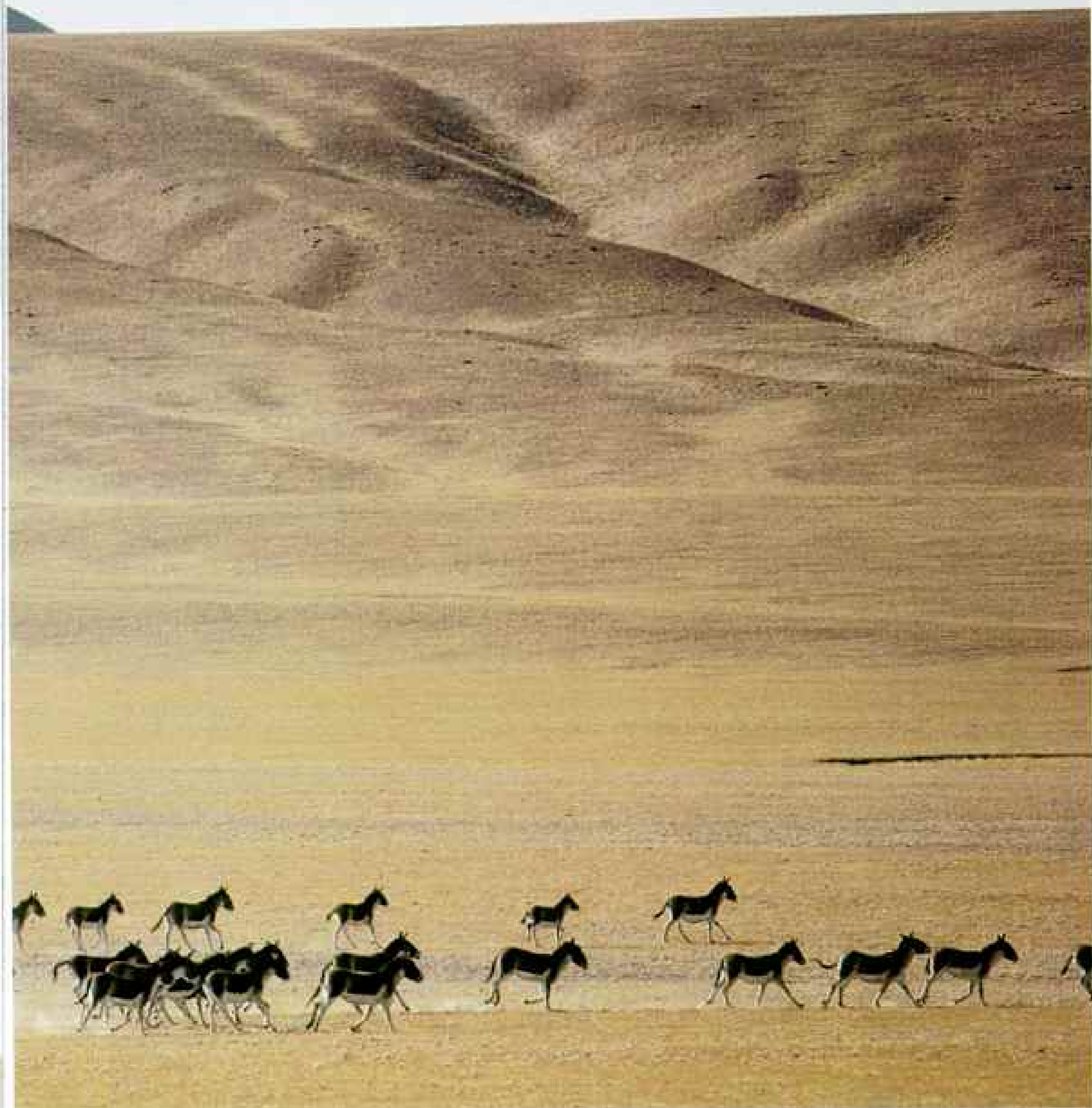
The high Chang Tang represents life at the edge, so precarious that wildlife cannot absorb the additional pressure of heavy hunting. On October 17, 1985, the most severe blizzard in 30 years covered the eastern Chang Tang with a foot of snow. Wind and sun usually clear away such snow, but this time it was calm and cold. At night, in our tent, the thermometer registered minus 25°F. The plains and distant white ranges, veiled by mist, had an Arctic aura. The wild hoofed animals had to paw through crusted snow for nourishment, and soon they were starving.

The dainty gazelles, trudging knee-deep through snow, suffered most. Exhausted, they reclined never to rise again, and in the great silence the snow drifted against their cold bodies. The lower legs of kiangs became abraded and bloody from the frozen crust. Being large, kiangs expended less energy in digging for food, and they survived the storm better than the gazelles and antelope. Many hundreds of antelope died of starvation, mainly females and young; we found 193 bodies in just one valley. Herds moved far afield from their usual wintering grounds, but they could not escape the icy grip on the land.

The blizzard had occurred not long before the onset of the rut. Those surviving females were in such poor physical condition that they did not breed, or, at least, very few had young with them when I returned the following year to check. This one blizzard reduced the antelope population in the eastern Chang Tang drastically and virtually eliminated two years of reproduction. Livestock suffered too. The pastoralists lost two-thirds of their sheep and half their yaks. Both the wild and domestic hoofed animals traditionally increase in number during good years only to be reduced by such unpredictable catastrophes.







Hoofs drum the brittle grasslands as a herd of Tibetan wild asses, or kiangs, gallop over the Chang Tang. In autumn groups of up to 200 kiangs collect in the broad valleys of the reserve. Generally not hunted, most kiang populations concentrate in the southern Chang Tang, where pasture — and nomadic herders — are more abundant. “Wildlife and livestock can easily coexist if grazing is well managed,” says author Schaller.

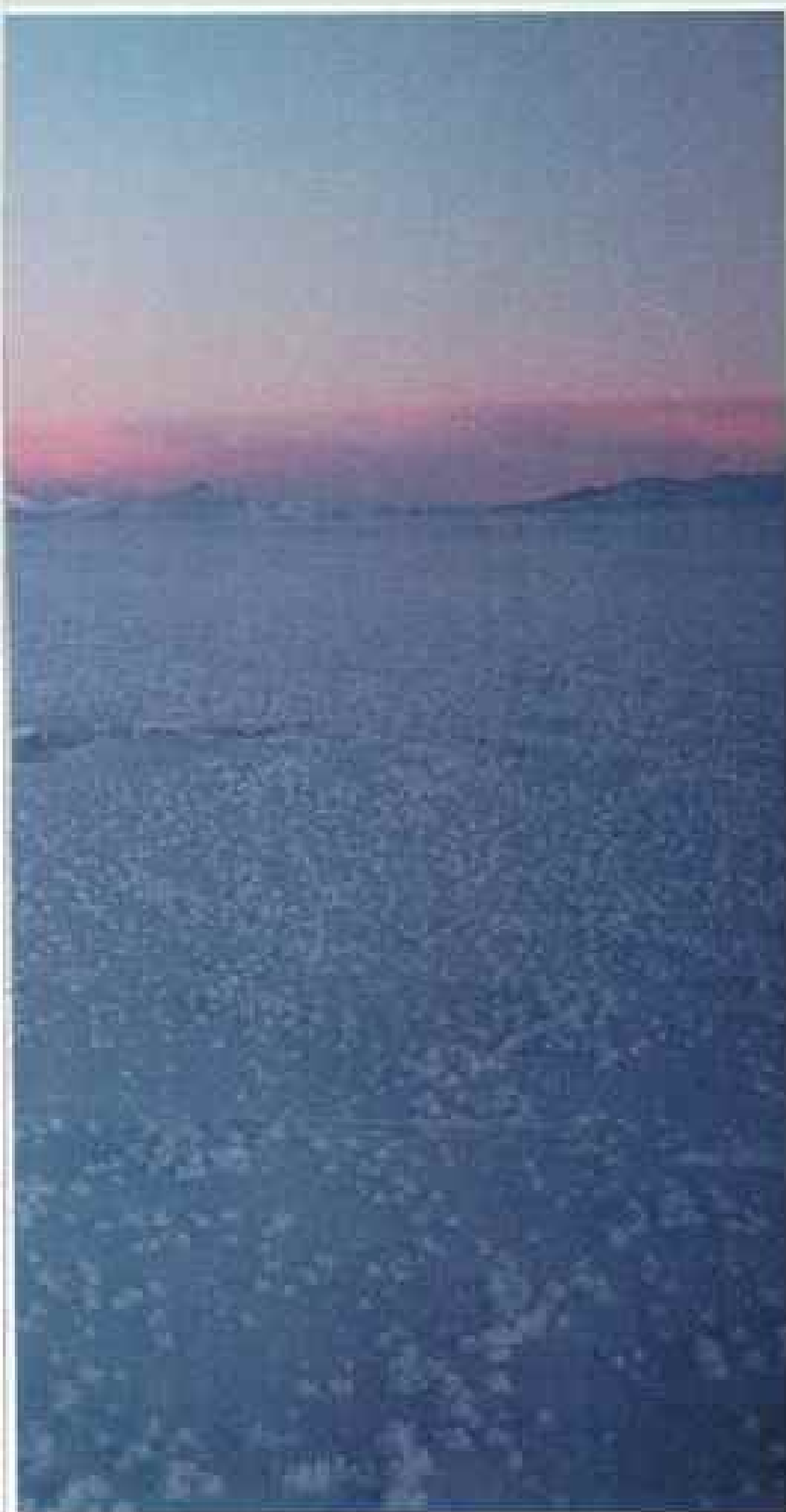


"The plains... veiled by mist, had an Arctic aura."

THE TIBETIAN ANTELOPE looks like an antelope and acts like an antelope—but it isn't one. George Amato, a conservation geneticist with the Wildlife Conservation Society, analyzed its mitochondrial DNA and found that the animal's closest evolutionary affinities are with sheep, goats, and their relatives.

To discover what traits this so-called antelope shares with its sheep relatives or with the antelope and gazelles, I had to observe its behavior in detail. The December rut, when animals are most active, is the best time to do this. The 80-pound males are then at their most handsome; their pale brown summer coat has changed to a light gray and white nuptial pelage, except that the face and front of the legs are black. A walnut-size bulge, a nasal sac, projects from the side of each nostril, giving the muzzle a swollen appearance. Tibetan antelope tend to aggregate at certain sites during the rut, a hundred or two hundred but sometimes more than a thousand.

One day I stood on a rise, eye to my scope, focused on antelope on the plain below. A male chased another full tilt for more than half a mile, puffs of dust exploding under their hoofs. I marveled at their stamina at these altitudes. And I also noted that my eyeballs were freezing. When I used the hand that had steadied the tripod and scope to thaw my face, the wind whipped the tripod away.



But there were also calm warm days with temperatures around zero. One such day I walked among the antelope and sat down, quiet and immobile as a rock cairn. The animals soon forgot me. Males trotted past with head held low and the white flag of the tail raised as they gave primordial bellows, challenging other males, their nasal sacs acting as resonators.

If females wandered near a male, he herded them with muzzle skyward, showing off his white neck. Usually the females ignored him, but sometimes one bolted and was pursued by him. And during his absence another male might appropriate the remaining females.

A male does not defend a plot of land but instead tries to maintain a small harem for a few hours, just long enough for a female to come into heat. If a female is receptive, the male high-steps close behind her, bellows, and kicks the air with a stiff foreleg. He mounts by standing bolt upright, barely touching

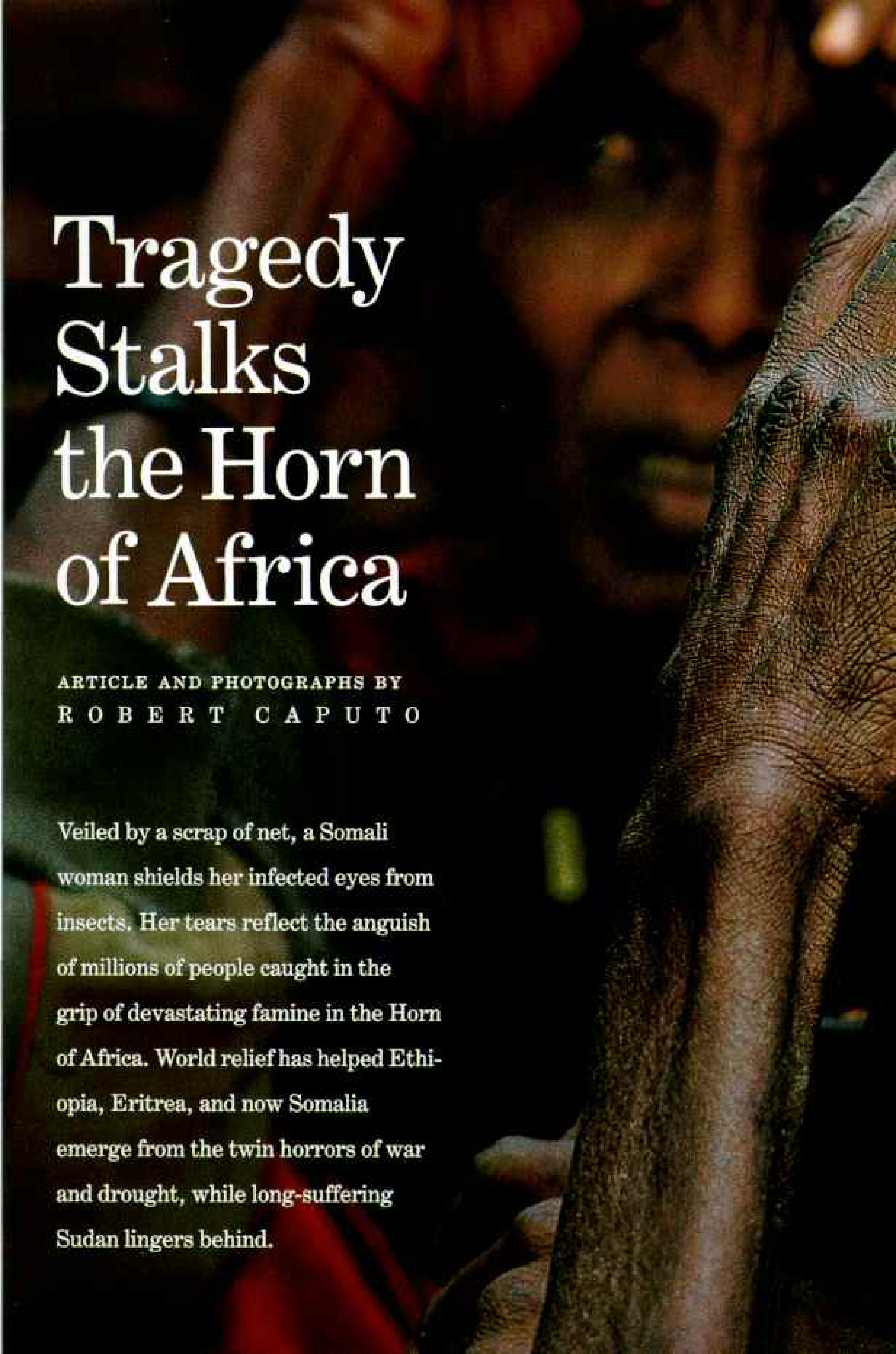
her—behavior typical of gazelles. This and some other behavior suggests that Tibetan antelope may be living relics of a line going back to the time when the true antelope and gazelles split from the sheep and goats during the Miocene, eight or more million years ago.

But such knowledge ceased to entice me that day, for the plain stretched into the sun's blinding light to a horizon of white hills aloof in their barrenness. A herdsman's tent huddled in the fold of the hills. A wolf strolled along a distant cutbank, and a flock of horned larks twittered by. And all around, the antelope danced on the tawny grass in their ancient ritual.

I was at the center of this sacred space, watching and aware, celebrating the harmonious balance of a fleeting moment. I was in a special place, as stated so well in a fragment of an old Tibetan song.

*The land where spiritual and human law reign supreme,
In the land where celestial powers are revered,
Where animals are partners in life's struggle,
Where birds fly without fear,
Where fish swim in freedom,
Where wildlife is protected,
Where men and women cherish inner peace and outer freedom. □*

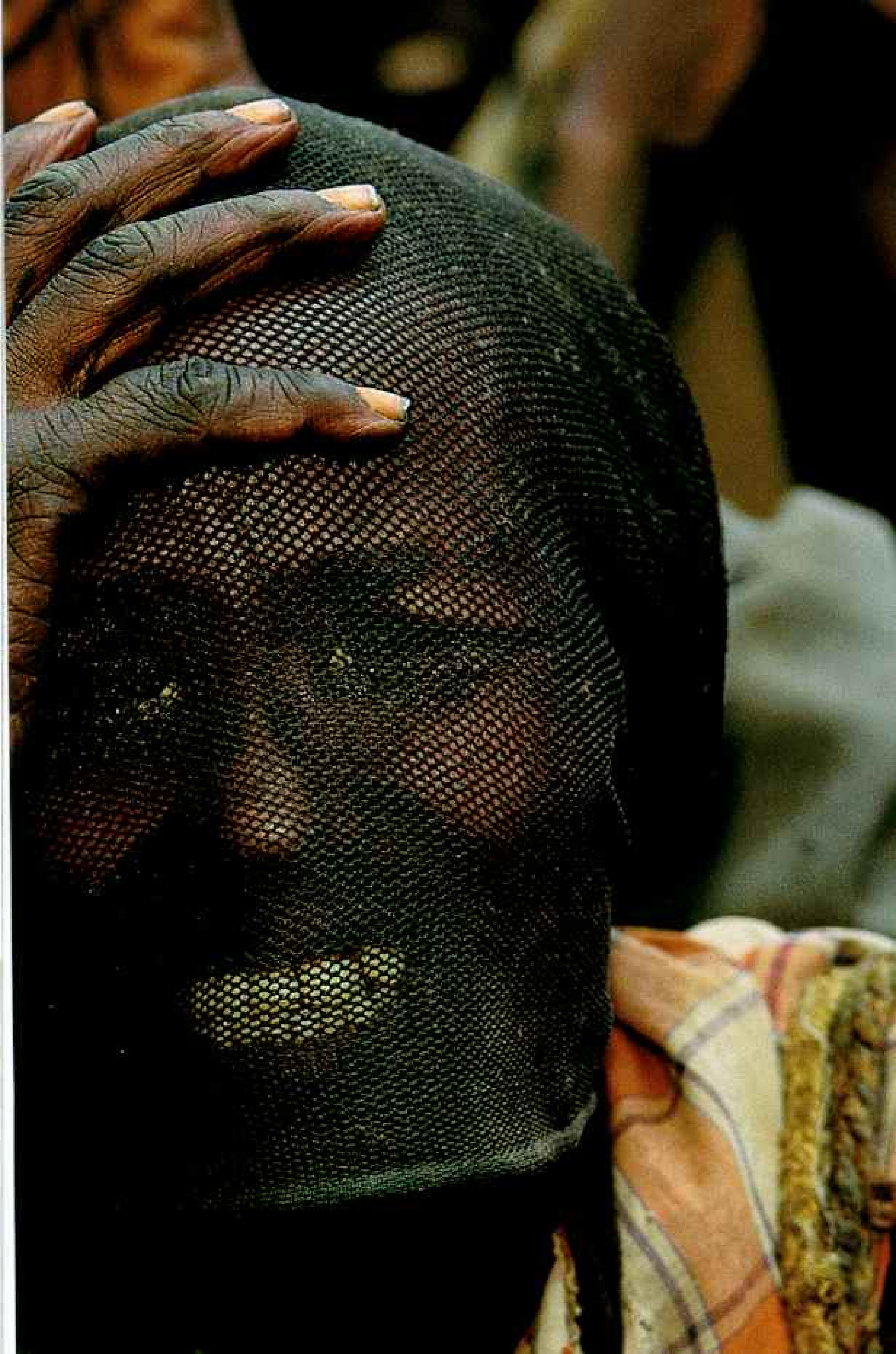
An exhausted Tibetan gazelle awaits its fate after a snowstorm in the far eastern Chang Tang. Unforgiving as it is beautiful, Central Asia's premier ecosystem has always weathered its storms in solitude. Human meddling may yet change that—though with care one of the earth's last intact spaces can survive.

A close-up photograph of an elephant's trunk and head, with a person's hand visible near its eye. The image is dark and moody, with the elephant's trunk being the central focus. The person's hand is positioned near the elephant's eye, suggesting a moment of care or observation. The background is blurred, showing other people and what appears to be a market or outdoor setting.

Tragedy Stalks the Horn of Africa

ARTICLE AND PHOTOGRAPHS BY
ROBERT CAPUTO

Veiled by a scrap of net, a Somali woman shields her infected eyes from insects. Her tears reflect the anguish of millions of people caught in the grip of devastating famine in the Horn of Africa. World relief has helped Ethiopia, Eritrea, and now Somalia emerge from the twin horrors of war and drought, while long-suffering Sudan lingers behind.





SOMALIA

Too weak to go on, a little girl lay dying in the dust of a Baidoa road last summer.

Bystanders, who had seen too much death, ignored the suffering beneath their feet.

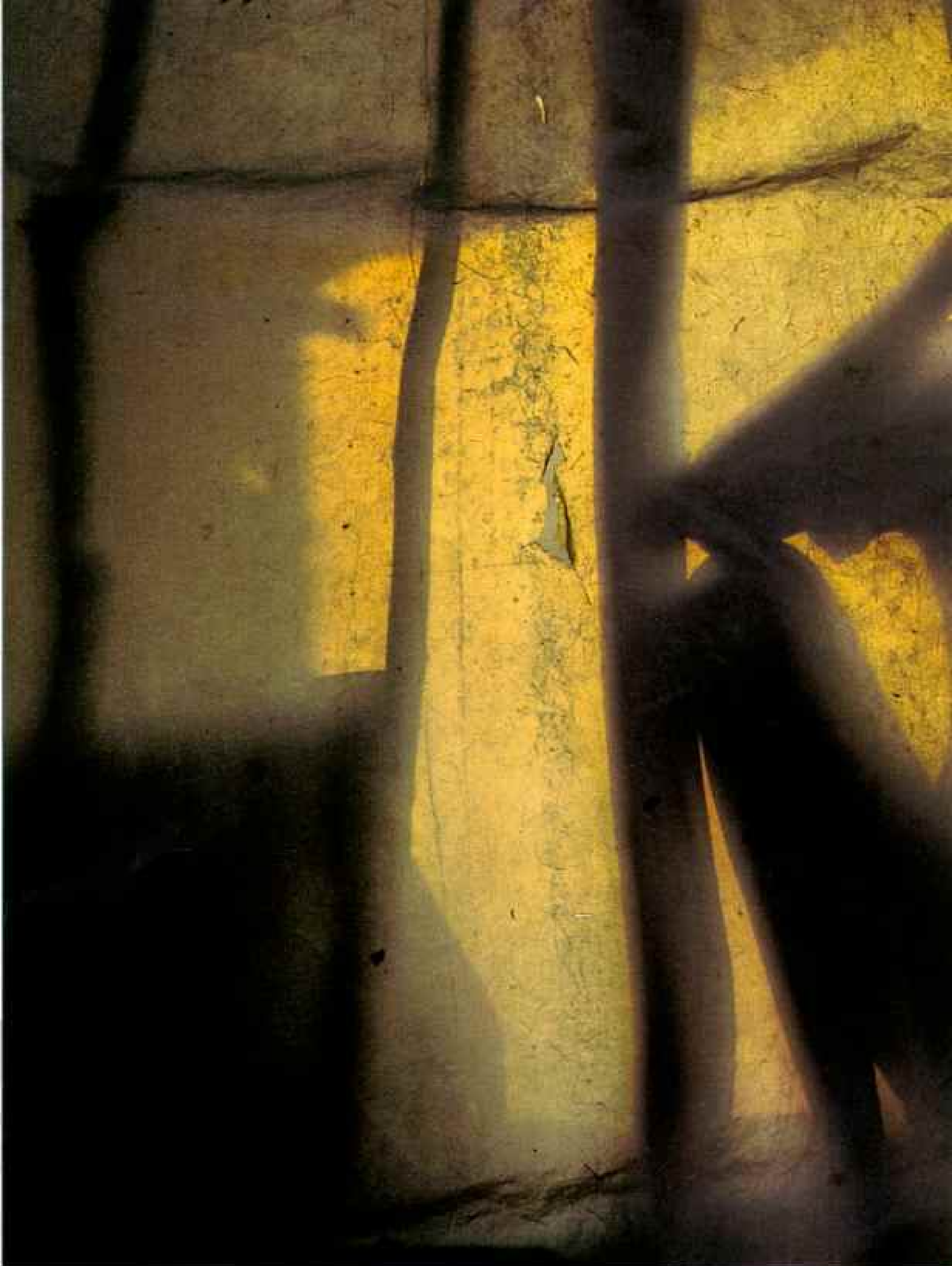


"These people were facing starvation themselves," says author-photographer

Robert Caputo. "They had nothing to give." In areas most affected by famine, more than

half of Somalia's children under five years old have died, while warring clans and

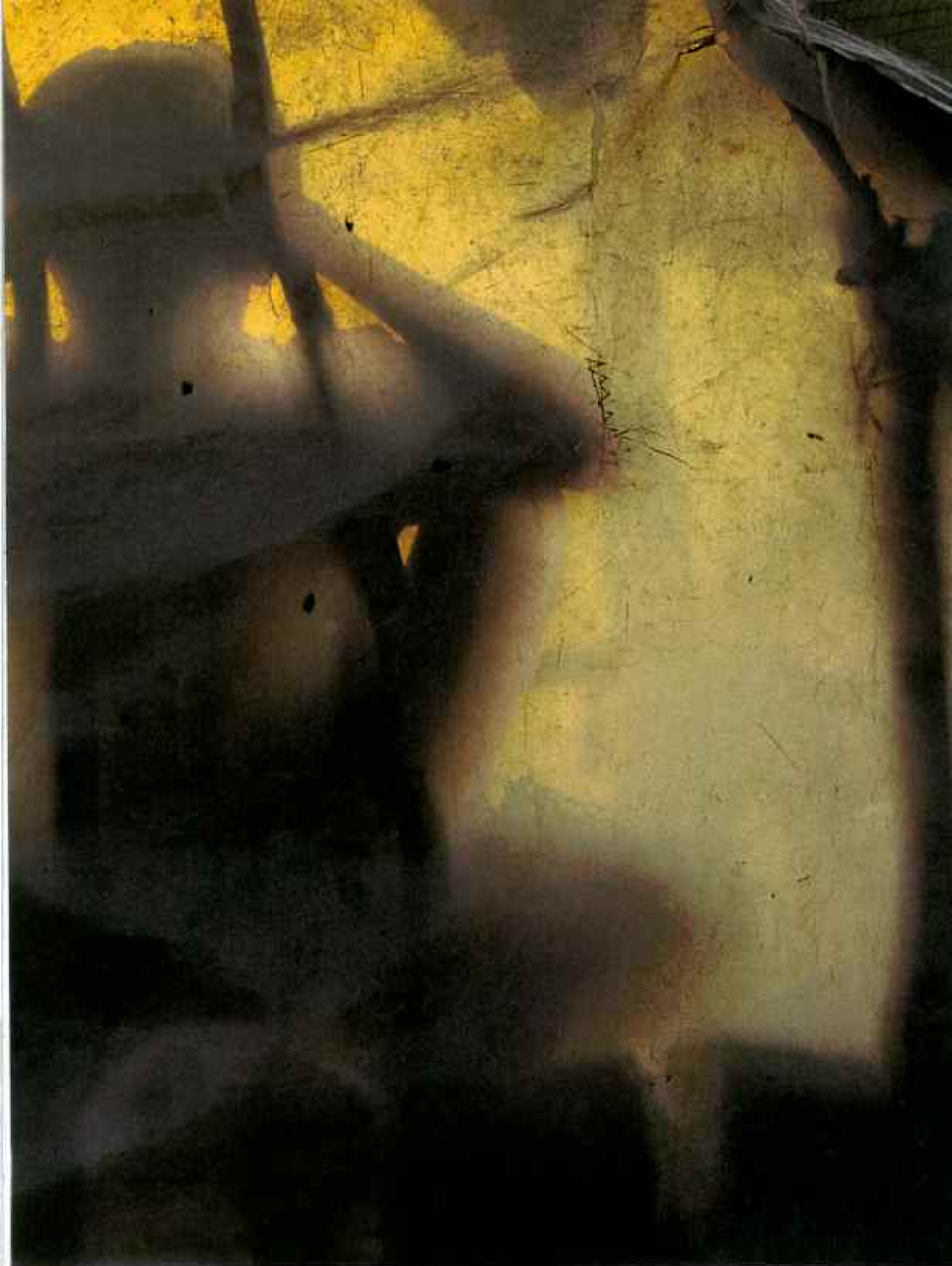
armed thugs spread terror through a land devoid of civil authority.



SUDAN

A hut of sticks and plastic sheeting is home to a Sudanese boy in Kenya, symbol

of a tragedy only now emerging from the shadows. Drought, floods, and civil war



have left more than a million Sudanese at risk of starvation, pushing thousands of

young boys to flee. Now in camps in Kenya, Uganda, and southeastern Sudan,

many lack skills they will need if they go home. "They know nothing about our

life," says an elder of the Dinka people. "They don't even know how to care for cows."



ETHIOPIA

Harvesting seeds of hope, Gide Abraham and Hailu Mare separate wheat from

chaff in the northern region of Tigray. For decades peasants struggled to make a

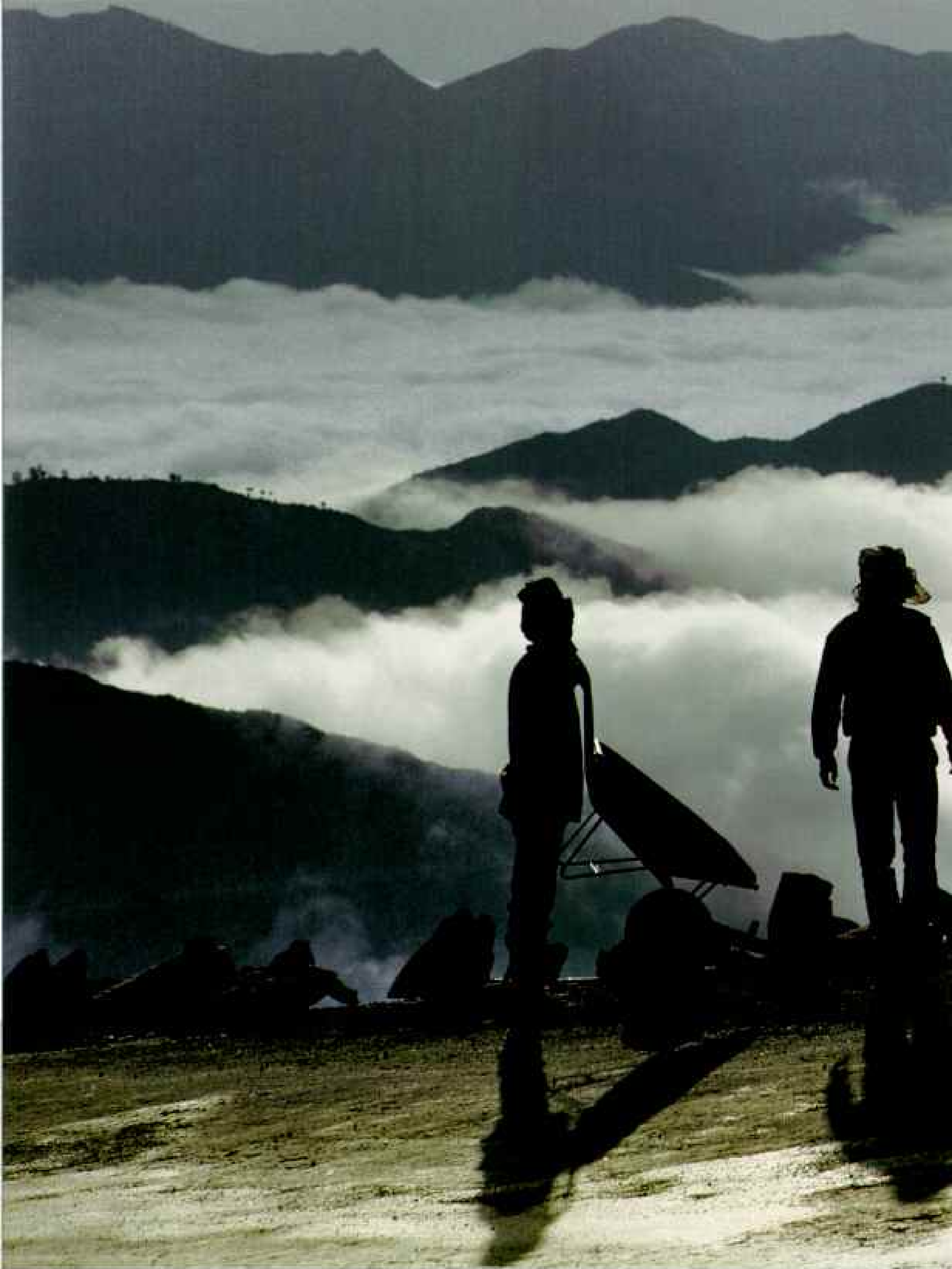


living under the feudal land policies of U. S.-backed Emperor Haile Selassie and the

tightly controlled grain market of his Soviet-supported successor, Mengistu

Haile Mariam. After 1991 when Mengistu fell from power, farmers produced a

bumper harvest, which they began selling on the open market.



ERITREA

Hammers and shovels make a joyful noise in Eritrea, along a war-damaged road

near the capital city of Asmara. After 30 years of fighting to break free of Ethiopia,



Eritrea faces its reconstruction with an air of celebration. Eritreans have earned

it: In their quest for stability, they have done what other Horn of Africa nations have

yet to achieve—put aside their weapons and tempered both ethnic and religious

differences to become one people, bound by a shared national identity.



War, famine, and faint hope

When cycles of drought coincide with political upheaval, famine is a tragic by-product. Such is the Horn of Africa's plight: Many people in rain-starved areas are isolated by surrounding war; those fleeing conflict often crowd into regions that cannot support them. Thus food becomes a weapon for warring factions. Peace, not rain, is the surest harbinger of relief.



SUDAN
Population: 27.4 million. A north-south civil war has forced displacement of two million people within Sudan; 275,000 others have fled to nearby countries. Destroying enemies' crops and livestock, marauding bands have left a trail of theft and rape.

ERITREA
Population: 3.3 million. The impact of a 1980s drought was heightened by a secessionist war with Ethiopia. In the two years since the war ended, newly independent Eritrea's crop yields have doubled. The nation has cut foreign food aid requests by half.

ETHIOPIA
Population: 53.4 million. Famine in the 1980s was aggravated by collective-farming programs and civil war. Victory by rebel forces in 1991 brought about the return of private farms. Last year's harvest of food crops was the largest in 20 years.

DJIBOUTI
Population: 481,000. An island of relative stability, Djibouti has had a defense agreement with France since gaining independence in 1977. With 3,000 French soldiers, plus ships and warplanes, this is an important staging area for supplies to Africa's Horn.

SOMALIA
Population: 8.5 million. The ouster of dictator Mohamed Siad Barre in 1991 unleashed open warfare among clans. Fighting and drought plunged Somalia into chaos and mass starvation. To date, strife and famine have claimed some 350,000 lives, mostly children.

MUSLIMA Aden Abdulrahman stood by the tiny grave, gently cradling the bundle of rags that held the emaciated remains of her seven-year-old son. Her daughter had died, also of starvation, a few days earlier and before that her mother, whom Muslima had carried on her back during a two-week, foodless trek to Baidoa, in southern Somalia.

"I have buried all my family," Muslima said. "Almost everyone from my village is dead. I have no more tears left."

Last year's famine in Somalia was only the most recent of the stories of hunger and war that continue to emanate from Somalia, Ethiopia, Eritrea, and Sudan in the Horn of Africa. The latest tragedy elicited an outpouring of compassion and generosity from around the world, as did the Ethiopian famine in 1984-85. The events in Somalia also caused an unprecedented international intervention, the only way the world could try to stop the social disintegration that was causing families like Muslima's to die. Led by 25,000 U.S. troops, the military force comprised units from 22 nations.

But as the spotlight focused on Somalia, others were starving in Sudan, while Ethiopia and Eritrea struggled to recover from their own brutal recent past. The human toll has been staggering. Following the overthrow of Somali dictator Mohamed Siad Barre in 1991, anarchy and famine have left 350,000 Somalis dead. In that same year, rebels in Ethiopia ended Mengistu Haile Mariam's 17-year reign

of terror; that and famine killed at least a million there and in Eritrea. In Sudan, civil war between north and south for 27 of the past 38 years—along with drought and floods—has killed more than a million Sudanese.

Toward the end of last year and the beginning of this, I traveled through the Horn of Africa trying to discover some of the reasons for its perennial troubles. I found problems common to much of a continent whose people have leaped from small traditional societies to late 20th-century nationhood in only a few generations: ancient tribal rivalries, illogical borders imposed by colonial powers, and the



SOMALIA

Signs of starvation mark a young boy in Baidoa. His reddish-brown hair and muscle-stripped body—draped in a shroud of leathery, sagging flesh—indicate that he is suffering from marasmus, a condition caused by protein

and calorie deficiency. Dehydration has also taken a toll, drying and peeling his skin.

Sadly, food alone cannot counter the long-term effects of famine, particularly in children. If he survives, the boy may fail to reach full height or may suffer blindness or mental impairment.

legacy of repressive and corrupt regimes supported by the Cold War superpowers.

Drought alone rarely causes mass starvation. War is the true plague of the region. "God makes drought," an old saying goes. "Man makes famine."

I WENT TO SOMALIA during the height of the crisis late last summer and again in January, after U. S. Marines had landed. The difference was impressive; the famine was over, the guns gone from the streets. But saving lives is one thing. Restoring a society that has fallen as far into anarchy as has Somalia requires more than force.

Last year's famine was confined mostly to southern Somalia, to the farmland that was laid waste during the war to oust dictator Siad Barre and the strife between clans that followed. The fiercest fighting was in Mogadishu, which was split into two sections supposedly under the control of warlords: Ali Mahdi Mohamed in the north and Gen. Mohamed Farah Aideed in the larger south.

Mogadishu was destroyed by artillery and gunfire. Thousands were killed. Neither warlord had control over the gangs of armed men in his area. The thugs ran amok, terrorizing the people, stripping every building. They looted to buy *kat*, the shoots and leaves of the *Catha edulis* bush, a habit-forming stimulant they chew. Every argument was settled with guns.

The population of Mogadishu, about a million, was the same as before the war, but it was a different population. Many of the city dwellers had sought refuge in other parts of Somalia, in camps in Kenya and Ethiopia, or, if they had money, in Europe, Canada, and the U. S. Many poor farmers fleeing the war and banditry in southern Somalia trekked to Mogadishu in search of food.

"Barre's clansmen came and took all our animals," said Abdi Mualim Abduli, a 20-year-old nomad in a camp in Mogadishu. "They even made us slaughter and cook one so they could eat it right in front of us. They beat me. They raped my mother and sister. They took our clothes, our shoes—everything."

"When elephants fight," an African adage puts it, "the grass gets trampled."

Based in Washington, D. C., author and photographer ROBERT CAPUTO has contributed numerous stories on African subjects, most recently on the Zaire River (November 1991).

I went to a hospital on the northern outskirts of Mogadishu. The Somali doctors and nurses and the International Committee of the Red Cross staff didn't have time to treat anything but gunshot wounds.

Felis Abdi Ali, a girl of three or four, sat in the middle of her bed staring at the stump where her leg had been. Felis had left home one afternoon to visit her neighbors. In the street an argument between two men had exploded into gunfire, and one of the bullets shattered her lower leg.

Felis spent the days alternately giggling and crying, as if she couldn't quite figure out what had happened. Ward 4 was the most depressing: mangled small bodies, bewildered young eyes. "This is the reason I stay here," Dr. Ahmed Mohammed Ahmed said, gesturing at the roomful of wounded children. "How could I abandon them? If we leave, they die. We see the results of the madness every day, especially when there's a food distribution."

SOMALIA

Feasting on famine, armed profiteers "guarding" Baidoa's airport (top) demand payment from relief workers in exchange for landing rights and safe passage. Here, a CARE worker hands over \$1,500 worth of Somali shillings.

Before international intervention such thugs also stole food from starving people to sell on the black market—which is why relief centers began serving cooked food (right) instead of handing out dry rations. Explains relief worker Dahabo Isse-Mohamoud: "If the food is cooked, gunmen don't steal it."







The food brought in by the relief agencies was the only thing left to steal in a city stripped bare. By some estimates, 50 percent of the food donated to Somalia was looted at port, warehouse, feeding kitchen, or in between.

Somalia was one big extortion racket. Laborers, truck drivers, and armed security men all demanded huge sums of money and a share of the cargo to let the relief agencies deliver the food. The airport was controlled by a gang that demanded payment to let mercy flights land. Strikes often closed the port.

Guns were everywhere. The streets were full of "technicals," four-wheel-drive vehicles mounted with machine guns or cannon—one even had missiles scavenged from a MiG fighter. Every agency had to hire its own private army of technicals and armed men, but many of these guards were the same young Somalis high on *kat* who stole, often from their own employers, and terrorized the city.

"Most of these guys are from the bush," an old man named Farah explained. "Two years ago they were herding camels. Now they're riding around in technicals chewing *kat*, looting and raping as they please. You think they want to just hand in their guns and go back?"

Somalis share a common history, language, and religion—just the ingredients needed to form a nation. But Somali society evolved

around small clans that roamed the arid plains with their camels, sheep, and goats, making alliances or warring with other groups over the limited resources of water and grazing lands. Armed with knives and spears, Somali men were constantly shifting loyalties to ensure the welfare of their group. Today's warlords and gangs are armed with hundreds of millions of dollars' worth of modern weaponry supplied by the United States and the former Soviet Union, as well as the world's arms merchants.

"In America, when you go to school, you learn about being a citizen of your country," said a young man named Ahmed. "Nomads have no schools. Children learn only about their clan; they memorize the names of their lineage back to the founder of the clan. Somalis believe in the clan as they believe in God—it's a religion."

Somalia didn't exist until colonial powers—Italy, Britain, and France—and the Ethiopian Empire divided up the land of the Somali clans and imposed central administrations, a concept alien to the fiercely individualistic people. These powers kept order by force. So too did Siad Barre after he seized power in a military coup in 1969. When his iron grip was finally broken, ancient rivalries reemerged.

"We've gone back a hundred years," Nurta Hagi Hassan, a lawyer, told me. "We



SOMALIA

Hell on wheels, marauders roamed the streets of Mogadishu in machine-gun-rigged vehicles known as technicals. These

men—many later disarmed by international forces—got rich by extorting protection money from relief agencies, which listed the expense as “technical assistance.”

Most of the young men were brash clan fighters ready to make names and money for themselves in the lawless city. There they found guns easy to come by, many from

Somalia’s former allies. They also found themselves idolized by children, frequently orphans, who emulated their heroes with toy guns made of scrap wood or wire.

are behaving as we did when we were all nomads, small groups constantly fighting.”

“The worst problem in the long run,” Stefania Pace, who works for an Italian relief agency, CISP, told me, “even greater than the dying and physical destruction, is the complete disintegration of the social fabric.”

THE TOWN OF BAIDOA was the epicenter of the disaster, the heart of the darkness.

Baidoa had been sacked in 1991 by Siad Barre’s retreating army. What had been a pleasant provincial town and market center lay in ruins. When I arrived in September 1992, thousands of skeletal, rag-draped souls were wandering up and down the main street, scavenging and begging for something to eat. Tiny and large bundles of cloth lay beside the road, people dying or dead.

At one feeding center operated by an Irish

relief agency called CONCERN, 4,000 children sat in rows, too weak to be as boisterous as that many kids should be. Five times a day their cups and bowls were filled with milk and Unimix—a high-energy porridge of cornmeal, beans, oil, and sugar.

Some of the children were orphans. “They are my children now,” said Halima Idow Mohammed, who fed, washed, and comforted them. Halima and her two children trekked to Baidoa after her husband died of starvation in their village. “When I came, I was sleeping in the street and begging for food; there were no kitchens. When I brought my children here, CONCERN asked me to stay and look after the orphans. They are so weak; they have no one. I will stay looking after them until I die.”

Every day C-130s ferried food north from Kenya to the airstrip controlled by one of the gangs. I was at the CARE office when the gang leader showed up for his daily extortion





SOMALIA

At the ready, Marine Corporal Larry Webb keeps a lookout as workers unload food at a Mogadishu warehouse. "I saw a lot of confused, hungry people," says Webb, one of 25,000 U. S. troops overseeing the safe distribution of supplies. "I hope this country can make it."

Arriving in December, U. S. forces found thousands of people living in makeshift shelters around the abandoned Somali naval officers club (below). A United Nations peacekeeping force will work to improve the living conditions of Somalis who are still unable to return to their homes.

money. The biggest note was a thousand Somali shillings, worth about 17 cents at the time. A table was piled high with 1,500 dollars' worth, the payment to allow three U. S. Air Force C-130s to land that day. In all, the relief agencies were paying this gang about \$20,000 a week. If the payment wasn't made, they would shoot at the planes.

The presence of relief agency food had not only brought about 50,000 displaced people to Baidoa, but gunmen had descended on the town too. They stole most of the food that came into Baidoa. They swaggered into the Bikiin restaurant wearing T-shirts emblazoned with "I Am the Boss," and "Join the Professionals." They slapped their Kalashnikovs down on the tables and barked at the frightened waiters.

Every morning the only vehicle that could move unescorted by guns made its rounds through the streets of Baidoa. The truck

stopped at the orphanage, the camps, the hospital, and at abandoned houses where those who had died during the night were brought to be washed and wrapped for burial. Two here, 20 there—the corpses were piled on. The death truck collected nearly 300 each morning, thin bodies wrapped in old cloth. Many of the almost weightless children were swaddled in the sacks that arrived in Somalia full of the food they never got to eat.

SUDAN. In Waat, a village in southern Sudan, it was the same nightmare, but not illuminated by TV lights. The displacement and death toll from Sudan's civil war are greater than Somalia's, but there was virtually no public outcry, no massive international airlift. The people in Waat were dying unnoticed by the world.

Sudan's war began in 1955, but its roots are deep in the nation's past. Nowhere in Africa is there a country whose people are more fundamentally dissimilar. Northerners, who form the majority, speak Arabic and are predominantly Muslim. Southerners speak a variety of African languages and most follow indigenous religions or Christianity. The south was historically a reservoir of resources—mainly ivory and slaves—exploited by the north.

Sudan's borders were defined by the colonial powers at the turn of the century. The British administration concentrated development in the north. As independence approached and northern administrators replaced British, many southern Sudanese feared the dawn of an era of Arab colonialism and took up arms. They fought until 1972, when they won regional autonomy.

But after an 11-year peace, war erupted again. Since 1989 the current government has moved to make Sudan an Islamic state, further widening the gulf between it and the southern rebels. But it's not just north against south, government army against the rebel Sudanese People's Liberation Army (SPLA). Southerners have been fighting one another for centuries for cattle and grazing lands. In 1991 the SPLA split into two factions—the main force led by John Garang, the splinter group by Riek Machar. Much of the fighting since then has been between them. The split was not originally a tribal issue, but it has become one: Garang's Dinka against Machar's Nuer.

There is another force also laying waste to southern Sudan: local militias armed and used

SOMALIA

Bullet-riddled buildings stand as monuments to strife in northern Mogadishu, where men crippled by gunfire hobble to a nearby food kitchen. This street is near the "green line" dividing the city—a deadly

no-man's-land ruled by bullets before U. S. troops arrived.

"We have nothing," said Faisal Mohamud Dalay, another amputee, who was hit by a mortar round. "Some of us sleep at the kitchen or in abandoned houses. This fighting has to end."

as proxy armies by every government since 1983. Some northern and southern tribes now have modern weapons to pursue their ancient feuds.

Many people had fled to Waat after being attacked by an old tribal enemy, the Murle. "The Murle came at night when we were asleep and set fire to our houses," said an old man named Simon Kun Rung. "When people tried to run out, they killed them and captured the children. I alone escaped from my house. My wife and two big sons burned to death. My two small sons were taken by the Murle.

"I joined with those who remained, and we walked here. We came here because we heard the United Nations is giving food. I was a rich man. I had nearly 200 cows. Now I have nothing."

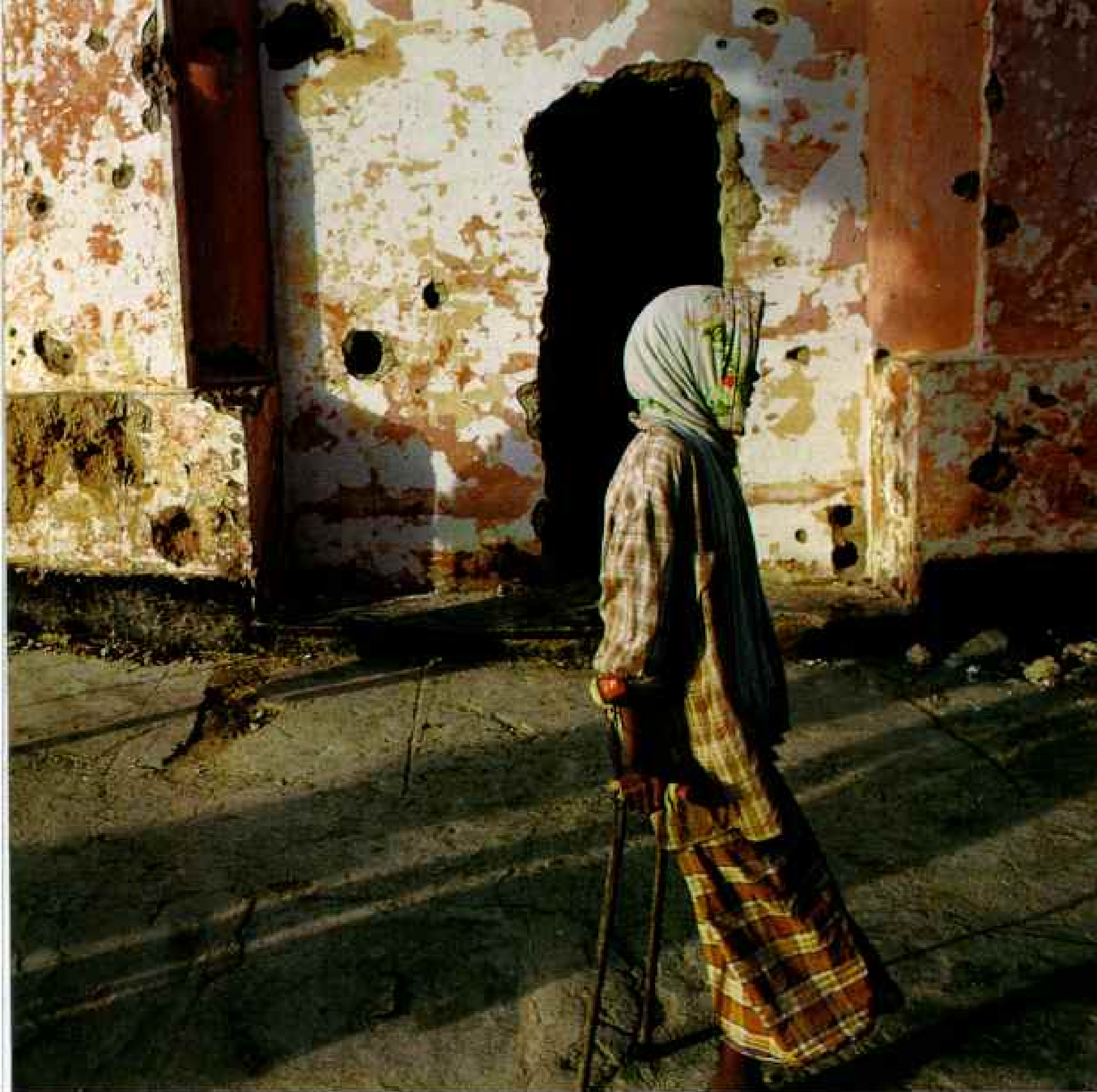
The population of Waat had swollen from around 2,000 to almost 10,000 as people poured in from the surrounding plains. Simon was one of 300 new arrivals who had gathered around the UN World Food Programme (WFP) storeroom waiting for food. But the room was empty. Women and children combed the ground looking for broad-leaved grass that was almost the only thing left to eat.

In Somalia food delivery was constrained by extortion and gunmen. In Sudan it was constrained by logistics and mistrust among the warring parties. Sudan is vast, many of the needy isolated in remote villages cut off from ground transportation by the war and the seasonal rains. Food had to be flown in, and every month the WFP had to get permits for each destination from the government as well as the SPLA factions. The permits were invariably delayed and never given for all the places requested; each side wanted more for its territory and less for its enemies'. And when I was in Waat last October, the WFP had only two planes to ferry food.



Over the past ten years the civil war has displaced an estimated two million southern Sudanese, perhaps half of the population. Two hundred fifty thousand have fled to Juba, the main southern town, and another 700,000 to Khartoum. Hundreds of thousands more are scattered at camps around the country. Others are stranded in their villages, and the warring parties often prevent help from reaching them.

Since Gen. Omar Hassan Ahmed al-Bashir seized power in 1989, the government has been notoriously closed. But stories of atrocities and human rights violations have leaked out of Sudan: massacres in the Nuba Mountains, the Khartoum "ghost houses" where people are



allegedly tortured, the forced relocation of most of the displaced people who had settled around Khartoum. Virtually all international funds except humanitarian assistance were cut off. Last December the UN passed a resolution condemning human rights abuses in Sudan.

When I went to Khartoum in February, the government seemed to be opening up. Officials were negotiating a new agreement with foreign relief agencies that all parties said they were happy with. The government even met with John Garang to discuss the agenda for peace talks they hoped to hold in Nigeria.

Some of the resident foreigners I spoke with thought that moderate voices within the ruling

clique were prevailing against the hard-liners. Others thought it was merely cosmetic, the government trying to appease the international community in order to get economic aid.

Certainly the isolation and the withdrawal of foreign aid money have taken their toll. With inflation running at over 100 percent a year, many goods are beyond the reach of average Sudanese. And the American-led military intervention in Somalia convinced many Sudanese that they would be next.

Meanwhile, the suffering continues. On the edge of Waat, where many of the new arrivals had settled, I saw some children squatting around a pot, cooking a few fibrous wild seeds. One boy, painfully thin and very shy, tried

to practice his uncertain English with me.

Awoul was 14. With other boys from his area, he was taken off to Ethiopia, at the age of nine, by the SPLA. He stayed there four years, receiving both education and military training, before being sent back into Sudan. But he left the SPLA and walked to his village.

"I was very happy when I found my family," Awoul said. "But then the government army came and burned our house and stole our cows. My father tried to run with the cows, but they found him and killed him. My mother, two sisters, brother, and I hid in the bush. We had 16 days' walking to reach here. I want to continue school, but how can I? When the food doesn't come, I have to go far away to collect wild fruit. And I have to look after my mother, who is sick. I am the only child who is big."

The plane finally arrived with food. Awoul and his family were given enough wheat to last four days. But for some it was too late. One group of new arrivals had lost three during the night; the body of a small child still lay next to the slumped figure of his mother. I asked about the other two.

Were they old?

"Yes," one of the survivors replied, "both of them were old. One was 35. The other was very old—almost 50."

KAKUMA REFUGEE CAMP, KENYA. Awoul was only one of thousands of boys who left southern Sudan in the late 1980s. After two long and dangerous treks, about 11,000 of them ended up at this camp in northern Kenya.

Izak Malong Dol, 15, escaped when a tribal militia attacked his settlement. "I lost my father and the rest of my relatives," Izak told me. "I just ran and ran. After two days I found

some other people who were fleeing. Together we walked to Yirol—it took us about three months because it is far. But the elders told us not to stay because it was always being bombed. They told us to go to Ethiopia where it was safe. Two hundred of us walked there together."

Izak stayed for three years until 1991, when the Ethiopian dictator was overthrown and the refugees lost their haven. Then he and thousands of other boys walked to Kenya.

"During all this time I have no news about my father or mother. I don't know if they are alive or dead. I can't think about it. I have just been following survival."

"We could get most of these boys home if there were peace," said Ian Lethbridge, the representative in Kakuma for the UN High Commissioner for Refugees (UNHCR). "But I think they will be here for some time."

Supported by various relief agencies, about



SUDAN

Dumped in the desert by government troops, residents at Al Salaam camp fill plastic jugs with water brought by a daily supply truck. Most are countryfolk uprooted by the civil war pitting the Muslim-controlled

national government in the north against rebels in the south. Some southerners fled to the capital, Khartoum, but were soon banished to Al Salaam and other desert camps. "In our home there is grass," says a Dinka woman (top). "Here we have only sand and rocks."



20,000 people live in the camp. The whole place is very clean and orderly—not what I expected in a place full of teenage boys. They are constantly sweeping the ground, cooking, and washing their clothes, though a bit embarrassed to be seen doing what is traditionally women's work. In the afternoon most of them do their schoolwork.

But the boys are cut off from most of the activities and lore that define their culture. There are very few girls, and the boys have no cattle to use as a bride-price if they succeed in finding a girl to marry.

Tribalism infected even the camp. After receiving threats from some of Garang's Dinka, all 350 Nuer fled to the UNHCR office. They were afraid to stay in camp because they were sure they would be killed by the Dinka, who make up 90 percent of the people here.

"Where can we go now?" asked Steven, a

young Nuer boy. "We were driven out of our homes by the government, driven out of Ethiopia. If we can't get along here, what hope is there for us?"

RETURN TO SOMALIA. Three hundred fifty thousand Somalis had died by the time the U. S. Marines landed in December 1992. Since then international forces have been making sure food is safely delivered.

In January Mogadishu looked like a city under occupation. There were as many guns visible in the city as there had been in August, but they were slung on Americans. "We are very glad the U. S. has come," said Farah, the old man I'd spoken with on the previous trip. "If they hadn't, Somalia would have totally disintegrated."

But in areas without a foreign military presence, the thieves were having a field day.

"In some ways it's more dangerous than before," Farah continued, "because people can't carry guns. The thieves know this, so now they come after you with pistols and knives and nobody can defend himself."

The airport had gone from being closed to being one of the busiest international airports in Africa. And the port! Hulking great, gray U. S. Navy ships, trucks and forklifts buzzing about, heli-

copters whirring overhead. I could have sworn I was in Norfolk, Virginia. I saw a Marine, dressed in fatigues and with an M16 slung over her shoulder, walking along by the docks. A group of Somali men walking the other way froze in their tracks, mouths agape. I'm sure they'd never seen a woman with a gun before.

I went back to the hospital in Mogadishu north to see Dr. Ahmed. "No new admissions today," he told me, grinning, "and very few for the past two weeks. I can't tell you how



SUDAN

Mercy is held hostage in rebel-controlled Waat, where thousands nibble at handfuls of wild plants (above) amid one of the worst famines in the world.

Food shipments to the war-torn region

have been sporadic at best: Rebels and government troops alike delay relief supplies and sometimes attack aid workers. While despair sets in (opposite), Sudan—touted as a potential breadbasket—exports food to earn foreign exchange.





much better I feel." Felis Abdi Ali, the little girl who had lost a leg, had long since gone home and was reported to be doing fine.

Not all were so lucky. Abdi Muallim Abduli, the young nomad at the camp in Mogadishu, had died shortly after I'd talked with him.

In the large displaced persons camp on the edge of Baidoa, near where Muslima Aden Abdulrahman and others had buried their kin, corn was growing. Like the rest of Baidoa, the camp was transformed; far fewer people, no children lying in the dirt waiting for death. The orphans at CONCERN's feeding center had recovered too. "Look," Halima Idow Mohammed said, beaming. "Do you remember how they were before?" The fragile little bodies she had so delicately washed last year were chubby.

"Some of them even have new names," she went on. "The very little ones we found in the streets could not tell us their names, so we had to name them. This is Kuuso Concern," she

said, pointing to a fat little boy wearing a T-shirt that proclaimed WINNERS. "And this is Ali Concern. They are all named Concern, because without CONCERN they would all be dead."

The guns had vanished from Baidoa, and Marines manned roadblocks to make sure no more entered. "The whole environment in which we operate is different," CARE team leader Lockton Morrissey said. "The Marine presence has meant that more food can get to Baidoa, and 100 percent of it gets distributed to the needy—not just in town, but in the villages as well."

SO MANY PEOPLE had returned to their villages that the International Committee of the Red Cross closed some emergency kitchens. Despite security risks, last fall the agencies had taken food to villagers so they could stay on their farms and had provided seeds and tools for November's

ETHIOPIA

Hope takes root in the terraced farms of Tigray (left), an area hit hard by Ethiopia's grinding famine of the mid-1980s. Since civil war ended in 1991, farmers here have resumed growing large amounts of wheat, barley, coffee, and a local grain called teff.

Ethnic Somalis, who escaped the fighting in Ethiopia's Oga-den region 16 years ago, have now been driven back by war in Somalia. Nomads who had taken up farming before they fled in 1977, they register for a government drawing (below) to assign plots of arable land along the Wabe Shebele River.

rains. Now ripening sorghum greened many of the fields around Baidoa. Village water sources were being refurbished, medical supplies provided for local clinics, and kits of blankets, cooking pots, and other basic needs given to each family to help them get started.

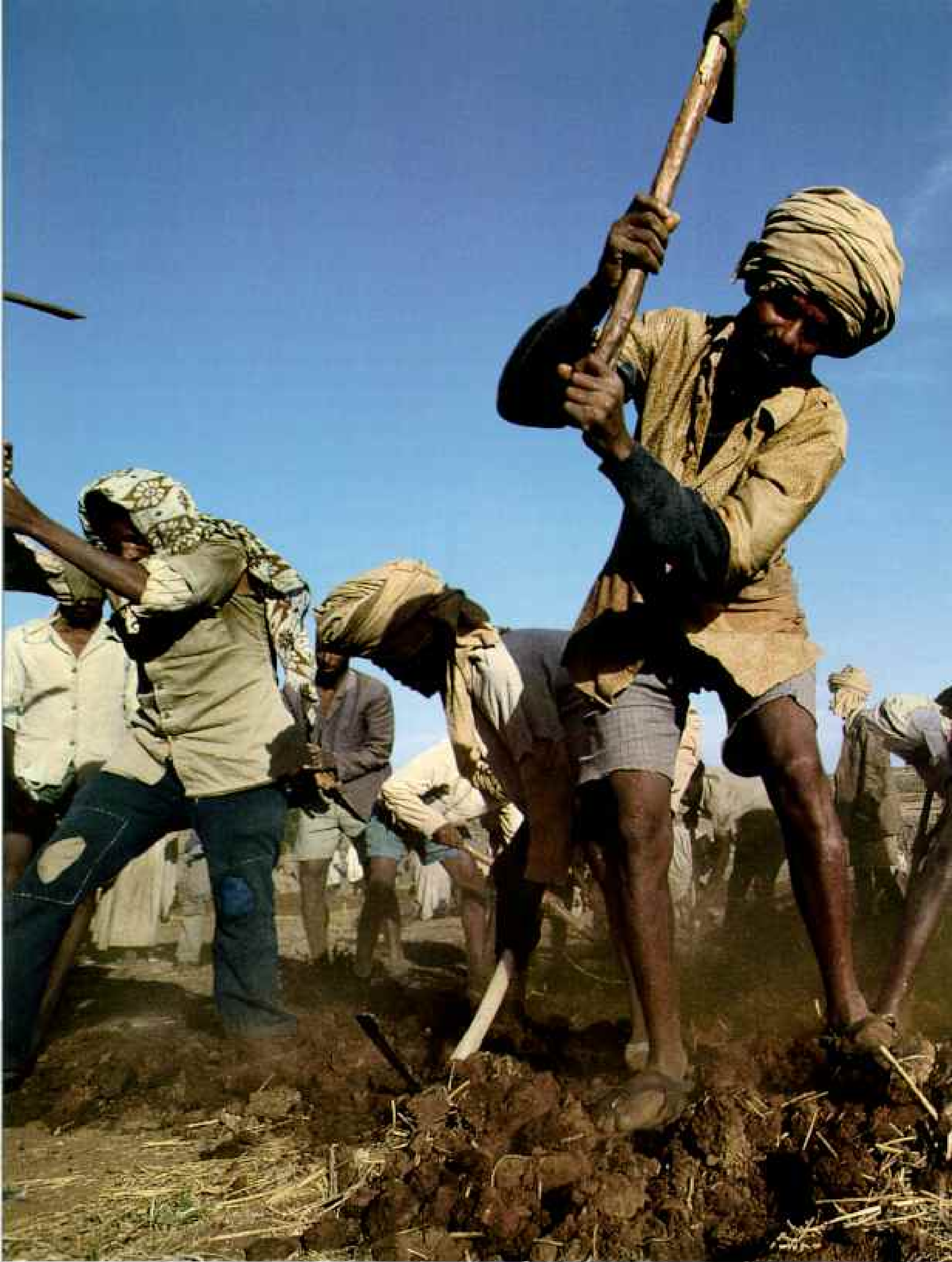
The immediate food crisis was over, but all the U. S. troops I spoke with asked the question on everyone's mind: "What will happen when we leave?"

There has to be a political solution, worked out by the Somalis themselves. After months of effort, the UN finally persuaded the heads of competing factions to sit down with one another in Ethiopia, first in January and again in March. Perhaps it's a beginning. Many Somalis told me they wished the Ethiopians would lock up all the warlords and keep them there.

IN ETHIOPIA the long war is over. The people whose images of suffering so shook the world during the 1984-85 famine are now rebuilding their country after Mengistu Haile Mariam's ouster. Mengistu, equipped with more than ten billion dollars' worth of armament for his 250,000-man army—sub-Saharan Africa's largest—sacrificed a million lives to stay in power.

He was finally overthrown in May 1991 by a coalition led by the Tigray People's Liberation Front (TPLF) and went into exile in Zimbabwe. After marching into Addis Ababa, the

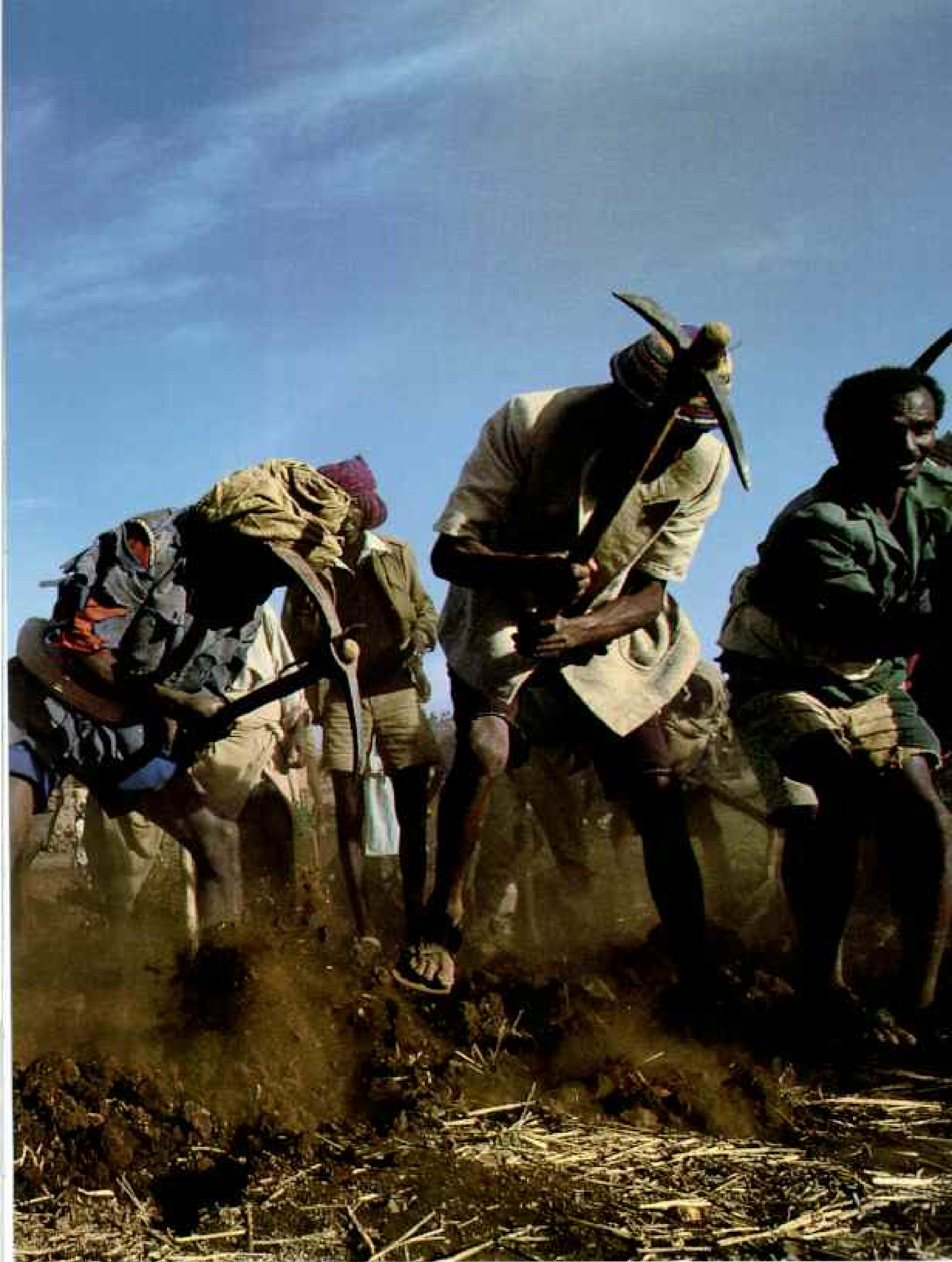




ETHIOPIA

Taking pickaxes to dry land, residents of the Tigray region break ground for an

earthen dam to trap water from a local stream. Ethiopia's abundant water



sources have been mismanaged for generations, though hope sparked by the end of

30 years of civil strife reigns today. Regional president Gebru Asrat tempers

optimism in a country where four million people still depend on foreign food aid to

survive. "War is quick to destroy," he says. "Development takes a long time."

ERITREA

A lethal crop stands idle in a field outside Asmara, where Ethiopian dictator Mengistu had mustered his forces before his downfall in 1991. Soviet-built tanks—each worth \$650,000 new—make up only a

fraction of the more than ten billion dollars' worth of arms he used to keep himself in power. Embittered by war-induced famine and hungry for independence, women like Abadit Measho, 18 (below, at left), and 20-year-old Jerome Aragai joined

the Eritrean People's Liberation Front to fight against Mengistu, who seemed bent on destroying the Eritrean people. Says another former rebel, "I ran away from home to fight for my country's freedom. Now I can help rebuild it."



coalition—the Ethiopian People's Revolutionary Democratic Front—invited other groups that had battled Mengistu's regime to join in forming a transitional government. This group now runs the country while a constitution is being drawn up in preparation for national elections. As far as I know, it's the first time a guerrilla army has seized power and offered to share it.

Unlike Sudan, Somalia, and most other African countries, Ethiopia's borders were not dictated solely by Europeans but through negotiation with the Ethiopian Empire. The emperor sat at the top of a feudal hierarchy. Peasant farmers, 90 percent of the population, tilled the land and paid tithes to absentee landlords and the Ethiopian Orthodox Church.

When Mengistu seized power in 1974, he imposed a new totalitarianism cloaked in the rhetoric of communism. People were herded into collective villages at gunpoint and forcibly resettled to work on state farms far from

their homelands. The farmers had no incentive to produce. Output plummeted.

The 1984-85 famine was caused less by drought than by Mengistu's policies and his war against various rebel groups. Supported by the Soviets, Mengistu's army laid waste to much of northern Ethiopia. It is no coincidence that the famine was worst in northern Ethiopia, where the rebels were most active. Nor is it a coincidence that Mengistu, like Siad Barre in Somalia, was overthrown shortly after the end of the Cold War. Poised strategically near the entrance to the Red Sea, both Ethiopia and Somalia had traded their loyalties to the rival superpowers in return for money and weapons.

Today in Ethiopia people say what they please without fear. About 60 newspapers and magazines have sprung to life, all but a handful critical of the government. But most people seem to be willing to give the new government a chance. Farmers have returned to their land



and sell their produce to anybody at whatever price they can get. Transportation has been deregulated; marketing is easier. Last year, with the help of abundant rains, Ethiopia produced one of its most bountiful crops ever.

In the Tigray region, scene of some of the worst suffering in 1984-85, farmers are restoring their severely degraded environment. In the 1950s, 40 percent of Tigray was covered by forest and woodlands. By 1979 it was down to 9 percent. Centuries of bad agricultural practices, decades of neglect, and years of war have taken their toll.

"Tigrayans worked 16 million man-days terracing last year," Zemichael Gebremedhin, who works for the regional government, told me proudly. "We terraced 250,000 acres. We planted 42 million seedlings. Water and soil conservation are our top priorities. If we don't do something now, we'll end up with nothing but rocks."

Dinkanesh Berhe was one of 1,170 farmers

who were building a big earthen dam near a village west of Mekele. "We are making this dam because it will help us," she told me. "We will build this dam with our hands. We don't want to suffer like we did before."

But Sebhat Nega, a member of the transitional government, sounded a note of caution in Addis Ababa. "There is peace now in Ethiopia, but it may not be sustained," he told me. "What will sustain it is development. The two are intertwined; there is no peace without development and no development without peace."

The cycle of war and drought has devastated the culture of the Somali people in the Ogaden region of Ethiopia near the Somali border. The Ogadenis have been seeking refuge from rival armies since 1977. Forty thousand of them are now huddled in camps around the Ogaden town of Gode. They are nomads without camels or goats. The only life they know is that of the camps.



"We have no animals and no food," Saphia Urur Hassan told me. She had run to Somalia when she was seven; she grew up, married, and had children in a refugee camp. She has lived in camps for 16 of her 23 years. "We will stay here."

Saphia and her family represent one of the biggest problems in the Horn of Africa: people who have lost both the means and knowledge they need to be self-sustaining in their own environments. Thousands of Somali children are growing up without camels; thousands of young Dinka and Nuer know nothing about cows. The wars have beggared them.

"I hated the life of a refugee," said Mohammed Ismael Yusuf, 88. "We were dependent

on food that was given to us. That is no life, especially for my children. I was always dreaming of my land here."

Mohammed was among the few nomads in the Ogaden region who had taken up farming before the 1977 war drove them from Ethiopia. Mohammed's land had been in an irrigated project near Gode that Mengistu had turned into a state farm. The returning farmers petitioned the new government for their land, and the government agreed. Mohammed was one of the first 400 who were drawing lots to determine which two-and-a-half-acre plot would be theirs. Other groups would follow until all 6,600 acres were distributed. Most of the pumps were broken, many of the

SOMALIA

Sweeping dust from a land grown hard, a Marine CH-53 Sea Stallion takes off after delivering food to a village near Baidoa. Due to the possible danger of mines along the road, truck drivers could not deliver the

relief supplies safely. Since international forces arrived, relief agencies worry less about the theft of food, but villagers are still at risk. At night, when troops are not on patrol, armed bandits sometimes raid houses for food, which they sell in Baidoa.

caught by the hyena was only wounded and is now recovering."

I went back to southern Sudan at the end of my trip. The war was still taking its toll. I was told that the people in Waat were recovering, but when I visited Ayod, a village not far away, I again saw starving people and heard more stories of famine and flight. An epidemic of a fly-borne, wasting disease called kala-azar is sweeping through the north-central portion of southern Sudan. Some communities have lost a third of their population; in the past five years an estimated 60,000 people have died.

IN SOMALIA the security situation was still a mess. Fighting continued in Kismaayo. The International Committee of the Red Cross pulled out of Mogadishu north after its workers were repeatedly threatened and \$180,000 was stolen. Nine hundred laborers and security men who had worked in the port before U. S. forces arrived demonstrated in front of the CARE and WFP offices, demanding back pay to December 9. The bill was \$500,000. The agencies refused and temporarily had to evacuate most of their expatriate employees for fear they would be shot.

The donor countries had had enough. At a March conference in Addis Ababa they put a condition on much of the money earmarked for Somalia, making it available only when there is sufficient security in the country.

"They have no ideas or policies or philosophy," the lawyer Nurta Hagi Hassan said, speaking of the warlords who were convening for a UN-sponsored conference. "So what do they have to talk about? When they think of a government job, they only think of the house, the car, and the opportunities for graft that come with it. They aren't interested in

canals clogged with vegetation, but the farmers were eager.

"When I was at the camp in Somalia, and at the camp here, I thought I might as well die," Mohammed said. "But when I saw my land again for the first time, I became strong and fresh. Now my family has a future."

There isn't enough water in the Ogaden to supply farmland for everybody. But these plots offer a way out of the camps for about 15,000 people.

"If a hyena wants to eat an animal and he catches it, the animal cries for help," Mohammed told me as I was leaving. "We are that animal, and the hyena is hunger. We cried for help, and it came. The animal

government, only in their own personal wealth and power."

THE AMERICAN FORCES were beginning to leave, and the ones I spoke with were more than ready. They had accomplished their mission of making sure food got to the needy but were frustrated by the unwillingness of the warlords to begin rebuilding their country. General Aideed, trying to manipulate upcoming talks in Ethiopia, stirred up anti-American feelings in Mogadishu south, sending crowds of women and children out to demonstrate and throw rocks at the Marines. He knew the Marines were unlikely to shoot at women and children.

The UN forces that are assuming command from the Americans will find themselves in a tough situation. It's impossible to disarm everybody in Somalia—there are too many

weapons and too many places to hide them. The UN, like the U. S., can maintain order in certain areas. But only the Somalis can rebuild Somalia. They have to want peace.

I can't help but compare Somalia and Sudan with Eritrea, which won its war for independence from Ethiopia after a 30-year struggle. Eritrea's 3.3 million people are of several ethnic groups and are about equally divided between Muslim and Christian. But their differences have been overridden by a genuine sense of being Eritrean.

"We all fought together in the trenches; we died in one another's arms," said Yemane Ghebream, assistant secretary for external affairs. "We have carried this unity beyond the war."

Like their neighbors in Tigray, the Eritreans inherited a severely degraded environment and a shattered infrastructure.

Eritrean farmers are now back on their land and making good use of limited supplies. In 1992 they produced such a good harvest that the government reduced its request for relief food from the international community by 50 percent for 1993.

For two years none of the people who worked in the provisional government, from the president on down, received any salary. They were working not for money or power but to build a society.

"We lost thousands of friends and colleagues in the war," Yemane told me. "People who were much better than we are. Can we live up to the sacrifices they made?"

Perhaps the Somalis and the Sudanese will one day emerge from their nightmares with a willingness to build together rather than simply destroy. I'm sure the Sudanese in Waat and the Somalis in Baidoa would agree with a man I met in Eritrea.

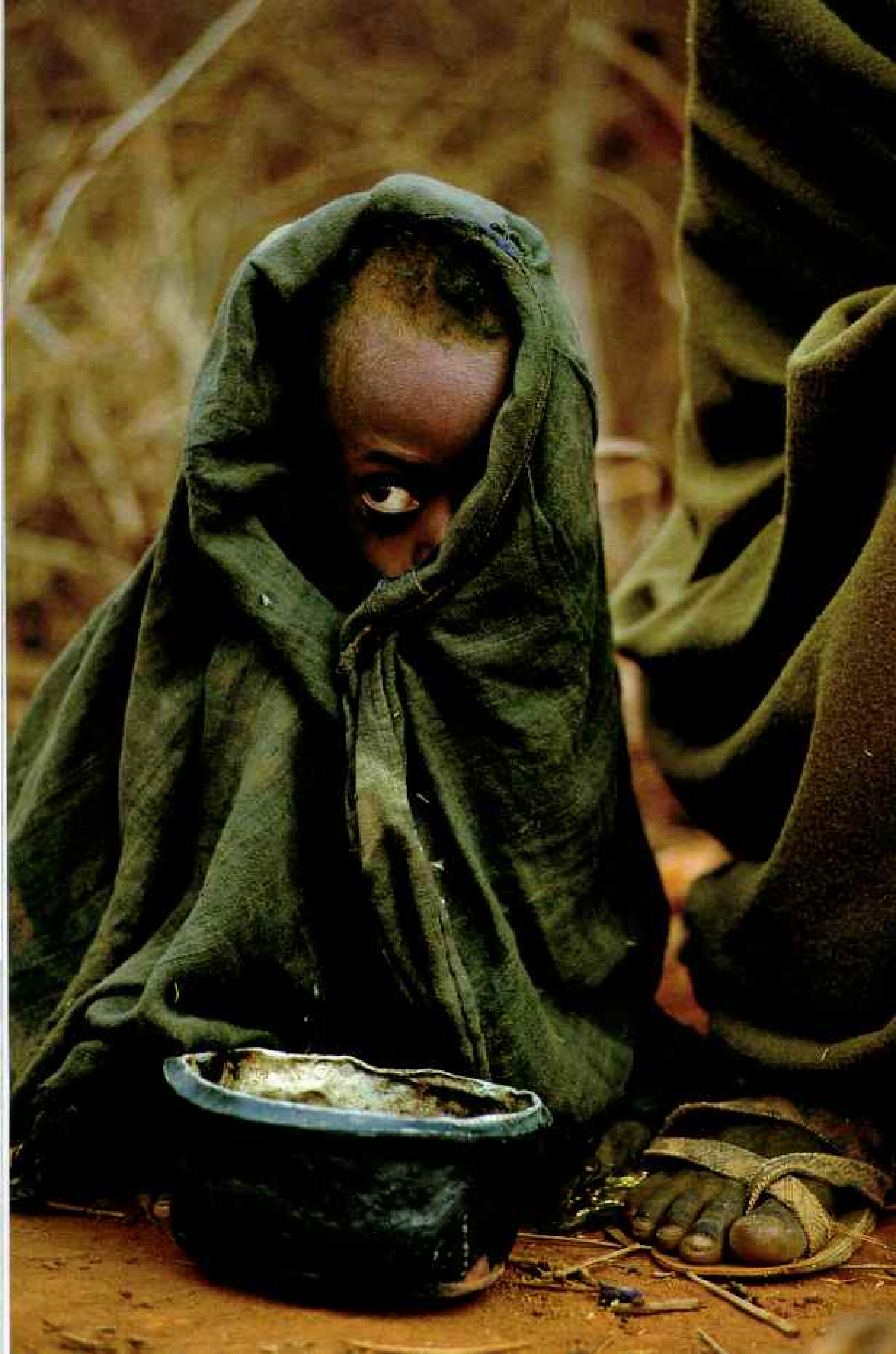
"We can make a good life if there is no more war," he told me simply. "All we need is peace and rain." □



SOMALIA

"Now we are all right," says 13-year-old Fatima Aaden Ibrahim (above), who planted corn kernels from UN food rations to grow her thriving plot. Her optimism is a beginning, but Somalis must go far to seize the promise that

gives hope to Eritreans and Ethiopians. And what of the Sudanese, whose problems are only now being addressed by the international community? The future of the Horn of Africa—and of children like this Somali boy waiting his turn to be fed—is anyone's guess.





Untamed Treasure of the Cumberland

Twilight fog pours into a valley near the Big South Fork
of the Cumberland River, once slated for damming.
The river winds through more than 100,000 acres in
Tennessee and Kentucky, land set aside by Congress
in 1974 for both preservation and recreation.

By HOWARD H. BAKER, JR.
Photographs by PETE SOUZA



JOHN HETHERINGTON

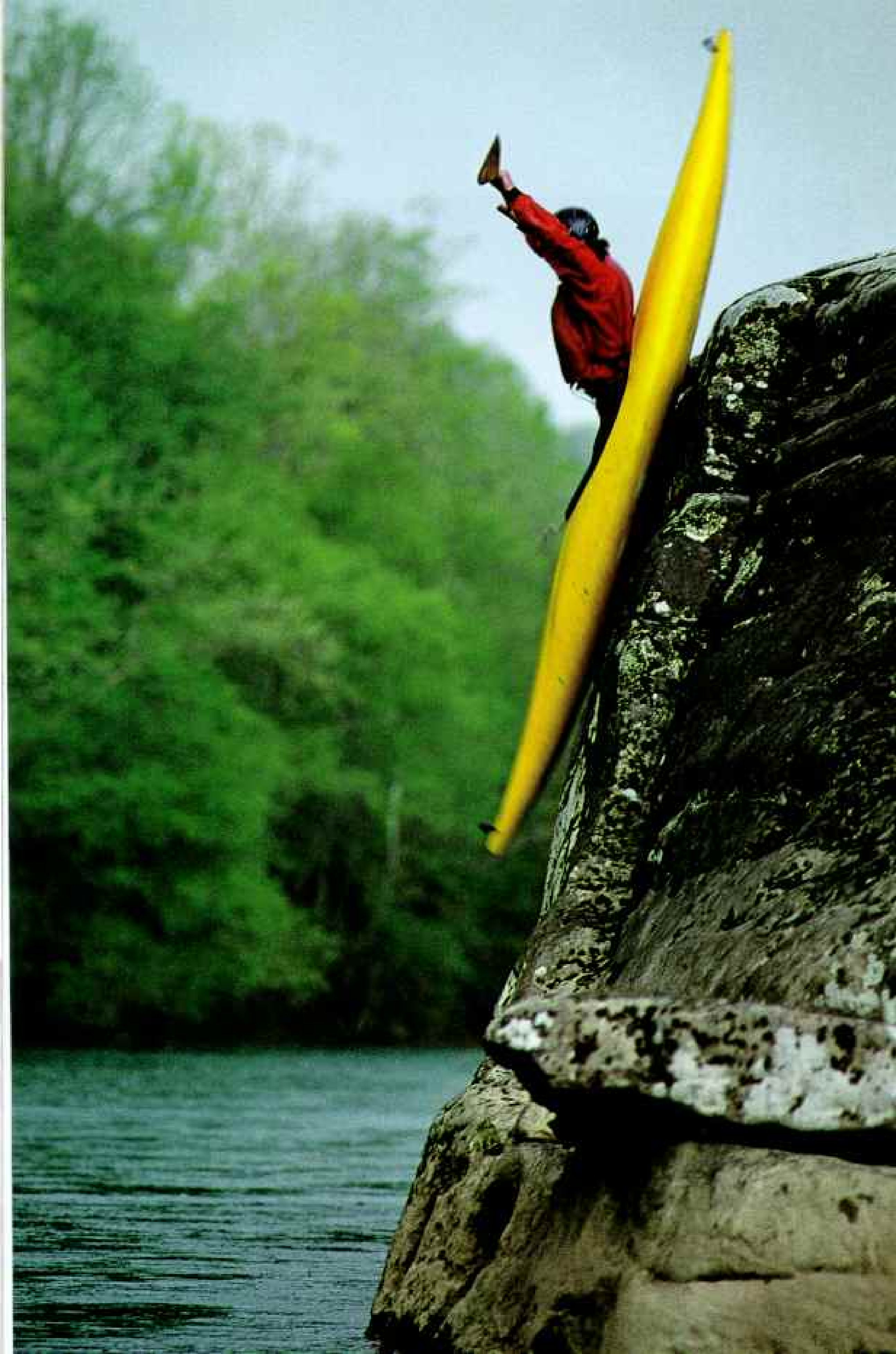
Geared up for white water and photography, author and former majority leader of the United States Senate, Howard H. Baker, Jr., readies for a run through rapids on the Big South Fork. Baker was a principal sponsor of the park's creation. His legacy includes a stretch of flat water with rock tower where Barry Crowder (facing page) dry launches his kayak. "What a rush!"

"SENATOR, you have some of the maddest old friends—and some of the strangest new ones—that I ever saw." My friend Lonnie Strunk meant coal and timber people on the one hand and environmentalists on the other. He knew that I'd badly ruffled some local feathers by cosponsoring two bills in the United States Senate. One put severe limits on the way that coal could be strip-mined and required a restoration of the land afterward. The other turned the region around the Big South Fork of the Cumberland River into a national river and recreation area.

I grew up near the river in Huntsville, Tennessee, and I knew the Big South Fork as a boy. I went down with my dad to Leatherwood Ford, and we would picnic and swim at the old bridge. I fished the river. I hunted some with my father, mostly for quail and grouse. But as I grew older, photography became my primary outdoor passion. That hobby lends itself to a deep appreciation for this corner of Tennessee and Kentucky, with its wildflowers and wildlife, oak and pine forests, towering sandstone bluffs and arches, and the river plunging through it all.

The people here have a strong frontier spirit and keep close communion between that spirit and this land. Just to give one example: When Tennessee seceded from the Union in 1861, my home county seceded from Tennessee.

People here also have to be tough; it's been a hard place to make a living. Bypassed by early pioneers, the region's first boom came from trees cut to supply railroad ties. The next one came from the coal mining that so devastated much of the Cumberland Plateau. I got a taste of the coal business myself after serving in World War II. For a time I





HOWARD H. BAKER, JR.

The warm green woods and cool surge of Pine Creek, photographed by the author, invite a visitor to rest and reflect. The nearest neighbor might be a bobcat or a wild turkey. Humanity's only traces might be a tool left by a Native American 10,000 years ago or pipe for a moonshiner's still dropped by a later American with need of seclusion—and haste.

helped survey the 40-inch-high “rooms” where miners would dig next, and I soon learned how to get around the mine by rolling on and off the conveyor belt.

Some might say that was good training for a career in the law and Congress, where both my father, a congressman in his day, and I had helped put legislation on the congressional conveyor belt to build dams that would have flooded much of the Big South Fork. I came to realize, though, that such lakes were, so to speak, a dime a dozen. It was free-flowing streams that had become the rarity.

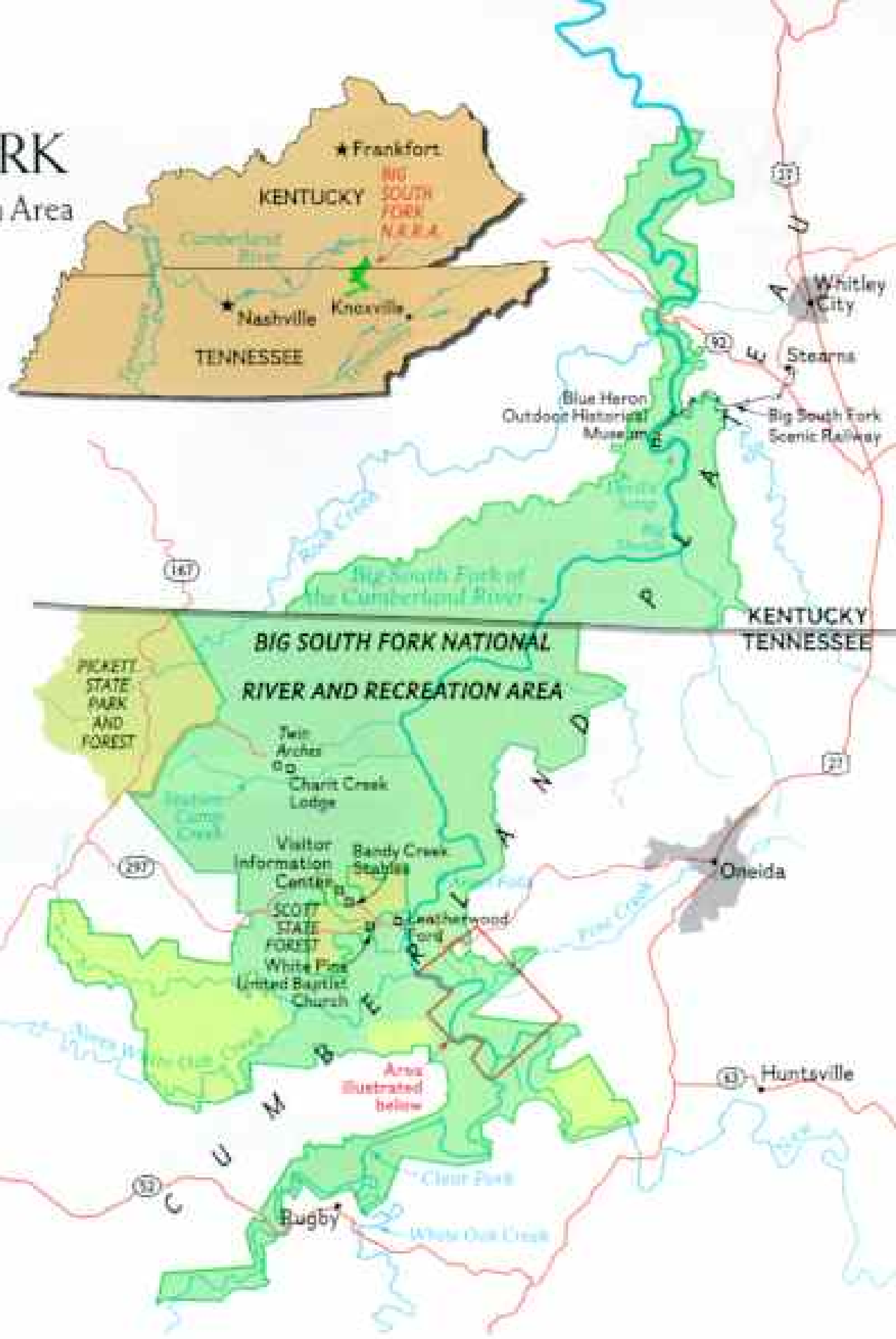
These days our rarity—the Big South Fork—and its good access roads attract 800,000 visitors a year. As my old friend, lifelong resident Dr. Milford Thompson, said, “Now any damn fool can get up here.”

So can the smart ones. We look forward to seeing you.

BIG SOUTH FORK

National River and Recreation Area

Crossing the boundary between two states, the park is divided in character. The gorge from bluff top to riverbed is to be protected in its "pristine and natural state." Surrounding land can be used, where designated, for driving off-road vehicles. Other attractions include hiking, camping, hunting, trapping, and a scenic railway to a coal-mine camp and museum. More land is under study for inclusion in the park, up to a maximum of 125,000 acres.



WE CALL IT Devil's Jump, but it's bloody legs for a hiker who slipped at these Kentucky rapids on the Big South Fork, once picked as the site for a dam. That would have turned the rattling river into a tame lake.

Drenched two ways, Dan Wheeley (far right, with paddles) and Mike McCane load canoes in a downpour after a river run ending at the O & W Bridge, built for a lumber-and-coal-hauling railroad abandoned in 1954. Last summer Dan, at age 16, placed fourth in the men's expert division of a white-water competition. Or, as Mike puts it: "He's a real hot dog."

Visitors might meet Dan or Mike as guides if they travel with one of the river outfitters, Cumberland Rapid Transit, owned by Dan's father. Thrill levels can be custom ordered, from a day's canoeing on gentle Class I and II riffles to five-day, 55-mile guided raft trips that churn through Class III and IV rapids.

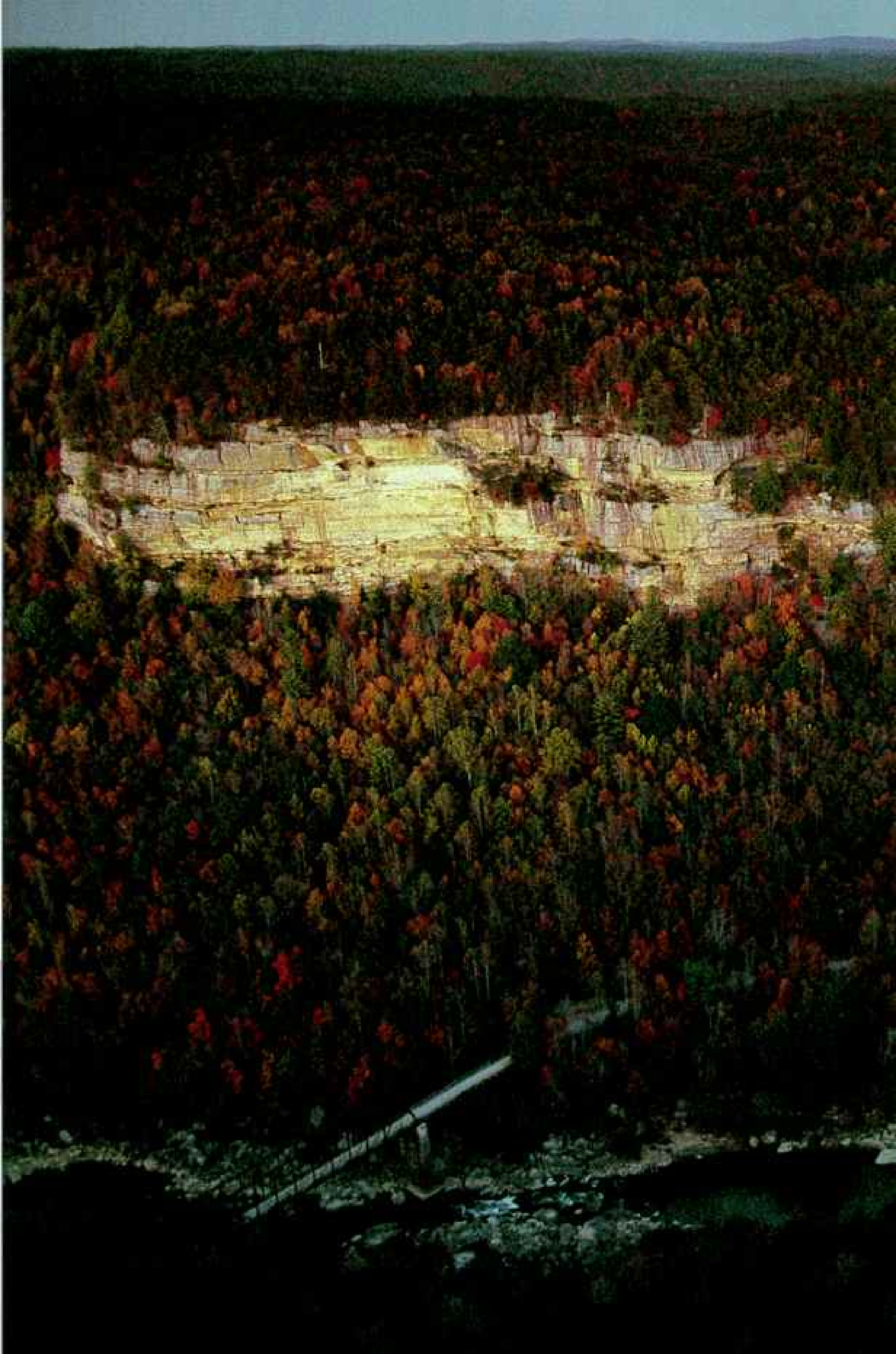
Bicycles don't usually run rapids, but Sam Poyner (right) hoists his across North White Oak Creek. He's one of a growing legion of mountain bikers who take to rough trails and steep terrain to enjoy the sport.

Joe Cross, who admits that "when I was a kid, I always rode through the puddles," heads the Big South Fork Bicycle Club. He helped arrange the first organized race here last Labor Day, and 160 cyclists entered. But if you want easy riding instead of hard racing, Cross says, "You can name your own poison."

Big South Fork Country, a look at the region by HOWARD H. BAKER, JR., with photographer John Netherton, will be published in September 1993 by Rutledge Hill Press. This is the first GEOGRAPHIC assignment for PETE SOUZA, who served as President Ronald Reagan's White House photographer.









The river in autumn's low water skitters through rapids at the Narrows, Jake's Hole, and O & W Bridge, cutting its way past eroded bluffs, their tops now remantled with hardwoods.





RAISING A HYMN on Easter Sunday at White Pine United Baptist Church, Joan Phipps holds the hand of her daughter, Amanda. Joan's husband, Andy, had a grandfather who taught shape-note singing in the region but eventually decided to move his family to Muncie, Indiana, where jobs were available. Come Fridays, the Phipps often head south with a stream of others moving in loose caravan bound for a weekend in home country.

Heading west more than a century earlier, a caravan of British under the tutelage of novelist and social reformer Thomas Hughes came to found the settlement of Rugby in 1880 and "create a new centre of human life . . . in this strangely beautiful solitude." A prime motive was to provide productive lives for the younger sons of British gentry, who were, by law of primogeniture, excluded from inheritance. All were



welcome who would put aside class distinctions, work cooperatively, and value manual labor.

For a time the community thrived despite a devastating winter and a typhoid epidemic. Long on philosophy, short on practical skills, Rugby declined from a utopian dream to a half-forgotten village. Its remoteness spared Rugby from unfortunate

improvement, and the few residents looked after the town.

Today its preserved buildings, such as Christ Church Episcopal (top) and the Hughes public library beyond, draw visitors like those from an Elder Hostel group (above), who come for a week's intensive study of Rugby's past, the park's natural history, and regional crafts.





NEXT UP at the horse wash, Danny Hatcher from Lenoir City, Tennessee, gentles his 14-month-old colt, Cisco Kid. The flax-maned, chocolate-colored horse—known as a Rocky Mountain—is said to have descended from a stallion brought to Kentucky in the 1890s from out West.

Hatcher rates his breed as surefooted and smoother gaited than our Tennessee walking horse. At 14 months Cisco was still too young to ride. That would start in another seven

months, but Cisco had already begun his training, harnessed to a small two-wheeled buggy. Hatcher brought him along on a family outing to Bandy Creek, the most heavily developed part of the recreation area.

There Sam Storey (who claims to be retired) and his wife, Sandra (also the postmaster of Huntsville), have watched their college-student daughters, Samantha and Sabrina, take complete charge of Bandy Creek Stables. And Sabrina specializes in sizing up horseflesh to buy for the rental operation.

While the stables have 21 horses for rent, the biggest part of the trade is from people who bring in their own mounts, rent stalls, and ride 130 miles of park trails, sharing some paths with mountain bikers and hikers.

"They come from as far away as Georgia and Michigan, Syracuse and Dallas," Sam Storey says, and they bring as many as a dozen animals, enough for a huge family to ride.

Some make an entire vacation out of the experience, camping in their horse trailers while the horses luxuriate in their stalls.

Boy Scouts, of course, learn to camp in tents. At a recent Camporee more than a hundred Scouts came in from neighboring counties.

Sammy Williams (left, at right) and Richard Whited, who make up one-third of Michael Joyce's Troop 230 from Jamestown, Tennessee, learned about search-and-rescue operations with the other Scouts. Then they tackled strenuous outdoor exercises, working together to get up, over, around, and through various rope and log obstacles.

(The flashlight, it has been said in Scout lore, is handy to have on a Snipe Hunt.)

Those traveling to Big South Fork on the lookout for real birds have a good chance to add to their life lists.

From the large and gaudy pileated woodpecker to the small and secretive nighthawk, more than 130 species have been spotted.

Among them is *Gallinago gallinago*—the common snipe. Honest.



MAKING LIKE A COMET, a powerboat carves a turn in a Kentucky flat-water section of the river. Eventually, the Big South Fork ends as a tame flow into a lake impounded by a dam on the Cumberland River.

True to its mission, the Big South Fork National River and Recreation Area offers an almost unlimited variety of outdoor experiences, from the

quiet of hiking to the roar of powerboating. More and more visitors have discovered what is no longer such a secret in a place that is no longer so hidden.

As trees of the second-growth forests continue to grow, the animal populations should diversify. A plan to reintroduce a small population of black bears for study is still in the discussion stage. One potential impediment is the lack of

enough big old oak and hickory trees to provide nuts to carry bears through the winter.

Another cause for caution is the mild controversy the plan has stirred up. Not everybody is convinced that it is a good idea to reintroduce such large predators, even in small numbers. Yet given enough time, bears may appear again, whether they are invited or not.

They too belong. □



GM Bonus \$84.75



Round-Trip Ticket, ORD to SFO
GM Partner Bonus \$59.50
through GM Travel Services



GM Bonus \$3.25



15 Gallons Mobil Super
GM Partner Bonus \$1.75



GM Bonus \$18.65



GM Bonus \$38.99



GM Bonus \$109.95

UP TO
\$1,000

A YEAR

toward a new GM car
or truck. Plus all the advantages
of a Gold MasterCard.



GM Bonus \$6.95



Dinner for Two
GM Bonus \$9.00



GM Bonus \$2.20



GM Bonus \$49.45



5 Long Distance Calls
GM Partner Bonus \$1.27



GM Bonus \$1.00



GM Bonus \$150.40



GM Bonus \$47.25



Round-Trip Ticket, EWR to DFW
GM Partner Bonus \$50.30



GM Bonus \$3.75



GM Bonus \$4.45

Don't Spend More, Spend Introducing The New GM

Offer is redeemable as discount on purchase or lease of a new GM car or truck. Up to \$1,000 annually, or maximum of \$7,000 over 7 years. May be combined with other offers. Subject to GM Gold Card Rebate Program Rules. Mobil Partner Bonus not available in New Jersey. GM Travel Services provided by Carlson Travel Network. *There is no transaction fee for Traveler Checks; normal finance charges apply from the date of posting. ©1993 General Motors Corporation.

Spalding and Top Flight are registered trademarks of Spalding and Beverly Companies, Inc. Eagen Beaver™ McCulloch is a registered trademark. Hamilton™ Viking is the registered trademark of Viking Range Corporation. Black & Decker™ IBM is a registered trademark, and Valuepoint is a



GM Bonus \$210.00



GM Bonus \$18.70



GM Bonus \$65.50



GM Bonus \$2.75

AVIS

4-Day Rental, Full-Size Car
GM Partner Bonus \$15.99



GM Bonus \$2.30



4-Night Stay
GM Partner Bonus \$74.00



GM Bonus \$10.25



GM Bonus \$22.50



GM Bonus \$8.75



Caribbean Cruise for Two
GM Partner Bonus \$533.80
with GM Travel Services



GM Bonus \$17.50

The new GM Gold MasterCard is here, and it's the only credit card in the world that lets you earn **up to \$1,000 a year** toward your choice of over 100 new GM cars and trucks.

Simply use the GM Gold Card™ to buy items as you normally would. 5% of every purchase (10% with GM Partners) will be credited to a special GM bonus account that you can use to lease or buy a new GM vehicle. You take any discounts or rebates that apply, then use your GM bonus account to save hundreds, even thousands of dollars more.

You even earn a 5% bonus on balance transfers*...5% on things you've already bought! All this *and* all the advantages of a Gold MasterCard.

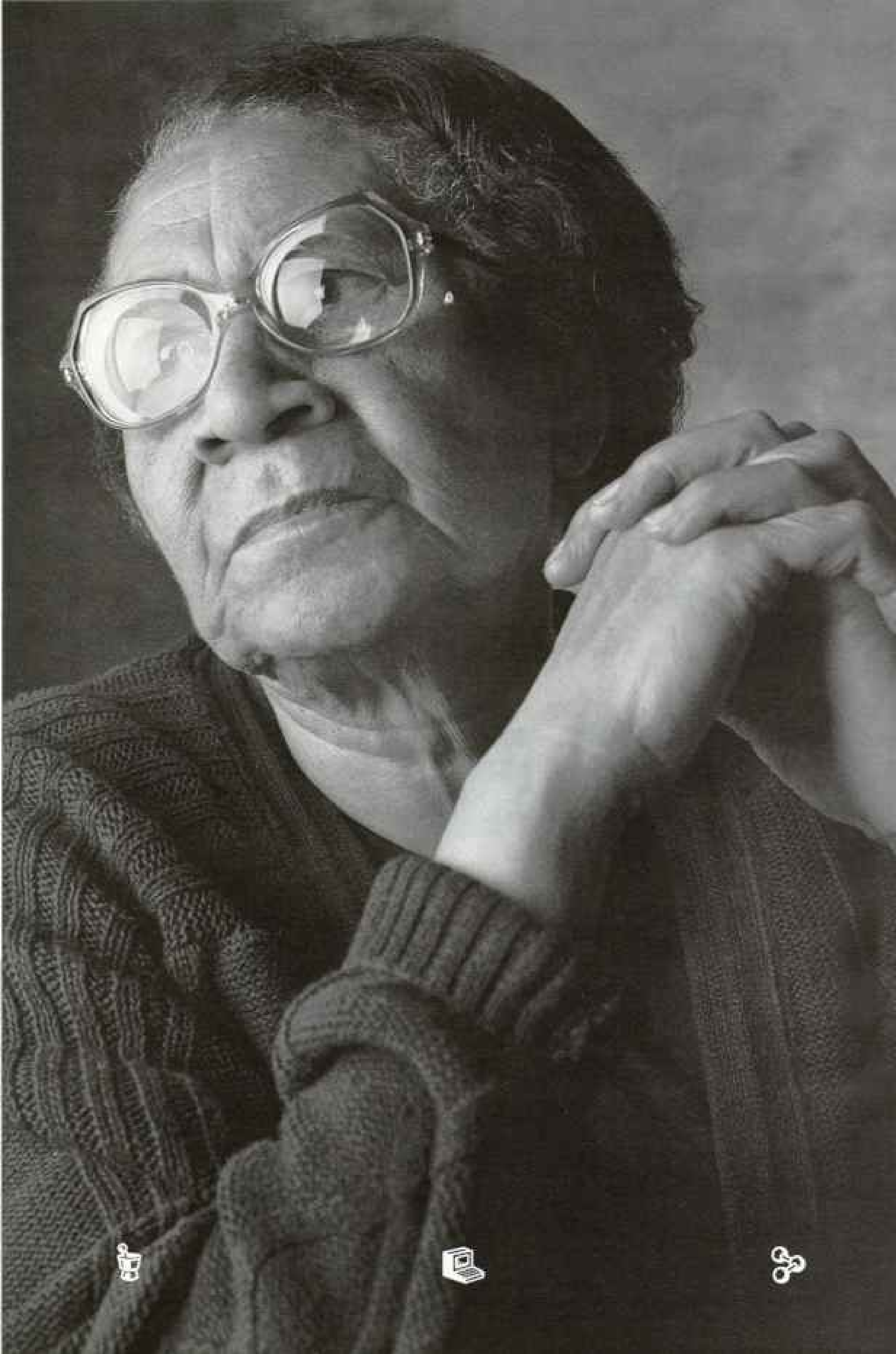
So don't spend more, spend smarter... with the new GM Gold Card. You'll get a lot more mileage out of everything you buy.

Smarter. Gold Card.™

To Apply,
Call 1-800-846-2273.



Trademark of the International Business Machines Corporation. Water® Genesis® 3000 Series Gas Barbecue. Even-Flavor is a registered trademark. Best® is a registered trademark of Best Corporation. Borden is a registered trademark of Borden Sperry, Inc.



Glaxo. Driven
by the hope of
the millions
of people for
whom there is
no medicine.
Yet.

Hope is the light that shines on tomorrow. It's the strength to carry on. Hope is the faith that the search for a cure continues. Somehow, somewhere, there will be an answer. At Glaxo, we make medicines. But our real job is to find them. And our search continues. Relentlessly. Unceasingly. Throughout the Glaxo network of scientists committed to finding answers. And medicines. Hope is real, the search goes on.

Glaxo. On The Brink Of Discovery.



Geographica



ISRAEL C. RUSSELL, USGS

New Chimp Study— Society's 5,000th Grant

In 1890 the National Geographic Society awarded geologist Israel C. Russell \$3,500 and sent him off to map Alaska's Mount St. Elias (above) and the surrounding region. The grant was the Society's first in support of research and exploration. Last March the Society's 5,000th grant—\$12,000—went to Rosalind Alp, a 23-year-old Englishwoman (right) who is studying chimpanzees in Sierra Leone.

The grants, now made by the Committee for Research and Exploration, have covered such topics as the distribution of army ant mites and leafhoppers, Byzantine shipwrecks, and tropical biological diversity. Primatologists Jane Goodall, Biruté Galdikas, and the late

Dian Fossey all launched their pioneering studies of the great apes with Geographic aid.

Alp follows in their footsteps. At 19 she participated in a tree-planting project in Sierra Leone and became fascinated by the country. She walked up to the wildlife superintendent of Outamba-Kilimi National Park and asked for permission to do a chimpanzee survey. Gradually chimps are acclimatizing to her presence; she has documented several of them capturing and eating a duiker and has noted others using peeled sticks to "fish" in anthills.

To get to her camp, Alp rides a motorbike about 200 miles from Freetown, then hikes 16 miles into the forest. First grantee Israel Russell, who trekked glaciers and climbed mountains 103 years ago, would smile at that.



ANDREA JONES



KENNETH GARRITT

Ancient Leaves Write New History of Forests

This fossil leaf looks familiar—as if dropped from a maple tree in North America or Europe. But it fell about 65 million years ago on New Zealand's South Island. Its resemblance to a maple, found today almost entirely in the Northern Hemisphere, reveals nature's way of devising similar-looking solutions to similar environmental pressures, no matter how far apart in time or space, says Kirk Johnson of the Denver Museum of Natural History.

Supported by a Society grant,

Johnson—who had studied fossil plants in North Dakota and Montana that died out at the end of the age of dinosaurs—was seeking ancient plants when he discovered maple-like leaves, new to science, and other fossils that mimicked oak leaves.

When they fell, New Zealand was near the Antarctic Circle and much warmer than it is today. They dropped not because of cold or lack of moisture, as leaves do today, but because there was no light for leaves to gather during the Antarctic winter, says Johnson. He expected to find ancient leaves but not such mimics of Northern Hemisphere trees.

Thankfully, the world has one resource that will never be exhausted: the Spirit of Enterprise.

The Rolex Awards for Enterprise were conceived in 1976 to recognize individuals who have displayed a remarkable spirit of enterprise in the fields of Applied Sciences and Invention, Exploration and Discovery, and the Environment. Since the Awards were introduced, 30 individuals have each received 50,000 Swiss francs and a specially inscribed Rolex Chronometer timepiece.

Rolex is proud to announce the five new winners for 1993:



STEVEN GARRETT, a physics professor, has developed a revolutionary system of refrigeration that does not contain the chemicals used in most refrigeration equipment, which we now know harm the ozone layer.

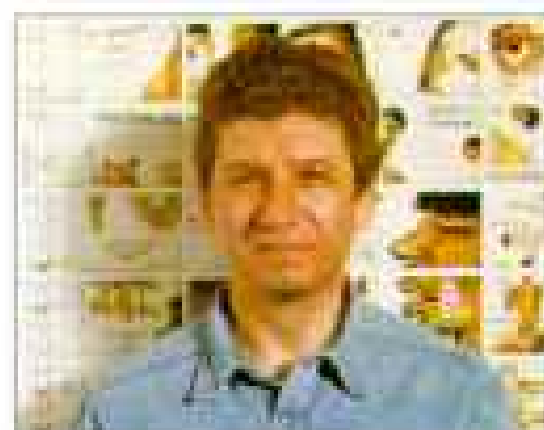
This unique refrigeration method has grown out of the science of thermoacoustics. Garrett's device exploits this science, utilizing sound to transfer heat and thus produce refrigeration. A prototype has already been tested on board the space shuttle *Discovery* in 1992. Garrett sees his award as being important because not only will it attract more physicists to work in this largely unknown area, but also "it will draw attention to these alternative technologies."



FORREST M. MIMS III is an entirely self-taught electronics specialist who has developed an instrument capable of measuring the thickness of the ozone layer. He has named it TOPS: Total Ozone Portable Spectroradiometer.

What makes this machine remarkable is the fact that it is about 500 times lighter and 200 times cheaper than existing detectors; yet its readings are highly accurate—vital information in this time of growing concern for the ozone layer.

It is Mims's aim to distribute TOPS to individuals in at least 10 countries, forming a network to complement measurements taken by the small number of official monitoring stations.



ALDO LO CURTO describes himself as a "traveling volunteer doctor." Since finishing his medical studies, he has spent his holidays traveling to remote parts of Africa, Asia, and the South Seas, giving free medical care to the people there.

In 1981, he went to South America to work with the Amazonian Indians. He studied their plant-based remedies, and wrote a manual for health workers which combined Western and Indian medicine.

This extraordinary book will be a valuable guide for health workers. For the Indians, it will serve as a reminder for future generations of the knowledge of healing accumulated by their ancestors. He will use his award to publish the first edition.

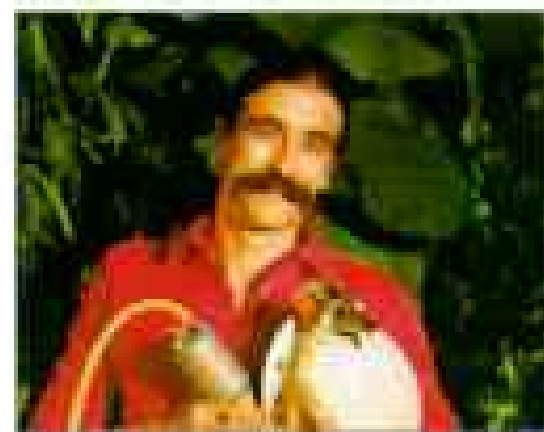


NANCY ABEIDERRAHMANE has taken the enterprising step of setting up a dairy in Mauritania, a country noted more for its desert than its pastures.

This is no ordinary dairy, however, since it specializes in pasteurizing camel's milk supplied by seminomadic herders.

The milk Nancy is processing is highly nutritious, and because it is pasteurized, it is healthier than the raw milk commonly drunk by the local population.

With the award, Nancy's next step is to produce cheese from camel's milk, thus adding to the improvement of the local diet.



ANTONIO DE VIVO is an Italian physical education instructor and a leading cave explorer. In an expedition prior to winning this award, De Vivo traveled down the La Venta River in Mexico and made some extraordinary discoveries, including a remarkably well-preserved Mayan altar. His expedition also studied the flow of water in the river and cave systems, in the hope that his research could help villagers a few miles away to make use of the water for drinking and irrigation.

This award will allow Antonio De Vivo to return to the area, to study further the archaeology of the caves in the hope of finding the entrance to a long-lost Mayan city.


ROLEX

THE ROLEX AWARDS FOR ENTERPRISE 1993

A book describing the projects of the winners and 250 other submitted projects is available. To order, please send \$39.50 to G. J. Blum Associates, P.O. Box 567, Bensenville, IL 60402-0567. For information on the awards, please write: The Secretariat, The Rolex Awards for Enterprise, P.O. Box 178, 1211 Geneva 26, Switzerland.



For Archaeologists, Oil Spill Could Be Worse

Finally some good news about the impact of the March 1989 *Exxon Valdez* oil spill in Alaska's Prince William Sound (*GEOGRAPHIC*, January 1990): The oil's presence will not hinder archaeologists delving into human history around the Gulf of Alaska.

The oil spill stained beaches and seeped into a few sites, but scientists can still get accurate radiocarbon dates, says Albert A. Dekin, Jr., of Binghamton University, SUNY. Dr. Dekin led a U. S. Forest Service-funded team that dug test pits at ten sites (map, above), made observations at 26, as here at Takli Island, and surveyed another 60. He found prehistoric tools and animal bones to be uncontaminated.

Now the bad news: Several sites held oil residue from decades of use of camp stoves, aircraft, and boats, raising concerns for the future. "We



ALBERT A. DEKIN, JR.

never got the globs we expected to find from the *Exxon Valdez*, but we commonly got small amounts from other sources," Dekin says. "In a way that's more scary."

Does Living a Stone Age Life Cut Cancer Risk?

Women in industrialized nations, beset by high rates of cancer of the breast, uterus, and ovaries, might consider the Kung San people of Africa (below). Females in this and other hunter-gatherer societies—the closest modern equivalent of Stone Age cultures—experience surprisingly low rates of these cancers, says S. Boyd Eaton, an Emory University radiologist.

Dr. Eaton's team found that these women eat a leaner diet, exercise more, begin to menstruate later, start bearing children earlier, nurse them longer and more often, and experience menopause earlier than their industrial world counterparts—all of which help lower cancer rates.

"The life-style for which our genetic makeup was selected was actually that of Stone Age foragers," Eaton says. He does not expect women to have babies early and often, as their ancestors did. But he suggests that new medications might be devised to mimic the cancer-resisting "hormonal milieu" of hunter-gatherer women.

Dove Love: Females Lay Eggs on Coo

Oh, the romance of it all: Two doves billing and cooing at each other, joining to build a nest for the forthcoming egg.

Time to amend that romantic notion. Yes, the male coos at the female, and scientists had thought he thus stimulated glandular



IRMA BLOCH

changes in the female that triggered egg laying. It now turns out that it is the female coo that causes follicles in the ovaries to grow and then burst to release an egg, according to psychobiologist Mei-Fang Cheng of Rutgers University.

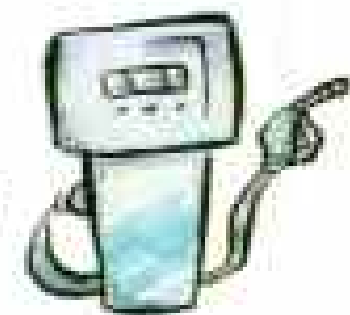
Dr. Cheng devised painless experiments that rendered the female unable to coo. The male cooed as usual, but nothing happened. But when a female heard recordings of her voice, the result was an egg deposited in the glass nesting bowl.

The male's cooing still plays an important role, Cheng cautions. It "is a very powerful stimulus in inducing the female to call," but her own call is what triggers endocrinologic changes, Cheng says.

—BORIS WEINTRAUB



ANTHONY BARRISTER, ANTHONY BARRISTER PHOTO LIBRARY



From now on, buying the necessities of life can be a very rewarding

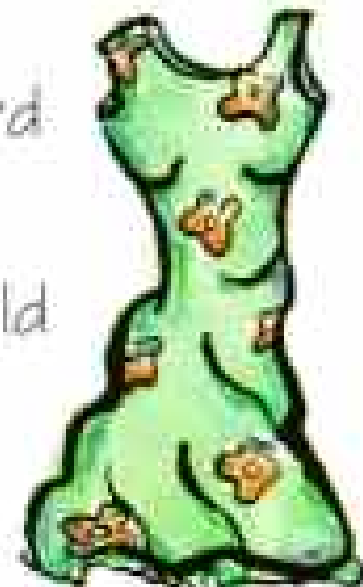
best-selling cars and light trucks. With the Ford Citibank card, **5%** of your



Everyday expenses now earn a daily dividend.

experience. All you have to do is apply for the Ford Citibank® card. You could save hundreds, even thousands of dollars toward

purchases will accumulate in your special Ford rebate account. Up to \$700 a year, for five years. What other credit card in your wallet is worth that much? Earn while you



the purchase or lease of

that much? Earn while you

any new Ford, Lincoln or Mercury –

spend. Apply for a Ford Citibank card today.



America's



The Ford Citibank Card. It's A Better Idea.
1-800-374-7777

Why settle for anything less?
**With prices starting
 at \$339⁹⁵
 you can afford a
 NordicTrack.**



*30-day
 in-home
 trial*

There are good reasons why the
 NordicTrack is known as
 "The World's Best Aerobic Exerciser".

While lesser cross-country ski exercisers provide an awkward "shuffling" motion, the NordicTrack uses a patented flywheel and one-way clutch mechanism that no other ski machine can match.

**It's the affordable way to
 meet your fitness goals.**

A NordicTrack® exerciser works all the major muscle groups, burning more fat and providing a better cardiovascular workout than exercise bikes, treadmills and stairsteppers. It's gentle on your knees, hips and back, and it's easy to use. Over a million people already know that exercise just doesn't get any better than NordicTrack.

At these prices you can own a NordicTrack!

NordicTrack Excel™only \$499⁹⁵!
 NordicTrack Sequoia™only \$429⁹⁵!
 NordicTrack Challenger™only \$339⁹⁵!
Other models priced from \$599⁹⁵

NordicTrack
 A CML Company

FREE Video and Brochure

Call **1-800-328-5888** Ext. 245H3
 or write: NordicTrack, Dept. 245H3
 104 Peavey Road, Chaska, MN 55318-2355

©1995 NordicTrack, Inc., A CML Company • All rights reserved.

**OWN A PIECE OF
 AMERICAN HISTORY**



**ORIGINAL MINT CONDITION
 SAINT-GAUDENS DOUBLE EAGLE \$699.**

The Saint-Gaudens Double Eagle is an outstanding tangible asset investment. Now you can own one of these investment-grade, mint-condition coins for \$699.

BUY WITH CONFIDENCE

Blanchard and Company is the nation's largest retailer of classic American coins. The only rare coins we sell are independently graded and certified by the Professional Coin Grading Service and Numismatic Guaranty Corporation. We will meet or beat any competitor's currently advertised prices, subject only to the availability of the coins and verification of the competitor's offer.

TO ORDER: 1-800-880-4653, ext. 728 TOLL FREE.

BLANCHARD

AMERICAN BARE.COM • PROOF OF PURCHASE FROM
 110 Veterans Blvd. • P.O. Box 61740 • New Orleans, LA 70111

An Academic Alternative

Kindergarten through Grade 8

You can bring a classic, comprehensive home instruction program to your child. Your home is your classroom; you are the teacher. Developed by certified teachers at our outstanding independent school, Calvert courses provide detailed, step-by-step instruction so that teaching experience is not required.



All materials are included and you may begin at any time. Coursework readily accepted by other schools; transcripts provided. Assistance from our certified Advisory Teachers is optional. Join over 350,000 student users since 1906. Fully accredited. Nonprofit. Write, call, or fax for free information.

Calvert School

Dept. N93A, 105 Tuscany Road
 Baltimore, Maryland 21210
 (410)243-6030 fax (410)366-0674

Established 1897

The pride
and joy of the
Blackfoot tribe...

BRAVE AND FREE

by *Perillo*

A porcelain collector doll designed by
one of America's foremost Western artists.

Gregory Perillo's spectacular paintings of Native Americans grace the walls of many prestigious museums and private homes. One of his most famous paintings is "Brave and Free," which portrays a proud youth of the Blackfoot tribe. Now, Perillo brings this young Blackfoot to life in a captivating new collector doll—*Brave and Free*.

Superbly sculpted... enchantingly lifelike.

Expertly sculpted, *Brave and Free* is remarkably lifelike. Just look at the expressive face...and those big brown eyes framed by tiny, hand-applied eyelashes. The doll's head, arms and legs are crafted of fine porcelain and the facial features are painted by hand. As your assurance of authenticity, Perillo's signature will appear on the back of your doll.

Brave and Free's hand-tailored outfit is fashioned of faux buckskin. Decorative symbols accent the doll's shirt, collar and headband...and a striking "Thunderbird" motif made of hand-sewn beads promises good fortune.

Attractively priced.

Created by Art affects, Ltd. for the Danbury Mint, *Brave and Free* is priced at \$111, payable in four monthly installments of \$27.75. To order, simply return the Reservation Application today.

Doll shown smaller than actual
seated height of approximately 10"

© 1993 Mint
© 1993 Art affects Ltd.

The Danbury Mint • 47 Richards Avenue • Norwalk, CT 06857

The Danbury Mint
47 Richards Avenue
Norwalk, CT 06857

Please return
promptly.

RESERVATION APPLICATION

Name _____
(Please print clearly.)

Address _____

City _____ State _____ Zip _____

Check here if you want each installment charged to your:
 VISA MasterCard Discover Am. Ex.

Credit Card Number _____ Expiration Date _____

Signature _____
(Orders subject to acceptance.)

Name to print on Certificate of Ownership (if different from above.)
Allow 4 to 8 weeks after initial payment for shipment.

Please accept my reservation for *Brave and Free* by Gregory Perillo, as described in this announcement. The doll comes with a serially-numbered Certificate of Ownership. I will pay for my doll in four monthly installments of \$27.75*, the first billed before shipment.

If not satisfied, I may return the doll within 30 days of receipt for a replacement or refund.

*Tax and applicable sales tax and 2% shipping and handling fee included.

BRAVE AND FREE

by *Perillo*

875ENG1

A Nation of Readers...

Want to read more?

Talk less.

Keep a book
in your briefcase,
by your bed.

Get up
15 minutes early.
Read a new poem
aloud each night
before dinner.

Can't sleep?
Don't count sheep.

Read.
Turn off the tube.
Tune into books.

Expand your
horizons.
Read for fun.
Read for
information.
Use your library.

A Nation of Libraries.

American Library Association

Forum

Hurricane Andrew Aftermath

I am a 17-year-old from Miami who witnessed the horror of August 1992, described in the article "Andrew Aftermath" (April 1993). Like many other people, I lost a great deal of my home. There were a lot of broken windows, a lot of broken boards, but, most of all, a lot of broken hearts. Your article was greatly appreciated.

ANDRÉS VIDAL
Miami, Florida

You devoted too little space in the article to the Louisiana area affected by this hurricane. Come down and I will show you many downed pecan trees, trailers cut in half by trees, and a lot of physical and mental suffering.

VINCENT J. PIZZOLATO
Plaquemine, Louisiana

My husband and I just returned on March 9 from a trip to the Homestead, Florida, area. It is still in shambles, and in my opinion not enough has been done to help the homeless. Garbage, debris, and appliances are piled as high as houses and as long as city blocks. People are living in places not fit for a dog. I think that until Homestead is cleaned up, the military should go back in and do everything possible to get these people's lives back to some level of normalcy.

DANA MATZ
Hampton Bays, New York

During my brief assignment to Miami with the Air Force, I was touched by the compassion of those assisting with recovery and the undaunted spirit of those who had lost their homes. While flying over the devastated area, I noticed several signs painted on what remained of roofs with messages for the relief workers. One read, "Thanks Troops & Volunteers." Another was more succinct: "God Bless You All." I was never prouder to be in uniform.

CAPT. JOHN BOYLE, USAF
Huber Heights, Ohio

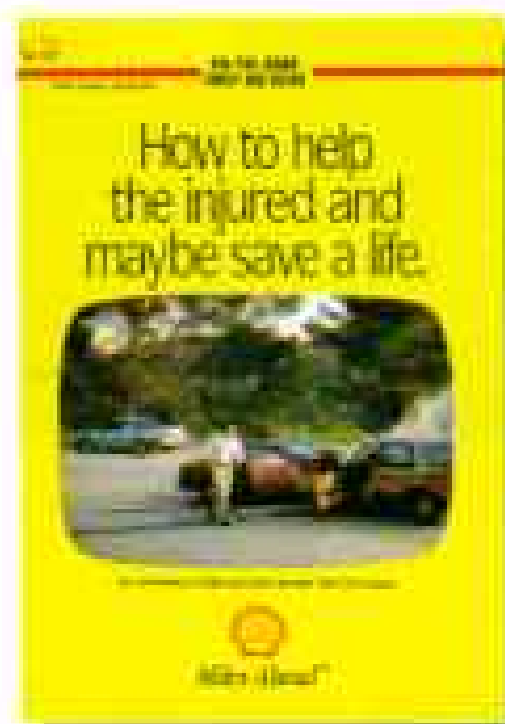
Construction techniques employed in low-income houses built by Habitat for Humanity permitted a group of 15 built in 1991 to survive with barely a scratch. If volunteer labor can build houses that can withstand the forces of Hurricane Andrew, cannot trained labor do the same?

MARSHALL TAYLOR
Mebane, North Carolina

Don't be a crash dummy.

Helping the injured at the scene of an accident requires more than good intentions. You better have a good understanding of some basic first-aid principles. Make sure that medical help has been called for. And remember your ABCs—Airway, Breathing, Circulation—to help

you check for life-threatening conditions. For more on how you can help, read the On-the-Road First Aid Book, free at your nearest Shell service station. Or just call 1-800-23-SHELL for this and other free Answer Books. You'll learn some lessons you should never forget. 🍷



The article did not mention the aid that came from Nova Scotia. A ship left the port of Halifax in September for southern Florida carrying supplies and materials for the rebuilding of schools. Those on board also helped in construction work. This was a return favor that dates back to the Halifax explosion of 1917, when the people of Boston helped rebuild the north end of Halifax. One good turn deserves another, whether it's neighbors or nations.

RON PRINGLE
West Bay, Nova Scotia

The worst natural disaster to hit this country was an unnamed hurricane on September 8, 1900, which struck Galveston, Texas, killing more than 6,000 people. To compare Andrew to this storm places more value on property than on human life. Property damage in Andrew was due in large part to negligent construction techniques. Every grand jury in counties hit by Andrew is finding evidence of this.

FLETCHER W. HARRIS, JR.
Galveston, Texas

There was no mention of the Federal Emergency Management Agency (FEMA). It received some criticism at the time, almost always based on ignorance of FEMA's statutory authority and operational capabilities. FEMA staff from all over the country volunteered to assist Florida and Louisiana residents in applying for federal disaster

assistance. The efforts of these dedicated civil servants should be noted.

DAVID L. SCHEIN
Mount Prospect, Illinois

Cover

Your April cover certainly showed the best of America. Marine David Ketcham with his determined chin and a heart full of care should be a lesson to us all.

KARL YUNGE
Mableton, Georgia

Cairo

The article on Cairo by Peter Theroux brought back the fondest memories of my stay in 1983-84. I was sent there by my company, and at least twice a month I would walk from Khan el-Kalili—where I went bargain hunting—to Ramses Square, the Egyptian Museum, and the Nile Hilton, a five-to-six-hour excursion at my leisurely pace. After a couple of trips merchants recognized me and invited me in for coffee, tea, or the ever present Pepsi. The picture of the beggar being whipped (pages 54-5) reminded me of a similar scene. My friend and I took the stick away from a manager and chased him away only to be berated by the beggar, who indicated he would receive a worse beating when the man returned.

BILL WORDEN
Fort Worth, Texas

© 1993 Eveready Battery Company, Inc.



(Mercury

You get the same long-lasting performance only now with no added mercury (apart from trace elements

The accent on the bad side of Cairo seemed somehow unfair. The life of the average Cairene was not displayed at all, not to mention the pomp and luxury of the old bourgeoisie.

NOUR EL DIN EL KHOLI
Alexandria, Egypt

With both insight and sensitivity you brought to light aspects of the city often forgotten. Your article has inspired our tour agency to consider including more of the authentic side of Cairo as well as the plentiful historical and tourist sites.

RASHA RAMZY
Atlanta, Georgia

Alone Across the Arctic Crown

Keith Nyitray has captured my imagination with his compelling account of his trek through the harsh wilderness. To face hardship for the sole purpose of fulfilling a dream gives the rest of us the hope, courage, and persistence we need to fulfill our own dreams, despite life's many setbacks.

LOUISE HOELSCHER
Varenes, Quebec

After reading Nyitray's article, I have only one question—why?

ROBERT B. CARTER
Towson, Maryland

As I am anticipating my own trip to Alaska's Brooks Range, I thoroughly enjoyed this preview. Parts of the tale began to ring hollow, however, in

Nyitray's attacks on the very things in "civilization" that made his journey possible. For example, he took a ride on a gasoline-powered motorboat but was offended by fumes from the trans-Alaska pipeline. The luxury of his journey was possible only because of the development he disdains.

JENNIFER L. ASKEY
Boulder, Colorado

Deadly Ambush in the Serengeti

An article on the giant crocodiles themselves would have been better, with more information on the animals and less focus on their eating habits.

LOIS E. GRACE
San Jose, California

One picture would have been enough. There are so many aesthetic things to show besides an unfortunate beast being devoured alive.

ELEANOR MCBRIDE
Anza, California

All of the photographs were very graphic, but two stood head and shoulders above the rest. Pages 98-9 and 102-103 show how brutally effective nature is when left to its own devices. They support the truism that some organisms die so that other organisms may live.

GIL DOERING
Mountain View, California



not included.)

that naturally occur in any battery). They may not save the world, but it's a step in the right direction.

Ask one of
the 3 million
Americans
who've survived
cancer,
if the money
spent on research
is worth it.

We are
winning.



This space contributed as a public service.

Mauritius

As a Mauritian living in France, I compliment the team who contributed to the excellent report. We Mauritians must acknowledge our debt to Britain for helping us create this prosperous island, often called the key to the Indian Ocean. Had Britain not taken over from the French sugar barons, we would not have achieved our transformation.

DAN CHELLUMBEM

Amboise, France

Mauritius may have developed its way out of poverty, but two questions remain. One: Is this development sustainable? Mauritius imports just about every comestible item. I visited in 1991 and was stunned to learn that this tropical island imports fruit juices from South Africa. Reliance on tourism has left a chain of hotels whose beaches are off-limits to residents. Fresh fish is beyond the reach of many Mauritians because hotels pay higher prices.

Two: What of the environmental damage? Currently endangered are the Mauritius kestrel, the echo parakeet, and the pink pigeon. The Jersey Wildlife Preservation Trust has a rehabilitation program attempting to save these birds, and another organization is pressuring the government to declare the first national park at Bassin Blanc.

LEN MILICH

Office of Arid Lands Studies

University of Arizona

Tucson, Arizona

My great-uncle, Brother Cassian Francis Darnody, spent years teaching in Curepipe at a college once run by the Irish Christian Brothers. His letters to my father were filled with vivid images of this island and its people. No mention was made in the article of the educational institutions founded by his and other missionary orders, which helped lay the groundwork for this prosperous society.

GEORGE C. KINGSTON

East Longmeadow, Massachusetts

I must correct the statement that "of all the African countries to gain independence in the 1960s, Mauritius is the only nation with an uninterrupted history of democracy." Botswana, independent in 1966, is a model of stability—a real democracy—as your coverage in December 1990 demonstrated.

W. LEE

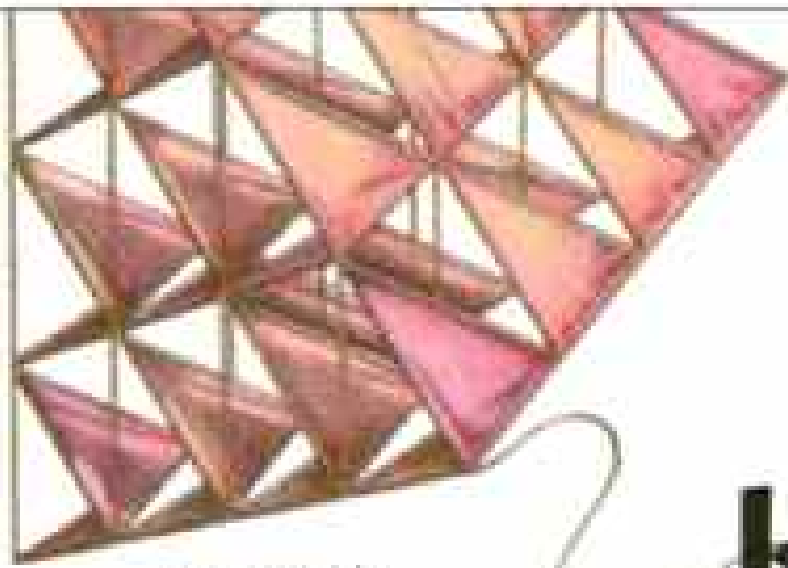
Gaborone, Botswana

To achieve zero-population growth despite so many ethnic groups is quite significant. Mauritius sets the pattern for the rest of the world to follow.

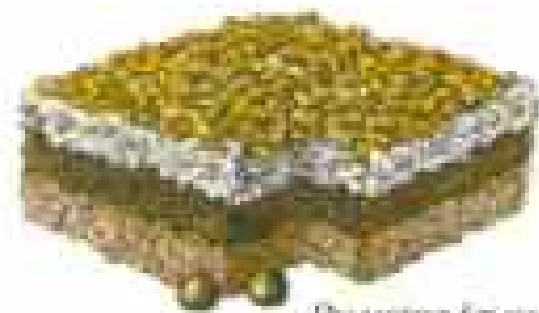
BEN HANSEN

Towson, Maryland

Letters should be addressed to *FORUM*, National Geographic Magazine, Box 37448, Washington, D. C. 20013, and should include sender's address and telephone number. Not all letters can be used. Those that are will often be edited and excerpted.



Nancy Ebsky uses kites to teach her students important math skills.



By using layer cookies and nuts, Mrs. Williams' students learn how sedimentary rocks form in strata.

KITES,

These six enterprising teachers, from kindergarten through high school, have found a better way to help further the cause of quality education.

SNAILS

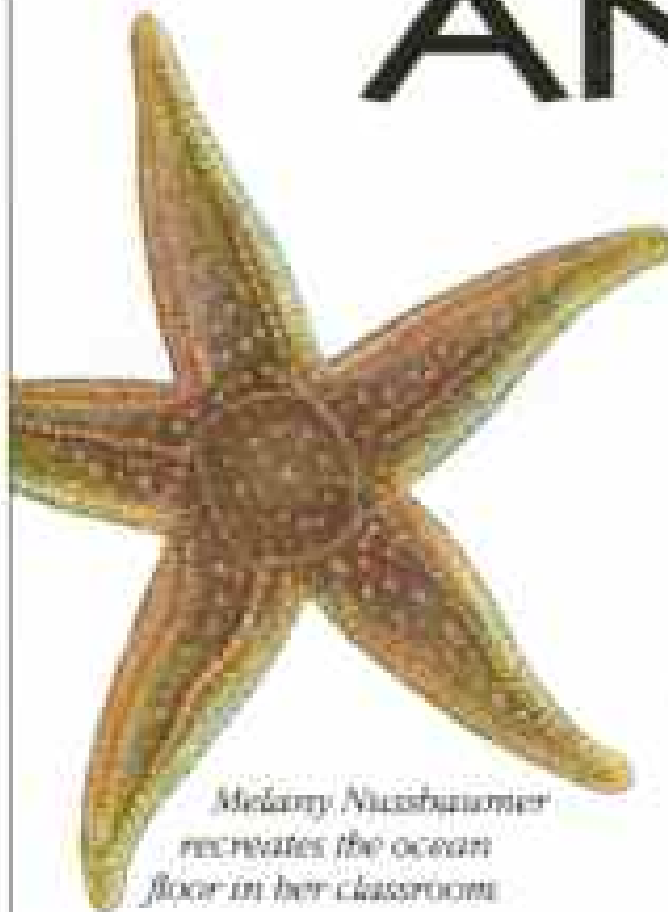
Through a series of national ads, State Farm has been honoring their creativity and originality.



In Ms. O'Brien's class, students learn the importance of nature through the study of snails.

AND BOATS

State Farm makes a donation of \$5,000 in each teacher's name to the educational institution of their choice.



Melany Nussbaumner recreates the ocean floor in her classroom.

THAT

These teachers, because of their innovative thinking, are our most recent honorees of math and science.

SAIL...



Theresa Johnson's students build a two-masted schooner as part of their science class.

STATE FARM PRESENTS THE WINNERS OF THE GOOD NEIGHBOR AWARD.



Mrs. O'Leary teaches her students to rely on their sense of touch to identify objects like cotton, cardboard and rocks.



Good Neighbor Award

State Farm Insurance Companies
Home Offices: Bloomington, Illinois

We have seen
the future and are
prepared to meet it,
side on.

The 1993 Buick Roadmaster Sedan meets the 1997 federal side-impact standard — four years in advance.

By 1997, all automobiles will be required to meet a new federal safety standard for side-impact collisions. But you don't have to wait four years to have the assurance of a safer automobile. You can have it now.

Safety

The 1993 Buick Roadmaster Sedan meets the 1997 federal

safety standard today, four years in advance. With a standard driver air bag, anti-lock brakes and a full-perimeter frame, the Roadmaster Sedan is a very safe car to drive.

Luxury

Safety isn't the only impressive feature on this luxury automobile. With its patented DynaRide® suspension system, the Roadmaster Sedan can handle

the road with comfort, style and elegance.

Commitment

Buick is committed to producing a safer luxury automobile. So to see what the future has to offer, take a test drive at your local Buick dealer today.



Freeze frame of actual side-impact safety test

Or call 1-800-4A-Buick for more details and information. The future is only a test drive away.



BUICK®

The New Symbol For Quality
In America



1993 Roadmaster Limited Sedan

NATIONAL GEOGRAPHIC MAGAZINE

GILBERT M. GROSVENOR, *President and Chairman*

WILLIAM GRAVES, *Editor*

Associate Editors

WILLIAM L. ALLEN, ELIZABETH A. MOIZE, ROBERT M. POOLE

SENIOR ASSISTANT EDITORS

ROBERT BOOTH, *Production* • ALLEN CARROLL, *Art* • RICK GORE, *Science*

DAVID JEFFREY, *Legends* • THOMAS R. KENNEDY, *Photography* • ROBERT W. MADDEN, *Imaging*
O. LOUIS MAZZATENTA, *Control Center* • CONSTANCE H. PHILLIS, *Layout and Design*

JOHN J. PUTMAN, *Manuscripts* • LEXLEY B. ROGERS, *Research* • W. ALLAN ROYCE, *Illustrations*
JOHN F. SAUER, *Cartography* • MAAY G. SMITH, *Research Grant Projects* • GEORGE E. STUART, *Archaeology*

EDITORIAL

ASSISTANT EDITORS: Don Beh, Judith Brown, Mike Edwards, William S. Ellis, Alice J. Hall, Jane Vassels, Peter T. White, Eric Zwingler. **SENIOR WRITERS:** Thomas J. Abernethy, John L. Ellis, Noel Grove, Bryan Hodgson, Michael E. Long, Joel L. Szwedlow, Fritz J. Venzel. **SENIOR EDITORIAL STAFF:** Charles E. Cobb, Jr., Larry Kohl, Peter Miller, Cathy Newman, Thomas O'Neill, Jennifer Reek, Cliff Tapp, Meg Nottingham Walsh, Boris Wernstahl. **PRODUCTION:** John L. McClain. **EDITORIAL STAFF:** Sandra D'Alto, Cassandra Franklin-Barhajova, Alan Mairson, William R. Newton, Oliver Payne, Peter L. Pirtouas, A. R. Williams. **RESEARCH:** Michaeline A. Sweeney, *Assoc. Director, Senior Researcher*; Carolyn H. Anderson, Danielle M. Beauchamp, Kathy B. Maher, Barbara W. McCormick, Jeanne E. Peters, Abigail A. Tyron. **RESEARCHERS:** Judith F. Bell, Clark M. Friedrichs, Stella M. Green, Jan Heiderman, Anne A. Jamison, Michael Kenna, Amy E. Korman, Carrie Raben, Christopher Scapum. **LEGENDS:** Victoria C. Duchateau, Margaret G. Zickow. **Planning Council:** Mary McPeak.

ILLUSTRATIONS

PHOTOGRAPHERS: Kent J. Kerberstein, *Assoc. Director*; Susan A. Smith, *Art Director*; Sam Abell, James P. Blair, Victor B. Bowdoin, Jr., Jodi Cobb, Bruce Dale, James Krutof, Joseph D. Laventure, George F. Mobley, James L. Stanfield, Technical: Claude E. Petroni. **ILLUSTRATIONS EDITORS:** William T. Douthett, *Assoc. Director*; Larry Nighswander, *Asst. Director*; David L. Arnold, Dennis R. Dumick, John A. Eshers, Bruce A. McElfresh, Robert S. Patton, Elie S. Rogers, Jon Schmechger, Susan Walthman, Kathy Moran. **LAYOUT AND DESIGN:** David Griffin, *Art Director*; William H. Marr, *Typography*; Betty Clayton-DeAdey; Douglas M. McKenney. **ART:** Mark R. Holmes, *Asst. Director*; William H. Bond, Christopher A. Klein, *Artist*; Karen E. Gibbs, Hilal J. Hoffmann, David W. Woodruff. **RESEARCH DESIGNERS AND DRAWERS:** William W. Smith, *Director*; Janet C. Evans, *Art Director*; Judy L. Gurley.

CARTOGRAPHY

Senior Assoc. Director: John F. Davis. **Assoc. Directors:** Marguerite B. Hummel, Leo B. Zeharth. **Asst. Dir.:** Harold A. Hanson, Harry D. Kaufman. **Geographer:** Alice T. M. Hutchin. **Map Editors:** Juan J. Váñez, *Supvr.*; Charles W. Genthart, Jr., Thomas L. Gray, Elzika K. Horvath, Jonathan E. Kaut, Gus Platts, Eric Sabban. **Designers:** Charles W. Berry, John A. Bonner, Robert E. Pratt, Nancy Schwenckart, Sally S. Summerall. **Researchers:** Dierdra T. Bevington-Aitark, Arthur J. Cox, Ross M. Emerson, Barbara F. Holland, Linda R. Kolar, Gauthier O. Kyber, David B. Miller, Joe A. Sayre, Andrew J. Wühl, Susan Young. **Production:** Thomas A. Wall, *Supvr.*; Iskandar Batias, Ellen J. Landsman, James E. McCulland, Jr., Stephen P. Wells, Alfred L. Zeharth. **Computer Services:** Richard W. Balfington, Charles F. Cape, Martin J. Golden. **Specialist:** Kevin P. Allen, Edward J. Holland, Charles L. Miller, Richard K. Rogers, Ronald E. Williamson.

EDITORIAL SERVICES

ADMINISTRATION: Britina M. Swain, *Asst. to the Editor*; Elaine Rice Ames, Barbara D. Case, Maria-Teresa Cortales, Sandra M. Dane, Lilian Davidson, Maria Demejko, Carol L. Dumont, Neva L. Folk, Eleanor W. Hahn, Ellen E. Kuhlberg, Katherine P. McGowan, Kathy Strader, Charlene S. Valeri. **Proof:** Ann C. Judge. **REPRODUCTION LIBRARY:** Sean Filer Conby, *Director*; Ellen D. Briasse, Arlene T. Dreyes, Carolyn Locke, Marta Strada. **ILLUSTRATIONS:** Maura A. Mulvihill, *Director*; Eudora L. Babayak, L. Fern Dome, Carolyn J. Harrison, William D. Perry, *Picture Requests*. **Records:** Mary Anne McMillen, *Director*; Ann E. Hults, Mennen M. Smith. **Correspondence:** Joseph M. Blanton, Jr., *Director*; John A. Rutter, Les Smith. **Indexer:** Irene M. Blasen, Anne K. McCann. **Translations:** Kathryn A. Bano. **COMMUNICATIONS:** Steve Raymer, *Director, News Service*; Joy Aachenbach, Metzer Cross, Donald J. Frederick, Donald Smith, Robert C. Radcliffe. **Radio:** Dale A. Petroskey, *Vice President, Public Affairs*; Mary Jeanne Jacobsen, Barbara S. Moffet, Susan S. Norman. **ADMINISTRATOR:** Joanne M. Hess, *Asst. Vice President and Director*; Jon H. Larimore, *Tech. Dir.*; Ronald S. Altman, Scott A. Braider, Robert G. Fliegel, Paul Gorski, P. Andrew van Duyn.

ADMINISTRATION

Asst. Vice Presidents: Joyce W. Graves, *Asst. to the President*; Carolyn F. Orwell, Joseph S. Fowler, Douglas E. Hill, Robert E. Howell, Thomas E. Kubiński, Carol E. Lang, Jimmie D. Priddy, Peter F. Woods. **Asst. Executives:** Richard T. Moseland, Dorothy M. Wagner. **Asst. to the President:** Richard E. Pearson, *Diplomatic and Civic Affairs*; Karen L. Hershberger, Karen S. Marsh. **Accounting:** Michael J. Cris, Larry E. Dorely, Laura L. Light, Stephen R. Vick, Janet C. Yates. **ADMINISTRATOR:** M. Jean Vile, *Business Manager*; David C. Beveridge, Mary L. Blanton, Robert V. Koenig, Myra A. McLaughlin, Jennifer Moseley, Myla Stewart, Frank M. Twigger, R. Miles White. **ADMINISTRATIVE SERVICES:** James P. McCray, *Vice President*; Richard A. Mechtler, *Asst. Vice President*; Scott Bolden, Warren Burger, William L. Cheung, Curtis L. Curwey, Jr., Fred R. Hart, George F. Hults. **EDUCATIONAL SERVICES:** Robert L. Graham, Christopher D. Mignano, Wendy G. Rogers. **EMPLOYEE HALL:** Nancy W. Beers, Richard McWalters. **GEOGRAPHY EDUCATION DIVISION:** Robert E. Dull, *Asst. Vice President and Director*; Mary Lee Eiden, J. Joe Ferguson. **HUMAN RESOURCES:** Shirley N. Wilson. **MESSAGING SERVICES:** Carol A. Hinck, Kathleen V. Howard. **PRODUCTION:** Joan M. Anderson, Virginia A. Bachant, James V. Bulford, Robert L. Feigs, Charles F. Herrmann III, Deborah A. Jones, Charley T. Kneeland. **PURCHASING:** Thomas L. Fischer. **FOREIGN EDITORS:** Robert W. Hernandez, *Director*.

PRODUCTION SERVICES

QUALITY: Frank S. Oliverio, *Asst. Vice President*; Bill M. Aldridge. **PRE-PRESS:** Geoffrey T. McConnell, Martin O. Anderson, Billy R. Barnett, David H. Chisman, Phillip E. Plude, Bernard G. Quarrick, John R. Reap. **PHOTOGRAPHIC LAB:** William S. Perrini, Alfred M. Yin. **PRINTING:** Hans H. Wegner, Joseph M. Anderson, Sherrie S. Harrison. **ADMINISTRATION:** Joan S. Simms, Judith S. Shier.

ADVERTISING

Joan McCraw, *Vice President and Director*; Peggy Dutch, *Detroit Manager*; J. Scott Crystal, *Western Manager*; Philip G. Reynolds, *Special Accounts Manager*; Laurie L. Kutsche, *Chicago Manager*; Michel A. Boutin, *International Director*; W. Champ Elyades, 75000 Paris, Washington; Margaret S. Boston, *Promotion*; Sarah L. Moffat, *Operations*; Renee S. Clepper, *Research*; Carl M. Jackson, *Production*.

TELEVISION

Timothy T. Kelly, *Senior Vice President*; Todd Berman, *Marketing/Distribution*; Susan Borka, *Business Affairs*; Tim Simon, *Executive Producer*; Lowell Saffler, *Finance*; Patricia Gang, *Film Library*; Kathleen F. Tress, *Publicity*; Yorgos N. Lampathakis, Marjorie M. Moseley, Nola L. Shrewsbury. **EDUCATIONAL FILMS:** Sidney Platt, *Director*; Donald M. Cooper, *Asst. Dir.*; Suzanne K. Poole, Carl E. Zick.

EDUCATIONAL SERVICES OF THE SOCIETY

BOOK DIVISION: William R. Gray, *Vice President and Director*; Margery Dunn, Charles Krigel, *Asst. Directors*; Leah Bendavid-Nal, Jim Fisher. **SENIOR EDITORS:** MARGARET DIVISION: David P. Johnson, *Director*; FRANK: Richard Bush, *Editor*; Paul Martin, *Managing Editor*; World: Pat Robbins, *Editor*; S. Mondschein Trijda, *Managing Editor*. **EDUCATIONAL MEDIA:** George A. Peterson, *Vice President and Director*; Raymond F. Cooper, *Asst. Vice President and Assoc. Director*; James B. Caffery, *Senior Assoc. Director*; David Beaman, *Assoc. Director*. **MANUFACTURING:** George V. White, *Director*; John T. Dunn, *Asst. Director*. **ADMINISTRATION:** Suzanne R. McDonnell, *Asst. Vice President*; Carolyn W. Jones.

COPYRIGHT © 1992 National Geographic Society. All rights reserved. NATIONAL GEOGRAPHIC and Yellow Border Registered Trademarks © Marcus Registrado.

NATIONAL GEOGRAPHIC ASSUMES NO RESPONSIBILITY FOR UNQUOTE MATERIALS.



NATIONAL GEOGRAPHIC SOCIETY
"For the increase and diffusion
of geographic knowledge."

THE NATIONAL GEOGRAPHIC SOCIETY is chartered in Washington, D. C., as a nonprofit scientific and educational organization. Since 1890 the Society has supported more than 5,000 explorations and research projects, adding to knowledge of earth, sea, and sky.

GILBERT M. GROSVENOR, *President*

Senior Vice Presidents

MICHELA A. ENGLISH

ROBERT B. SIMS

Vice Presidents

SUZANNE DUPRÉ, *Corporate Counsel*

H. GREGORY PLATTS, *Treasurer*

PAUL B. TYLOR, *Secretary*

H. LANCE BARCLAY, FREDERICK C. GALE

DONNA L. HASSLINGER, JAMES P. KELLY,

JONATHAN W. LANDERS, GEORGE E. NEWSTEDT

BOARD OF TRUSTEES

GILBERT M. GROSVENOR, *Chairman*

OWEN R. ANDERSON, *Vice Chairman*

LLOYD H. ELLIOTT, *Vice Chairman*

JOE L. ALLBRITTON

Chairman, Riggs National Bank

THOMAS E. BOLGER

Chairman, Executive Committee, Bell Atlantic

FRANK BORMAN

Chairman and C.E.O., Paces Corporation

LEWIS M. BRANSCOMB

Kennedy School of Government, Harvard University

J. CARTER BROWN

Director Emeritus, National Gallery of Art

MARTHA E. CHURCH

President, Hood College

MICHAEL COLLINS

President, Michael Collins Associates

GEORGE M. ELSEY

President Emeritus, American Red Cross

MICHELA A. ENGLISH

WILLIAM GRAVES

A. LEON HIGGINBOTHAM, JR., *Former Chief*

Judge for the Third Circuit, U. S. Court of Appeals

JOHN JAY ISELIN

President, The Cooper Union

TIMOTHY T. KELLY

J. WILLARD MARRIOTT, JR.

Chairman and President, Marriott Corporation

FLORETTA DUKES MCKENZIE

Former Superintendent of Schools, District of Columbia

PATRICK F. NOONAN

President, The Conservation Fund

NATHANIEL P. REED

Businessman-Environmentalist

ROZANNE L. RIDGWAY

Co-Chair, Atlantic Council of the United States

B. FRANCIS SAUL II

Chairman and C.E.O., B. F. Saul Company

ROBERT C. SEAMANS, JR.

Department of Aeronautics and Astronautics, MIT

TRUSTEES EMERITUS

ROBERT L. BREIDEN, WARREN E. BURGER,

CRAWFORD H. GREENEWALT, CARYL P. HASKINS,

MRS. LYNDON B. JOHNSON, WM. MCHESENEY

MARTIN, JR., LAURANCE S. ROCKEFELLER,

FREDERICK G. VOSBURGH, CONRAD L. WIRTH

RESEARCH AND EXPLORATION COMMITTEE

BARRY C. BURRIS, *Vice President and Chairman*

FRANCIS C. WARDMORE, JR., *Vice Chairman*; ANTHONY R. DE SOZZA,

Editor, Research & Exploration; STEVEN S. SIEGEL, *Secretary*;

H. J. DE BLAS, *University of Miami*; WILLIAM GRAVES; GILBERT M.

GROSVENOR; BERRY J. MESSERS, *Smithsonian Institution*; DAVID

PIKARETTA, *Cornell University*; PETER H. RAVEN, *Missouri*

Botanical Garden; ROBERT C. SEAMANS, JR.; EDWIN W. SMITH,

CHARLES H. SOUTHWICK, *University of Colorado*; JOHN H.

STOCK; Woods Hole Oceanographic Institution; GEORGE E.

STUART; GEORGE E. WATSON; ROBERT S. WILLIAMS, JR., *U. S.*

Geological Survey; HENRY T. WILSON, *University of Michigan*

EDUCATION FOUNDATION

TERRY SMITH, *Executive Director*; BETTY ELLISON

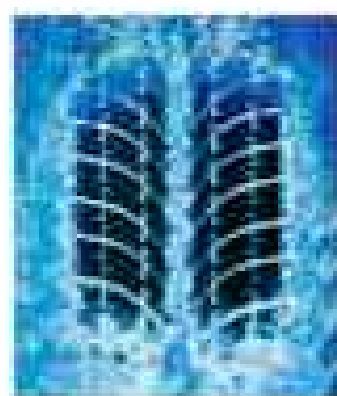
INSTANT TRACTION. JUST ADD WATER.



This is hydroplaning:

This is "Aquatreding."

THE ALL-SEASON GOODYEAR AQUATRED.[®] YOU GET TRACTION. WET OR DRY.



Aquatred's deep-groove AquaChannel[™] in action.

Hydroplaning is great for skiing. But not for driving. The Goodyear Aquatred, with its deep-groove AquaChannel[™] moves water away. This keeps more tread in contact with the road for superb wet traction. Its design is so successful, it can be found in Goodyear's newest Formula One racing rain tire. Try a set of Aquatreds. And put traction into action. **AQUATRED. ONLY FROM GOODYEAR.** *#1 in Tires*

For your nearest retailer call 1-800-GOODYEAR.



Aquatred's 60,000-mile limited treadlife warranty. Ask your retailer for details.

THE BEST TIRES IN THE WORLD HAVE GOODYEAR WRITTEN ALL OVER THEM.



Experience Goodyear traction for your high-performance, passenger and multi-purpose vehicles. Remember, traction varies with road conditions, speed and vehicles.

EAGLE GS-C.[®]

Dual tread zone for high-performance traction.

AQUATRED.[®]

Deep-groove design for outstanding wet traction.

WRANGLER GS-A.[®]

"Triple Traction" tread for all-surface traction.

GOODYEAR

PREVIA



WHEN IT COMES TO SAFETY, WE DIDN'T OVERLOOK THE SMALL DETAILS.

The biggest concern parents can have is creating a safe environment for their children. Which is why we equipped the Previa with safety features like a roof that meets federal strength standards for cars, available anti-lock brakes and a child-protector side door lock. There's a standard driver-side air bag, too. Because when it comes to your family's safety, no detail is too small.

"I love what you do for me."

 **TOYOTA**

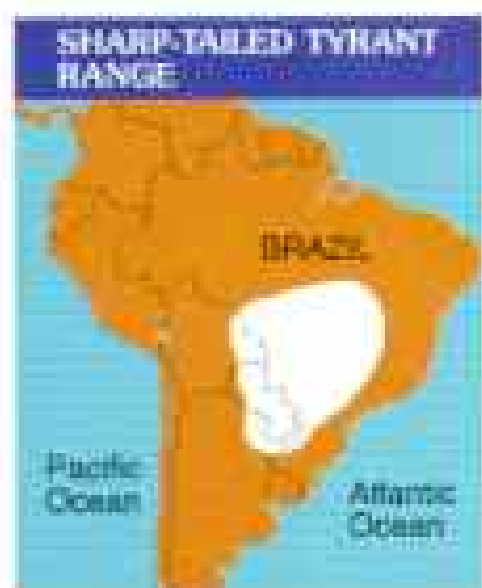


THE ONLY VAN TO MEET ALL PASSENGER CAR FEDERAL MOTOR VEHICLE SAFETY STANDARDS* WITH AN AIR BAG.

*Except models with optional privacy glass due to window tinting. Call 1-800-GO-TOYOTA for a Previa brochure and location of your nearest dealer. Buckle Up! Do it for those who love you. ©1992 Toyota Motor Sales, U.S.A., Inc.



WILDLIFE AS CANON SEES IT



Sharp-tailed Tyrant

Genus: *Culicivora*

Species: *caudacuta*

Adult size: Length (including tail), 10 cm

Adult weight: Estimated at 9 g

Habitat: Grasslands in Brazil, Paraguay, Bolivia and Argentina

Surviving number: Unknown

Photographed by Lutz Claudio Marigo

A sharp-tailed tyrant blends with the shades of parched grassland as it waits for an insect to stir in the hot dry air of summer. Sharp-tailed tyrants usually fly together in small groups, gleaning a life exclusively from the *campos*. A member of the flycatcher family, which includes over 300 species throughout the Americas, this tiny bird is threatened by continuing habitat loss. To save endangered species, it is essential to protect their habitats and understand the vital role of each species within the earth's ecosystems.

Photography, both as a scientific research tool and as a means of communication, can help promote a greater awareness and understanding of the sharp-tailed tyrant and our entire wildlife heritage.



EOS 1
The New Classic



Watch "NATURE" on PBS, Sunday 8:00 p.m.
This program is funded, in part, by Canon U.S.A., Inc.

Canon

On Television



In the Swim With Riders of the Open Sea

Forces of darkness and motion make life in the seas appear strange and difficult for land dwellers to fathom. Creatures of bioluminescent beauty, such as a stinging jellyfish (above), a sea cucumber (center), and a gelatinous web called a siphonophore, have adapted to a life of constant drifting. They are swept along by ocean currents that swirl around the least understood realm of life on the planet.

A new film, "Ocean Drifters," produced by Rodger Jackman, looks at sea life thriving at the edges of the Gulf Stream, a powerful current that flows northeast from Florida along the Atlantic coast. "Ocean Drifters" goes with that flow, following a

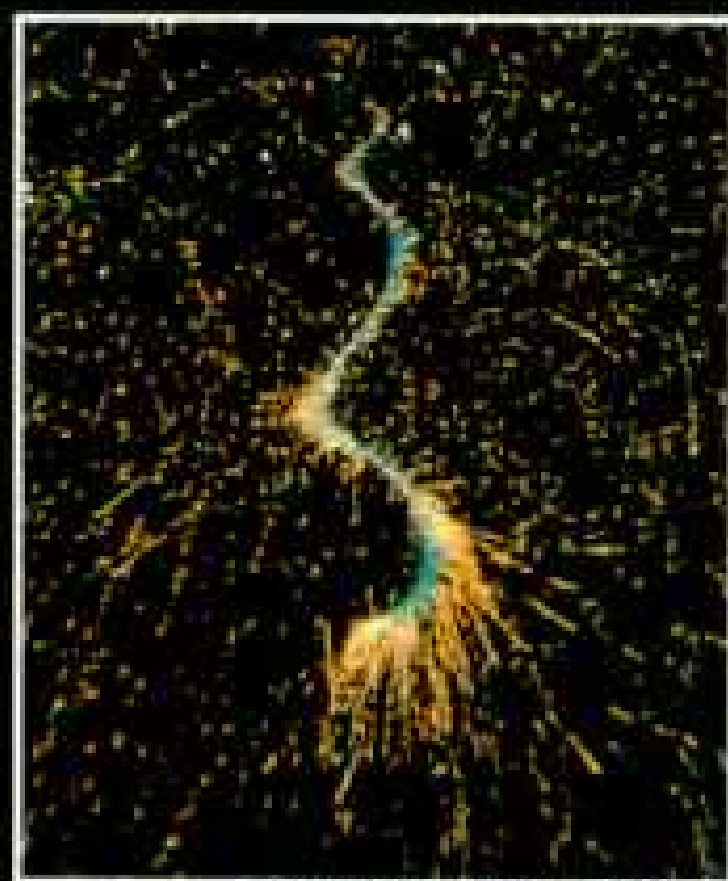


L. P. MADIN,
WOODS HOLE OCEANOGRAPHIC INSTITUTION

hatchling loggerhead turtle as it begins its odyssey in the Gulf Stream and enters the carousel of currents known as the North Atlantic Gyre.

National Geographic EXPLORER launches its 1993-94 season with an evening dedicated to this kingdom of hidden life—and to a new way of discovering its secrets.

Diving off the coast of Belize in 1986, marine biologist Greg Marshall caught a brief glimpse of a remora attached to a shark's belly. "I saw how a specially designed video camcorder



TOM SMOYER (TOP) AND MARSH
YOUNGBLUTH (ABOVE), BOTH HARBOR BRANCH
OCEANOGRAPHIC INSTITUTION

could substitute for the suckerfish, collecting a range of images from the shark's perspective." A film by John Breddar, "Critttercam," tells the story of Marshall's efforts to turn sharks and sea turtles into their own cinematographers. Carrying a streamlined camera, they can compile a visual record of behavior and habitat that no human could match.

"Ocean Drifters" and "Critttercam" air August 22 on EXPLORER, TBS Superstation, 9 p.m. ET.

FeatherWates Light As A Feather



LensCrafters

FeatherWates Bring You Lighter Weight For Greater Comfort

Exclusive FeatherWates offer a higher standard of comfort in eyewear because they are dramatically lighter than ordinary glasses. And LensCrafters, America's leading one-hour eyewear store, has the technology to custom-craft your "light-as-a-feather" glasses in about an hour. Experience the comfort of glasses you will hardly know you're wearing.

Call 1-800-775-LENS
(5367) for your nearest
LensCrafters.

FeatherWates



*Lighter Weight,
Greater Comfort
In About An Hour*

LENSCRAFTERS
Better Fit For Greater Comfort In About An Hour.



FeatherWates offer the greatest impact resistance today. No lenses are unbreakable or shatterproof.

© Copyright, 1999 LensCrafters

Earth Almanac



CHAMELEONS: PARDALIS; ART: WOLFE

Chameleons' Emotional Signals: Color These Mad

To be a chameleon is to blend in. Then why are these panther chameleons from Madagascar lit up like neon toys? The two foot-long males, battling for territory, are showing the colors. The one on the left, still mostly a cooler green, is not yet as aroused as his rival. Panther chameleons are well named, for they can be extremely aggressive.

Equipped with pigment-bearing skin cells called chromatophores, all chameleons can change color for various tactical reasons: to camouflage themselves, to intimidate the competition or look submissive, to initiate sex—or not. Female panther chameleons, normally brownish, turn tawdry orange when ready to mate. After winning a partner, the female changes to black, accented with orange, signaling other males to back off because she has already mated.

Madagascar's chameleons have nothing to fear from local people, whose superstitions prevent them from killing, eating, or even touching the lizards. But demand from the worldwide pet trade is another matter. "Shipments of thousands go to Europe," says Ron

Crombie, a Smithsonian Institution researcher. "A huge percentage of them die in transit—they are such delicate beasts."

Pelicans Suffer Accidents and Abuse in California

The fishing was terrible last summer along southern California's coast, with tragic results for migrating brown pelicans. Desperate for food, the endangered birds became even bolder than usual, haunting harbors, competing with fishermen and tangling in their lines.

South of Los Angeles in Laguna Niguel, about 700 of the pelicans were treated by a wildlife hospital called the Pacific Wildlife Project. Its director, Linda Evans, and her husband, Richard, a veterinarian, remove sutures after surgery to excise a fishhook (right)—the most common problem but by no means the most serious.

"We have received about 50 pelicans that were deliberately killed or mutilated," Linda reports. "Nine birds were strangled, and more than ten others had half of their upper bills cut off with a sharp instrument. All died." Last August one man was convicted in state court of clubbing a pelican to death and sentenced to ten days of community service and a year's probation; federal penalties would have been far more severe. The Evanses are circulating posters seeking tips about such ghastly incidents, information that could bring a \$3,000 reward.



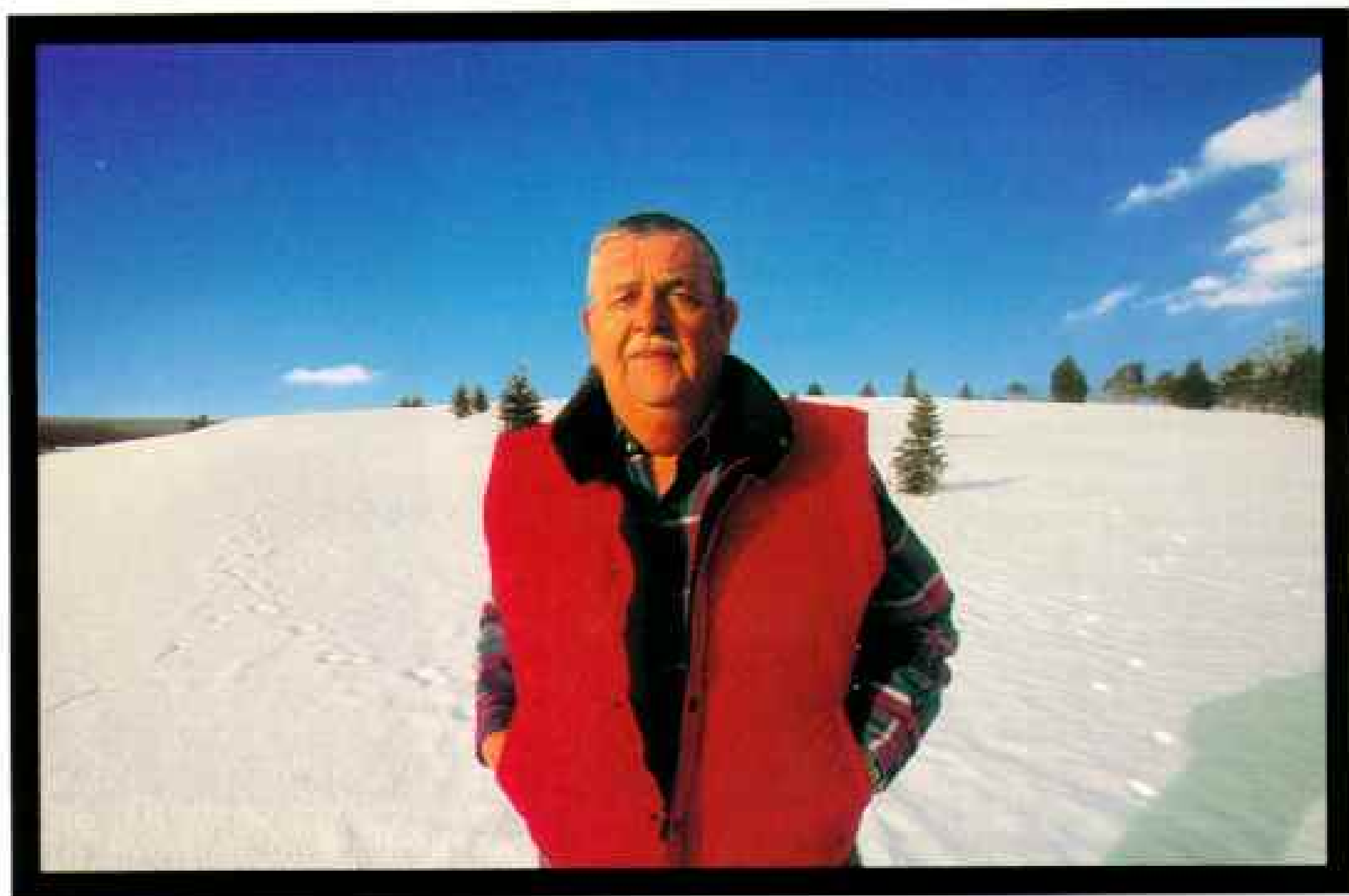
DEBRA LEE

Mayor OSCAR WELSH

won't hesitate to tell you

THAT **NUCLEAR** ENERGY

HELPS KEEP HIS TOWN *clean.*



Oscar Welsh is mayor of a small Pennsylvania town not far from Bald Eagle Mountain. He lives eight miles from a nuclear plant that started generating electricity about 10 years ago.

Mayor Welsh is a man who prefers to arrive at his own conclusions.

"I don't see any reason to be afraid of nuclear energy," he says. "It's a clean, efficient way to generate electricity without polluting the air."

America has more than 100 nuclear plants. Because they don't burn anything to make electricity,

they help protect our environment and preserve our natural resources for future generations. All while providing enough electricity for 65 million homes in the U.S.

No single energy source is the whole answer to America's

energy needs. But, as Oscar Welsh will tell you, nuclear energy is part of the answer.

For more information, write to the U.S. Council for Energy Awareness, P.O. Box 66080, Dept. W, Washington, D.C. 20035. © 1993 USCEA

NUCLEAR ENERGY MEANS CLEANER AIR

Earth Almanac



BARBER/MOORE, KATZ PICTURES

The Future Is Now for a Global-warming Test

How will plants adapt to the greenhouse effect—rising temperatures and carbon dioxide levels, the wages of fossil fuel burning and deforestation? To study the effects of such climate change, British scientists quite sensibly are using greenhouses—eight very sophisticated greenhouses (colored by creative photography) called Solardomes.

Built on the coast of Wales by the Institute of Terrestrial Ecology, the domes create conditions predicted for the late 21st century. Their air contains twice today's carbon dioxide and is 5.4°F warmer than outside air. Growing in the domes, grasses and small oaks and

sycamores are measured by scientists, who also monitor caterpillars and aphids that feed on the vegetation. "Some plants may adapt by growing quicker and bigger. Others may slow down," says project leader Trevor Ashenden.

Contaminated Soil: Can Plants Get the Lead Out?

For 30 years an E. I. du Pont de Nemours & Co. plant in Deepwater, New Jersey, made tetraethyl lead, a gasoline additive that was phased out in the 1980s. High concentrations of lead now contaminate 25 acres. Yet in this wasteland, two weeds—common ragweed and hemp dogbane—not only grow but thrive, even as lead accumulates in their tissues. So

company researchers (left, from left to right) Scott Cunningham, Steve Germani, and Bill Berti have planted more of the weeds to see if these and other plants can draw significant amounts of heavy metals from contaminated soils, a technique called plant remediation.

"All plants store some metals in their roots," says Scott, "but a few have likely gained

an advantage by storing them in their leaves too. That way they may avoid being eaten by bugs or infected by a fungus." If the researchers can increase a weed's lead intake to one percent of its mass, the plants could be cut, dried, and burned to reclaim and recycle the lead.

Tiny Desert Fox Must Be Wily to Survive

Life presents a host of hazards for the cat-size San Joaquin kit fox. Of this endangered subspecies only about 5,000 remain. Their southern California neighbors



LEPUS MACROTIS NUTTALLII, B. "MOORE" PETERSON

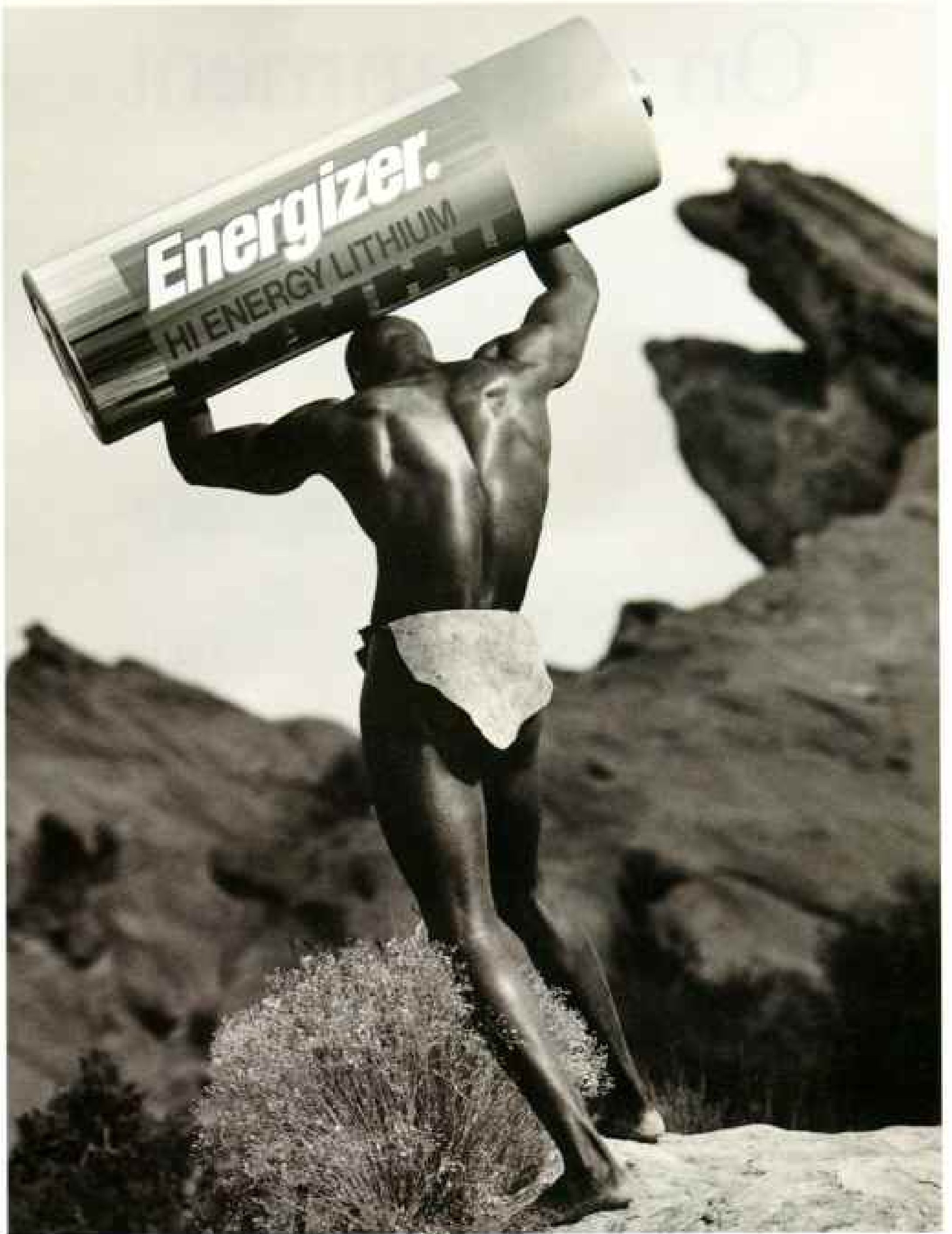
include coyotes and golden eagles, which prey on them. A bullying outsider, the red fox, is invading their territory. Agriculture has gobbled up more than 90 percent of the kit foxes' former range, virtually restricting them to the Carrizo Plain, a 400-square-mile basin of grassland and scrub. And that shrunken habitat can be seared by drought.

But the foxes have friends. The Nature Conservancy has bought a 23,000-acre ranch, expanding the Carrizo Plain Natural Area to 200,000 acres, which the group manages in cooperation with the state and the U. S. Bureau of Land Management.

—JOHN L. ELLIOT



MARTY KATZ



THE WORLD'S LONGEST LASTING AA CAMERA BATTERY

GREGG EGGMAN



New! Energizer® Lithium AA batteries last 3 times as long as alkalines in today's most popular cameras, even in extreme temperatures.

© 1993 Energizer Battery Company, Inc. Claim based on 8-second flash recycle time.

On Assignment



KAY SCHALLER

Early on, naturalist GEORGE B. SCHALLER set his sights on his life's work. As a boy he roamed the countryside, collecting creatures for his own mini-zoo. As a man he has roamed the world, often with his family, to work for wildlife conservation. He has studied gorillas in Zaire, tigers in India, jaguars in Brazil, and pandas in China. "The more rare and remote a species," he says, "the greater the challenge to become the chronicler of its life."

In Tibet's isolated Chang Tang region (above), George and his wife, Kay, endured tent living for months, but says Kay, "We can hardly wait to go back to continue our research."

"No conservation task is ever completed," adds Schaller, who returns to the Chang Tang this fall. His photographs are an invaluable tool in his work. He thinks of them as forging a bond between the viewer and the subject: "Pen and camera are potent weapons against oblivion, helping species to survive—or serving as memorials."

Schaller has described his work in ten books, including National Book Award winner *The Serengeti Lion*, *The Year of the Gorilla*,

Stones of Silence, and most recently *The Last Panda*.

It was too warm for ice skating in Stockholm, and Assistant Editor DON BELT, at center, was about to learn something about Swedes. For six hours he sliced across the melting surface of Lake Mälaren with a group of Swedish skaters. Then the ice roared and split, swallowing Björn Nilsson, at right. Rolf Svallänge, at left, hurried Don and the others to shore while Björn struggled onto firmer ice. He emerged: bloodied, dripping—and completely prepared. Björn peeled off his sopping red coveralls and from his backpack produced a plastic bag containing an identical dry suit. Another bag carried fuel for an impromptu fire that warmed him as he dressed. The last sack held Björn's cellular phone. "You guys plan for everything, don't you?" Don asked.

"Welcome to Sweden," Rolf said.






Don's own immersion—in writing—came at the University of South Carolina, where he studied under poet James Dickey. Keeping a journal while traveling in Central America "sparked my career," Don says. "I realized that going places, and writing about them, was what I wanted to do when I grew up."



HENRIK THÖRNQVIST



After all these years there's only one thing wrong with Mrs. Krane's Maytag: it's still avocado.

 It's not often we report that people have problems with our washers, but Mrs. Kathy Krane of Western Springs, Illinois, is an exception.  In all the time she's had her Maytag washer, she's only had one repair. The fact is, her washer shows no signs of giving out any time soon. And that's just the problem, because it's avocado.  Mrs. Krane didn't choose the color; her washer was a gift. Besides, back in the '70s, avocado was very popular. She always figured in ten, maybe twelve years, she'd have to replace it. Then she'd be able to choose a new color. Sorry, Mrs. Krane, but this isn't just any old avocado washer, it's a Maytag.  We can't promise that every Maytag washer will last this long, but all our washers are built to last longer and need fewer repairs.  In her letter Mrs. Krane included some advice for anyone looking for a new washer: make it a Maytag. Better still, she suggests, just make it a plain white Maytag.

