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LIGHTNING

Nature's high-voltage spectacle 83

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COVER: Following the jagged pattern common in cloud-to-ground lightning, a brilliant bolt strikes Arizona's Tucson Mountains during an August storm. Photograph © Thomas Ives.

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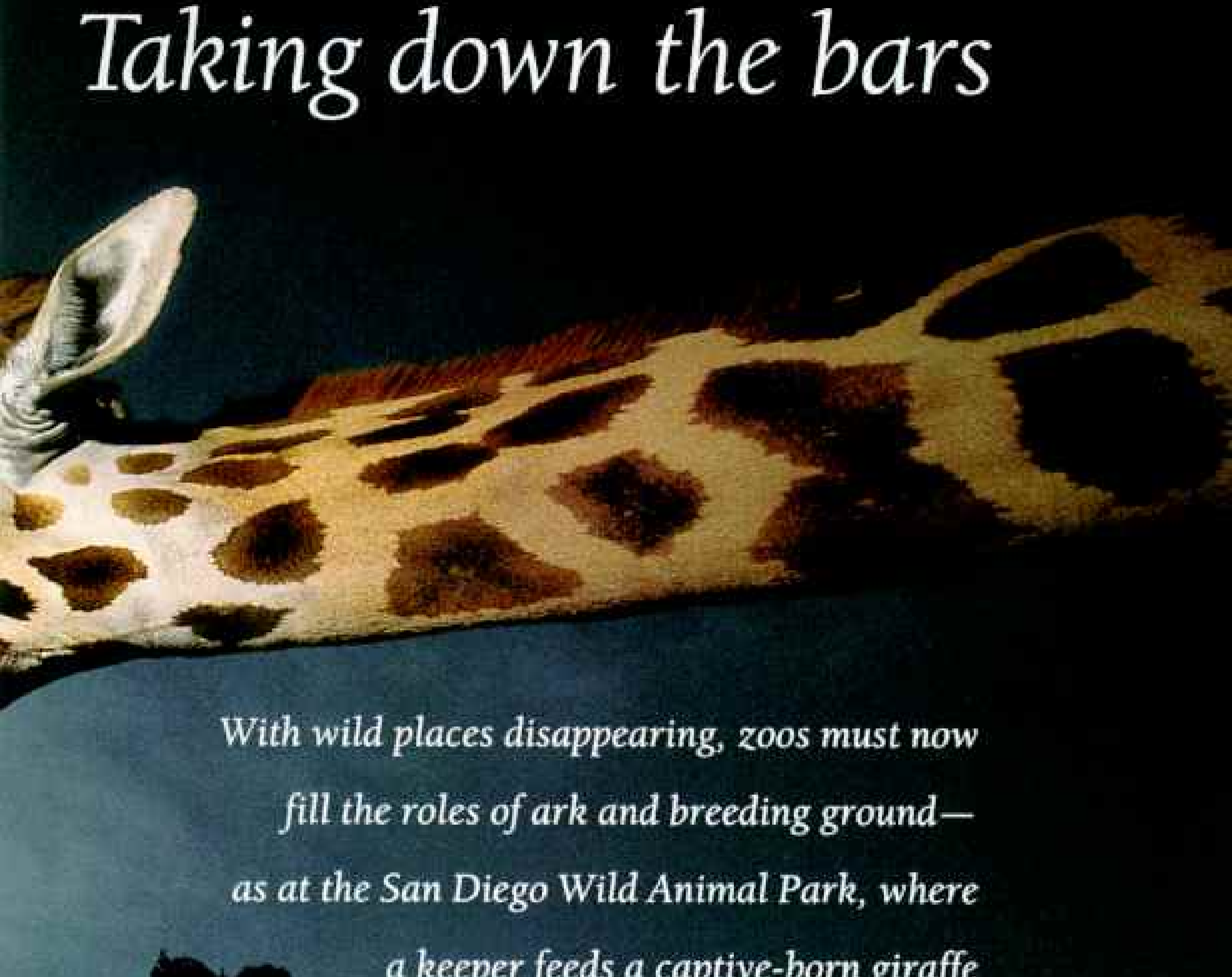
NEW

Zoos

Taking down the bars



With wild places disappearing, zoos must now fill the roles of ark and breeding ground—as at the San Diego Wild Animal Park, where a keeper feeds a captive-born giraffe in an ersatz African savanna.

By CLIFF TARPY
NATIONAL GEOGRAPHIC SENIOR STAFF
Photographs by
MICHAEL NICHOLS


TEXAS
160·GYD

Kudu and an ostrich nose about for breakfast at Fossil Rim Wildlife Center in Glen Rose, Texas. Like many other zoos, it runs a vigorous breeding program, the only hope for some endangered species.

Artful deception enhances the natural look of the Pittsburgh Zoo's "African Savanna," where a dry moat separates a giraffe from an elephant standing by an imitation termite mound made of concrete. A man-made pond hides a submerged fence of steel poles and cable.

WILLIE B — GORILLA AT ATLANTA'S GRANT PARK ZOO

In a dramatic turnabout, Atlanta has rehabilitated what was once among the nation's worst zoos. For 27 years a gorilla named Willie B. was kept alone in barren quarters. At the renovated and renamed Zoo Atlanta, he's now a beloved civic mascot living with four female gorillas in a grassy hillside exhibit that exhorts visitors to care for the environment. Yet refined exhibits do little to satisfy animal-rights activists who question the very existence of zoos.

CURT TEICH POSTCARD ARCHIVES, LAKE COUNTY MUSEUM, ILLINOIS (ABOVE)

DEEP IN THE RAIN FOREST the air was warm and humid. Water dripped and trickled down trees and rocks. Above me, bats shrugged their wings and hung upside down like cocoons. Parrots squawked, monkeys shrieked, and pygmy hippos ambled beside a small pool.

I picked up a small, brittle leaf from a plant and crushed it in my palm; the aroma gave it away—allspice. Nearby I noticed cinnamon, nutmeg, vanilla, and black pepper plants and many wild orchids.

We are not in Brazil, Borneo, or West Africa, but close by the Missouri River. Among the numerous species surrounding me on this Saturday morning is *Homo sapiens*, humans, hundreds of them, noisy children and adults.

It is opening day for the world's largest indoor tropical rain forest—the "Lied Jungle" exhibit at Omaha's Henry Doorly Zoo.

The jungle exhibit, named for its benefactor, Omaha businessman Ernst Lied, covers an acre and a half and measures 80 feet from floor to translucent fiberglass ceiling. A half mile of trails carry visitors to displays showing more than 130 species of animals living among some 2,000 species of exotic plants and trees. Fog wafting from 300 nozzles keeps the humidity at 75 percent.

Zoo director Lee Simmons, a wiry man in his 50s, shows the exuberance of a young boy with the biggest new toy on the block. "It's beautiful, isn't it! The folks seem to love it." For him the 15-million-dollar jungle represents the summit of his long career at the zoo.

Photographer MICHAEL "NICK" NICHOLS is known for his coverage of wildlife and the environment, including GEOGRAPHIC articles on New Mexico's Lechuguilla Cave (March 1991) and apes and humans (March 1992). In September the Society will publish his work in a 200-page book, *The Great Apes: Between Two Worlds*, which explores primates in the wild and in the world of humans.

Pillars of a rain forest rise 80 feet during construction of the "Lied Jungle" at Omaha's Henry Doorly Zoo (upper right). The reinforced-concrete trees conceal air ducts and misting nozzles for the world's largest indoor tropical rain forest exhibit. Opening-day crowds spy a pygmy hippo amid the greenery (above) while a giant fruit bat greets his upside-down visitors.

L. S. SIMMONS, OMAHA'S HENRY DOORLY ZOO

For me the "Lied Jungle" stands as a symbol of the dramatic changes that have transformed the American zoo, that stately dowager residing in all our childhood memories. Visiting zoos throughout the United States, I saw a revolution under way—one that, like most revolutions, has crept up on us almost unawares.

Of the many zoos and aquariums in the U. S., 154 are accredited by the American Association of Zoological Parks and Aquariums (AAZPA), the industry's professional group. They are visited each year by more than a hundred million people, a number that exceeds the combined attendance at all big-league baseball, football, and basketball games.

The provenance of our zoos traces back millennia. Powerful rulers, taking time out from war, collected exotic animals—for their own amusement, to impress foreign visitors, and to display some of the marvels of nature's work. The number of animals in a royal or private collection, the variety of species, in time came to confer prestige.

This conception of the zoo as menagerie had an extraordinary persistence. "Twenty-five years ago a zoo was still rated on how many species it had in its collection," one zoo director told me. "The thought that species were going to become extinct had not penetrated. The idea of conservation is, by and large, new stuff."

THE CHANGE WAS SEEDED in the 1960s and began to bear fruit in the '70s. Palmer Krantz, director of Riverbanks Zoo in Columbia, South Carolina, lived the experience. He told me: "In the '70s you could see a shift in the public's attitude toward zoos. Wildlife shows on television were a big influence. They showed you animals running free in the wild, their behavior, the importance of ecosystems.

"In 1973 Congress passed the Endangered Species Act, and the animal-rights and environmental movements became more active. An awareness of ecology and wildlife just built up. Even the Disney company and other theme park operators had an effect, showing how stimulating exhibits could be and, by comparison, how old-fashioned were those of many zoos.

"And I think there was an influx into the profession of young, ambitious, creative people—all shaped by these things."

Zoos felt the ground shift beneath them. Many animal-rights groups

A caress brushes the window as a child follows Cupid the hippo along 55 feet of glass in Toledo. The zoo's "Hippo-quarium" reveals the surprising grace of these bulky submarines.

picketed and claimed zoos were no better than prisons—that even the best zoos abused animals by confining and controlling them. To keep a polar bear in a warm climate, a San Diego protester claimed, "is like giving a human being a fur coat and telling him to go sit in a sauna. It's inhuman." (Zoo biologists deny there is any scientific basis for such a claim.)

Some conservationists argued that zoos should devote less money to confining animals and use it instead to help preserve animals in their habitats. Even friends of zoos said they should exhibit animals not as single trophies—like rare postage stamps from far-off lands—but as part of interdependent ecosystems.

The very sight of an animal alone in a cage no longer fit the public mood.

IN LONDON LAST YEAR the zoo in Regent's Park provided a worst-case scenario. It announced that because of lack of funds it would close. Some of the animals, it was feared, would have to be euthanized. It is among the oldest and most influential zoos in the world, founded by the great empire builder Sir Stamford Raffles in 1826 "for teaching or elucidating zoology," and had been the recipient of many marvelous specimens brought back by Charles Darwin from his famed voyage on the *Beagle*.

But over the years it had lost the public support it needed. The previous year, when the zoo turned to Her Majesty's government for additional funds, the environmental minister had answered coldly: "My view is that people in the 1990s believe that confining animals in a 37-acre site like Regent's Park zoo is not appropriate. There will be no more government money for Regent's Park."

At the last moment some funds did come; the zoo lurches on, its future uncertain.

American zoos had already responded to public opinion. They replicated natural habitats designed to be more comfortable for animals and more appealing to visitors. And instead of displaying animals in the classic taxonomic arrangement (a panther beside a tiger beside a lion beside a cheetah), they grouped animals according to a geographic area or common ecosystem, as in the "Lied Jungle."

The watchword became interpretation, educating visitors not only about an individual animal but also about how that animal fits into its environment. Aspects of show business—a tip of the hat to Disney—are drawn on; you could call it educating through seduction.

Enter the new "Amazonia" rain forest exhibit at the National Zoo, in Washington, D. C., and you'll find the camp of Dr. Brasil—his name uses the Portuguese spelling of that country. His assistants, zoo staffers and volunteers who have received acting lessons to help them in their task, encourage youngsters to examine the artifacts on Dr. Brasil's tables: dried reeds, coconut husks, giant seedpods, fish specimens in glass jars. Ask an assistant where the good doctor is, and he'll answer: "He's gone. He's upstream."

Walk up a flight of stairs and you follow the doctor's path into the rain forest: There are kapok and gumbo-limbo trees, titi monkeys, an elusive three-toed sloth, in all 360 species of plants, 100 of animals. Along the trail are open books with Dr. Brasil's musings: *Here I sometimes walk all day and rarely see the same species.* Or: *The European mind-set doesn't work here. You can't conquer this land—you must live with it.*

"I entertain and hope people learn," says the Columbus Zoo's ebullient Jack Hanna (left), who waits in a hotel room before appearing on Good Morning America. *From the Bronx Zoo William Conway oversees five New York zoos and conservation programs in more than 40 nations.*

At the Philadelphia Zoo children climb atop a giant fiberglass honeycomb and enter a huge bee's head. There they peer through a bee's multifaceted eyes. The smell of honey is heavy—a scent specially ordered from a New York perfume maker.

The Riverbanks Zoo in South Carolina has sleepovers for school groups and Scouts—filling the days and nights with lectures and opportunities to get close to the animals.

The Cincinnati Zoo goes a step further: It has high school juniors and seniors attending school at the zoo *(Continued on page 20)*

The orange coat of a baby stands out from a crowd of adult silvered langurs in the Bronx Zoo's "JungleWorld," an exhibit designed to envelop the visitor.

Captive-breeding programs link conservation efforts throughout the world. At the National Zoo, in Washington, D. C., reproductive physiologist JoGayle Howard performs a laparoscopy to monitor a lion's response to hormone treatments. The goal: Increase genetic diversity by impregnating females with semen from wild lions in Africa. At the Omaha zoo, researchers examine a black-footed ferret to check her readiness to mate. Nearby, another member of this endangered species looks up from its meal of mink chow and ground rabbit.

full-time. They do academic studies, then work with the keepers, getting hands-on experience. The program pays off for the students, 70 percent of whom pursue animal-related studies in college. Nearly a quarter of the zoo's keepers are graduates of the program.

The change of ambience for human visitors has been matched by a change for the animals. As we walked the primate area at the Los Angeles Zoo, behavior specialist Thaya du Bois explained: "There has been a dramatic shift in attitude—a coming to realize that animals may be better off when they have some control over how they spend

their time. This is difficult because there seems to be a natural inclination in people to do things for animals—to cut fruit into pieces or peel a hard-boiled egg. This helps feed the animals, but does not take care of their behavioral needs, the need to do for themselves. The behaviors that take up most of an animal's time in the wild are foraging, prey catching, play, and exploration.

"We have an artificial termite mound—there—with a little door. A chimp can open it up, and there are vials inside with honey, applesauce, or other treats. The chimps make tools of branches and fish for these foods just as they would fish for termites in the wild.

"We also drill holes in logs and stuff the holes with raisins, seeds, and other tidbits. Our lemurs and monkeys have to pick the food out with their fingers. And we hide tiny dabs of food in the nooks and crannies of rocks—cooked rice, peanut butter, anything that gets the animals moving around and foraging."

The new attitude not only makes the animals happier and healthier, it also gives the zoo visitor a better sense of life as lived in the wild. "You may not be able to go to Tanzania and observe chimp life in the

wild with Jane Goodall," du Bois said, "but here you get a glimpse."

As zoos increase the naturalness of their settings, the results are sometimes surprising. The San Diego Zoo decided to add jungle sounds to its "Gorilla Tropics" exhibit. An audiospecialist traveled to central Africa and collected high-quality recordings of birdsong, gorilla calls, and other animal noises.

The effect of the sounds on the gorillas has been difficult to discern, says Don Lindburg, chief of the zoo's behavioral division. "But it certainly perked up the visitors, and our bird people got a tremendous crop of eggs last year from the surrounding aviaries, including eggs from a few birds that never reproduced here before.

"The evidence is only anecdotal," Lindburg says, "but we're going to investigate this." He wonders if the auditory stimulation somehow affected the birds' propensity to build nests or caused their gonads to become active.

Confined in the name of freedom, a wild California condor identified by a wing patch will probably live out his days at the San Diego Wild Animal Park. So dire were the species' prospects that the last known wild condor was captured in 1987. Captive breeding has boosted the census from 21 to 67, with 32 kept at San Diego and 28 at the Los Angeles Zoo. So far, eight have been released in California, where toxic substances have killed one condor and remain a worry. Conservationists dream of the day that a condor might again glide in dark majesty above the Grand Canyon.

ZOOS NOW GAMBLE on exhibits featuring creatures not previously known for their charisma. When the Cincinnati Zoo built its "Insect World," says director Ed Maruska, "some of my colleagues from other zoos decided I had lost it totally. Here I wanted to spend over a million dollars for creepy crawlies that bite and sting, that are totally alien, and that are not very attractive to most people.

"But more than 90 percent of terrestrial animal life is invertebrates. They pollinate our flowers and work our ground, and they are vital to every other form of life."

"Insect World" has proved a big attraction. Coming soon: the inch-long bullet ant, one of the world's most venomous insects!

And some privately owned zoos, well financed and fully accredited by the AAZPA, offer innovative ideas. Fossil Rim Wildlife Center sprawls over 3,000 undulating acres southwest of Dallas with the ambience of an East African game preserve. Visitors in cars ride past clusters of zebras, wildebeests, oryx, gazelles, and cheetahs. Here, too, reside two rare black rhinos from Zimbabwe; their numbers in the wild have dropped in the past two decades from 60,000 to 2,300.

The Arizona-Sonora Desert Museum near Tucson spurns the "charismatic megavertebrates"—lions, tigers, elephants—that bring in the crowds at many zoos. It focuses on the animals and plants of the surrounding Sonoran Desert. Director David Hancocks—a self-acknowledged "nuisance" among his peers—thinks every zoo should concentrate more on its local environment and less on exotica.

"Zoos in the Pacific Northwest," he says, "teach more about the destruction of tropical rain forests than about the clear-cutting of temperate forests in their own region, where the rate of depletion staggers the imagination. We seem to find it more convenient to highlight problems in distant places."

One zoo in agreement about local fauna is in Audubon Park in New Orleans; there you'll find gators, black bears, catfish, and copperheads in the "Louisiana Swamp" exhibit.

In defending their role today, zoos often describe themselves as "modern arks," preserving and breeding endangered species that are disappearing in the wild. Indeed there are a number of species with more representatives in zoos than in the wild. There are, for instance, perhaps 800 Siberian tigers in captivity and fewer than 400 in the wild (see following story). And yet even in this role zoos are not without

critics, not without those who question the whole idea of modern arks.

Zoos first got into large-scale breeding when importing animals from the wild became more difficult and controversial. Today less than 10 percent of mammals in North American zoos are imported from the wild.

To facilitate breeding of larger animals, some zoos have established expansive retreats. Zoos in Columbus, Cincinnati, Cleveland, and Toledo recently helped create the Wilds, a 9,150-acre facility in southeastern Ohio. The National Zoo has a 3,100-acre conservation and research facility near Front Royal, Virginia. And the New York Zoological Society breeds on St. Catherines Island off Georgia.

TO COORDINATE THE BREEDING efforts, the AAZPA established in the early 1980s a Species Survival Plan (SSP). It links its efforts with two international groups based in Minneapolis: the International Species Information System and the Captive Breeding Specialist Group of the World Conservation Union. There are now nearly 70 SSP programs, each with a coordinator. One concern is the danger of inbreeding. Captive populations are inherently limited in number, so the danger is great. Each SSP program keeps its own studbook listing the sex, parentage, and location of each individual.

To see how one SSP program works, I journeyed to the Riverbanks Zoo in Columbia. It sits by the Saluda River, a pretty zoo, small, well maintained, and surrounded by pine and deciduous trees. There bird curator Bob Seibels, a slender, intense young man, spends half his working hours propagating the Bali mynah, a bird native to that Indonesian island.

About ten inches tall, with snowy color, graceful crest, and blue coloration around the eyes, the bird became a favorite pet of Indonesians. "They keep them in little bamboo cages, a sort of status symbol," Seibels said. Then American and European aviaries began to collect them. In time their number in the wild dwindled to about 20.

Seibels's tools in rebuilding the population—and avoiding inbreeding—include a computer holding the parentage, if known, of all registered Bali mynahs. When mating is considered, the question is: "If we breed male number 36 with female number 87, will the offspring help prevent inbreeding in the captive population?"

Seibels has taken 20 pairs of U. S.-bred Bali mynahs back to Indonesia to form the nucleus of a captive-breeding program there. So far 16 offspring have been reintroduced to the wild. He and his colleagues in the SSP program have also worked with the Indonesian government on a plan to encourage local people who keep wild-caught Bali mynahs as pets to exchange them for captive-bred birds, thus ensuring a vigorous new supply of genes.

The deeper I got into the breeding issue, the more complex it became. I had only to step from Riverbanks Zoo's birdhouse into a modern building holding reptiles. Herpetologist Scott Pfaff explained: "This is a specialized room for quarantine of new reptiles; it has its own water system, sewer system, and air-handling system. The purpose is to make sure that a disease or parasite brought in by new animals does not spread to others. They stay for at least two months, sometimes up to a year.

"We do blood work and fecal analysis. If they have parasites, we try to clear them up. Then we retest them. With reptiles our biggest

People watching animals watching people: Popping up like the creatures they observe, two girls learn about animal behavior as they play prairie dog at the Bronx Zoo. In New Orleans an unusual white alligator floats in "suspended animation" at the Audubon Zoo's "Louisiana Swamp." Says curator Rick Atkinson: "It's more a nature center than a zoo exhibit."

problem is eradicating all the internal parasites. We treat them, test them, re-treat them, and test them again."

Feeding these creatures calls for a sort of gourmet kitchen: For some reptiles, whole rats and mice; for others, whole live fish; and for the vegetarians, chopped fruits and vegetables with vitamin and mineral supplements.

Attention is paid to psychological comfort, which varies among species. "Chameleons don't like one another—even males and females," said Pfaff. "So we keep them separate to reduce the stress."

Among the residents here are rattlesnakes from Aruba, an island off the coast of Venezuela. "They're a threatened species," Pfaff told me. "Aruba is only five miles wide and 20 miles long, and 65,000 people live there. There's not much room for these guys. But if we can establish a healthy captive population and the Arubans can create a nature preserve, this species can be saved."

THE CINCINNATI ZOO, using hormones to stimulate breeding, helped build up a population of near-extinct Puerto Rican crested toads. Loss of breeding habitat had devastated the species. "We introduced 575 toads back onto the island as part of a cooperative venture," said amphibian and reptile specialist Johnny Arnett. "The number is not insignificant."

Threatened species from the United States reside at Cincinnati too, including some Appalachian salamanders. "Those mountains hold more species of salamanders than does any country in the world, and many are unique," Arnett said. "Now because of clear-cutting in the mountain forests, it is estimated that 14 million salamanders die each year in North Carolina alone.

"Trees help filter the runoff of water and hold the soil. When the trees are cut, all the runoff goes directly into streams and into the subterranean water in the caves where many salamanders live. The muddy, dirty water kills the salamanders' offspring.

"We're not playing God," Arnett insisted. "We're simply trying to save some of these things while we can. Once they are gone, they are lost forever."

Delight beams from Michael Shawn Landry, hospitalized in New Orleans with cerebral palsy, as he views an alligator brought in by an Audubon Zoo outreach program.

At the Omaha zoo, on a late winter's evening, I donned a blue surgeon's gown and face mask and entered an isolation room where reproductive physiologist Tim Gross keeps 49 black-footed ferrets—another of our nation's endangered species. Small and tawny-colored, the animals are black on their feet and around their eyes, giving them the look of bandits. Diseases and the attempt to eradicate prairie dogs, their chief prey, nearly wiped out the black-footed ferret. The captive population now numbers about 500, and another 139 have been released to the wild.

Gross and his colleagues, having determined the pairs they wanted to mate, opened doors between cages and turned off the normal lights—ferrets are nocturnal creatures. The room was bathed in infrared light, which the ferrets could not sense but which provided illumination for our TV monitoring.

On one monitor I saw Willis, a male, approach Spook, a female. Spook yielded. Willis got the nape of her neck in his mouth and began mating. Other encounters were being depicted on other monitors. Gross and his colleagues were watching and cheering—the population was sure to climb.

A hands-on exhibit at the Audubon Zoo displays purses, shoes, and jackets made from illegally caught wildlife and seized by U. S. Fish and Wildlife Service agents. The message: Ignorant or uncaring consumers hasten the disappearance of rare and endangered species.

Other zoos are taking steps to ensure the survival of a species even if the last living animal of that species should die. At the San Diego Zoo, research director Werner Heuschele explained a program focused on bonobos, also called pygmy chimpanzees, among the rarest and most fascinating of primates.

"Our premier male breeder died after siring 11 offspring," he said. "Biologist Barbara Durrant rushed to the corpse and collected the testes. She pressed semen from the testes and then put it in scores of tiny vials with a fluid that protects it during the freezing process. These

A hissing cougar prowls the "Louisiana Swamp," a display designed for indigenous animals. The cat, of Rocky Mountain origins, is a stand-in: A related subspecies that once roamed the Southeast is now endangered and found only in Florida.

vials of frozen semen can be used for future artificial insemination.

"Barbara also collects eggs from females that die. She hopes down the road to do in vitro fertilization—fertilizing an egg with semen, then placing it in a surrogate mother."

When Ling-Ling, a beloved giant panda at the National Zoo, died last year of heart failure at 23, more than 150 eggs were retrieved from her body. The eggs were immature, because her natural breeding cycle was some months away. To encourage maturation, the eggs were placed in a culture dish with hormones and nutrients, then placed in an incubator. Sperm had been taken earlier from Ling-Ling's consort, Hsing-Hsing, and frozen. Some was now thawed and placed in the dish with Ling-Ling's eggs.

The sperm were healthy and strong, but the eggs remained too immature to be fertilized. "If an egg had been fertilized and reached the four- to eight-cell embryo stage," said reproductive physiologist JoGayle Howard, "it would have been frozen for an attempt at embryo transfer to another female." Ling-Ling and Hsing-Hsing had produced five cubs, but all died. There remain fewer than 110 pandas in captivity and an estimated 1,200 in the wilds of China.*

At the Cincinnati Zoo's Center for Reproduction of Endangered Wildlife, liquid nitrogen tanks hold straws containing the frozen semen, eggs, and embryos of other species: cheetah, black rhino and white rhino, snow leopard.

Zoos—it is clear—are planning ahead, far ahead. Even the Old Testament's Noah could not have planned more scrupulously.

*See "Newborn Panda in the Wild," text and photographs by Lu Zhi, NATIONAL GEOGRAPHIC, February 1993.

Flouting a moratorium, the Columbus Zoo "rented" two pandas from Chinese zoos and lost its membership in the U. S. zoo industry's professional organization. Lured by the endangered species' cuteness, attendance boomed as did sales of souvenirs. The zoo raised $730,000 for panda conservation programs and regained its membership after the pandas were returned.

BUT EVEN BREEDING PROGRAMS attract the wrath of zoo critics. "You cannot have a viable captive population without breeding a surplus," says Don Lindburg of San Diego. "The population is healthier genetically if it has many founders, each contributing only two or three offspring to future generations. You often end up with animals that have met this goal while they are still quite young but must be maintained until they die many years later."

What is to be done with these surplus animals? "You start euthanizing surplus orangutans or gorillas and your zoo is going to be shut down in a week," says Lindburg.

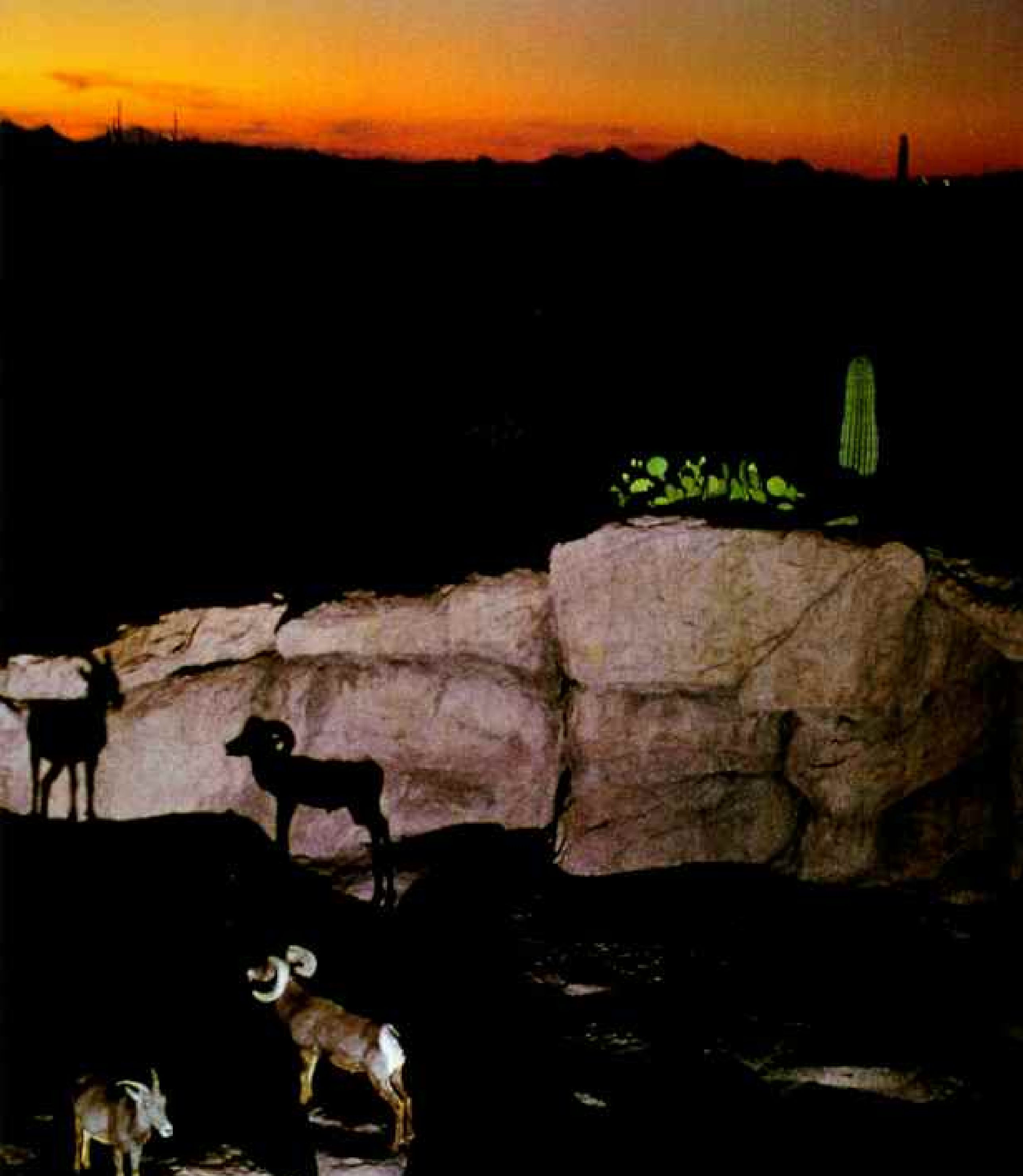
Some zoos sell their surplus animals to dealers, who sell them to other zoos and sometimes to hunting camps. Hunters pay to shoot exotic species. Control of the animals' use after they are sold to dealers is difficult, and criticism mounts.

Naturalist George Schaller of the New York Zoological Society suggests: "Zoos will have to use contraceptives more often." Many zoos also perform vasectomies on animals.

Breeding often requires moving animals about—sometimes unsettling to them and to the public as well. When Timmy, a 33-year-old silverback gorilla in the Cleveland Metroparks Zoo, was scheduled to be moved to the Bronx Zoo to mate with females there, Timmy's fans in Cleveland hit the roof. Animal-rights groups went to court, claiming that it would be cruel to separate him from Kribi Kate, his female companion.

But Kribi Kate was barren. Moreover, zoo officials countered that gorillas are not monogamous, and that in the wild a band's dominant

Rocks of sculpted concrete suit bighorn sheep just fine at Tucson's Arizona-Sonora Desert Museum, an innovator in natural zoo exhibits.



male will mate with any number of females. For a time, said one zoo worker, "Timmy was the only gorilla in the world with his own attorney." But a U. S. district court judge ruled against Timmy's friends.

Timmy's concrete quarters in Cleveland had been indoors; the Bronx gave him a sizable stretch of grassy outdoor territory and three female companions. At the Bronx, Timmy first just sat on a pile of rocks by a door. All that green seemed to scare him.

"Several weeks ago, when he walked on grass, it was like he was walking on hot coals," said Jim Doherty, the zoo's general curator, as we viewed Timmy in his new home. "Now, over the past few days, he's mated four times." Since then, one of his companions, Pattycake, has become pregnant.

For Timmy, a happy ending. But for Hannibal, an African bull elephant at the Los Angeles Zoo, another story.

As Hannibal matured, he became increasingly aggressive. Twice he tore a 20-foot-high, two-inch-thick steel door off its hinges. Arrangements were made to send the animal to a zoo in Toluca, Mexico, which had a much larger elephant holding area. Animal-rights groups protested, but the move went ahead.

Hannibal was tranquilized before being loaded into a special crate. He went down on his knees in the crate, and the next morning—March 20, 1992—he died from heart failure. The incident was a zookeeper's nightmare.

The very idea of a modern ark is challenged, even by some zoo professionals. Working against the concept are both reality and philosophy. Says San Diego's Don Lindburg: "All this talk that our zoos are arks and we're going to take wildlife through the demographic winter

Snowflakes and polar bears paint an arctic tableau at the renovated Central Park Zoo. Tight budgets force many cities to refurbish aging zoos rather than build anew.

Prairie winds buffet a rare Siberian tiger at the Minnesota Zoo, where he successfully bred with a female donated by Russia. Another infusion of genes into the breeding stock came with the rescue of two cubs in Siberia (see following story).

and someday rebuild the world's habitats and put the animals back is just blowing smoke. You can say, so OK, maybe these are arks that never end their journey, arks where the passengers never get off. The question is whether we really can—in light of projections about human populations—save anything in the wild."

WHEN THE WILD GOES FROM WILDLIFE, a moral question arises. University of Colorado philosopher Dale Jamieson writes: "Is it really better to confine a few hapless Mountain Gorillas in a zoo than to permit the species to become extinct? . . . If it is true that we are inevitably moving towards a world in which Mountain Gorillas can survive only in zoos, then we must ask whether it is really better for them to live in artificial environments of our design than not to be born at all."

Perhaps wildlife and wild habitats are doomed—to be destroyed by the press of population and the attendant farming, wood-fuel collecting, and animal husbandry. Worldwide an estimated 10 billion to 15 billion domestic animals are now using former wildlife habitat. More than a billion of these are ruminants, and they dominate at least seven billion acres of land, an area nearly the size of Africa. Some biologists predict that by the year 2100, of the 23,000 species of four-limbed animals, we're going to lose as many as 6,000—more than a fourth.

Is the idea of preserving wildlife and its habitat an illusion? Will both become mere cherished memories along with steam locomotives, clipper ships, long-dead relatives in fading brown photographs? I took these issues to Bill Conway, president of the New York Zoological

Wary of flash floods, keeper Torrey Pillsbury steers a young okapi to safety during a downpour at the San Diego Wild Animal Park (right). Outside New Orleans a barred owl found ensnarled in fishing line a month earlier is released to the wild by Jamie Primm of the Audubon Zoo. Besides tending their own animals, zoos cope with migrating birds, vermin, and other wild interlopers—and unwanted pets thoughtlessly left at their doorsteps.

Society, at his office at the Bronx Zoo. It is a corner office with arched windows; a portrait of a snow leopard looks on from behind his desk. Conway is a lean man of patrician bearing with an aquiline nose hinting of a raptor. He is the doyen of American zookeepers.

For 40 years he has worked as ornithologist, globe-trotting researcher, stern taskmaster. Under his guidance the New York Zoological Society operates not only the Bronx Zoo and four others but also 158 conservation projects in 41 nations, and it has made possible the creation or survival of more than a hundred wildlife parks and reserves.

To emphasize its far-reaching activities, the society recently changed its name to NYZS/The Wildlife Conservation Society. It also changed the names of its zoos: The Bronx Zoo is now officially the International Wildlife Conservation Park.

"Conservation is a matter of buying time," Conway said. "That's essentially what zoos are doing. In many instances we are going to buy time for creatures that will have no place in nature ever again, and at some point we are going to face some very tough decisions.

"For instance, the beautiful little Guam kingfisher became extinct in nature in 1987, killed out by a snake introduced to that island. But zoos still breed them. How long shall we continue?"

And where can we keep all the species? "All the animal spaces in all the zoos of the world," he said, "could fit comfortably within the borough of Brooklyn. That's not much space."

But Conway continues to push zoo breeding. He believes some conservationists—those who would let a species become extinct in nature rather than breed it in a zoo—are mistaken, if well-meaning.

"It was only about eight years ago that the Javan tiger was the

subject of conflict. Zoo biologists were saying, 'For heaven's sake, let's get a sample of these animals in captivity before they're all gone.' And the conservationists said, 'No, that's not necessary, we're going to preserve them in nature.'

"'Then one day the question was asked, 'How many Javan tigers do we have left?' The answer was none—they were extinct, gone.

"'The point is that if we have some of these animals, we have future options. If we don't have them, there are no options."

As for reintroducing species, Conway cited successes in areas where population levels are low. "A lot of people said, 'Oh, you'll never be able to reintroduce the Arabian oryx to its native habitat.' Well, it's being done quite successfully now. And there are other examples, including the reintroduction of the bison in the American West."

Concerning the future of wildlife: "I have thought for many years that the way to save wildlife, the be-all and end-all, was the national park or wildlife preserve. But a fence, legal or physical, is not enough. You must control the surroundings, the water tables, and so on.

"One thing that concerns me is the insularization of parks and reserves around the world—all those little 'islands.' Lake Nakuru National Park in Kenya, a marvelous place for water birds, including flamingos, is such an 'island.' It now has a seven-foot-high electric fence all around it. Not to protect the animals, but to protect surrounding farms from the animals. The antelope, the giraffes.

"What does this mean? That the animals have been placed in a zoo—a big zoo, 73 square miles. But it isn't all that big, because Kenya has a very uncertain rain pattern. You may have two or three years when the lake dries out. The animals must be able to move to different areas for food and water.

"They've reintroduced rhinos. Among them, inbreeding will be a problem. Zoo-like techniques will have to take place. From now on, Nakuru's animals will have to be managed and their habitat monitored and supervised."

Welcome to the megazoo!

I'D ALWAYS THOUGHT running a zoo would be fun, but after weeks of visiting these institutions, I had come to understand that this was a profession besieged with problems too. Consider money: Funds come from municipalities, gate admissions, profits from the sale of food and souvenirs. But major gifts are also needed. George Schaller, who has studied everything in the wild from mountain gorillas to Bengal tigers, declares: "Zoos must go out and hustle more.

"One problem is cultural. The Bronx Zoo, for example, has a Sumatran rhino. There are a hell of a lot more Rembrandts in the world than there are Sumatran rhinos. But the value that is placed on them is different. You have donors who will give a million dollars to a zoo, but you have donors who will give hundreds of millions of dollars of art to a museum. That's a difference in cultural values. An artist can replicate a Rembrandt, but nobody is ever going to duplicate a Sumatran rhino."

And there's that nagging question: If zoos are evolving, what is their ultimate destination? What will the zoo of the future be like? Schaller's answer: "Zoos have no validity nowadays, no purpose, except to help protect and raise endangered animals and to raise public consciousness about the plight of wildlife. Zoos need to get outside

Alone at twilight, a northern white rhinoceros at the San Diego Wild Animal Park is one of perhaps 40 that remain on earth, 11 in captivity, the rest in a national park in Zaire. Whatever the motivation to create zoos, humans—like it or not—are charged with the animal kingdom's welfare on a planet that we are crowding with ourselves.

their own walls more often and put more effort into saving the animals in the wild."

For Michael Robinson, director of the National Zoo, the future lies in the zoo becoming a "biopark" with the emphasis on the relationship between plants and animals. Such a biopark would draw on many disciplines: ecology, zoology, botany, geography, anthropology. Its object—to educate and to help save the environment and its complex ecosystems.

The Bronx's Conway says the zoo will evolve to fill "a new role for society as an environmental resource, with a significant function in preserving the earth and its wildlife."

But Conway had another thought, one that struck me forcefully, triggering childhood memories and reminding me of what has been at the core of zoos for so long: "At a zoo or conservation park, you do not confront a photograph or a video. You confront the living, breathing animal. There is an immediacy of enormous value and importance. It's something that cannot be Xeroxed. The power of that confrontation—as concerns our feeling about wildlife and our struggle to preserve it—cannot be gainsaid, ever."

Maybe, just maybe, the American zoo is here to stay. □

Saving Siberia's Tigers

By HOWARD B. QUIGLEY
Photographs by the author
and MAURICE G. HORNOCKER

They were helpless, completely in limbo. Their mother was gone, killed by poachers in the Siberian forest. Two siblings had died of natural causes, leaving these four-month-old Siberian tiger cubs abandoned. In a temporary pen in the city of Khabarovsk, they waited while my wife, Kathy, and I fought paper tigers in the ferocious Russian bureaucracy for a permit so the cubs could be flown to Omaha's Henry Doorly Zoo, renowned for its work with big cats.

We were part of a Russian-U. S. team cooperating on a three-year study of Siberian tigers, in which we learned firsthand how real the threats are to these endangered cats, the world's largest. We had known the cubs' mother, Lena—she was one of our study animals.

MAURICE G. HORNOCKER

The tiger team

Russian biologists have always studied Siberian tigers the traditional way: Wait for snow and track them. The government has never funded anything more sophisticated. Tracking a female and her cubs, I find it is still a good method (above), if only from October to April.

In 1989 project co-director Maurice Hornocker and I approached the Russians, hoping to marry our radiotelemetry and tranquilizing techniques with their groundwork. Our goal was to define the ecology of this tiger subspecies, which can weigh 800 pounds, and develop conservation plans. How much territory do they require? How many elk and wild boar do they need for food? How will they react to increasing human pressure?

In February 1992 we radio collared our first tiger, a young female we named Olga, here awakening from the anesthetic (above right).

With grants from the National Geographic Society and the National Fish and Wildlife Foundation we collared six tigers and gathered much data. With additional support from the National Wildlife Federation and the Exxon Corporation, we have begun work in a second study area southwest of our main workplace, the Sikhote-Alin Biosphere Reserve (map).

The Siberian tiger's range

Once they roamed from Russia into China and Korea, but poaching and habitat loss have reduced Siberian tigers to fewer than 400 in the wild. Perhaps 20 dwell within the 1,314-square-mile Sikhote-Alin Biosphere Reserve. About half of it makes up our study area. At another reserve, Kedrovaya Pad, we have created a new study site, which extends beyond the protected area into territory where hunting of other animals is allowed.

Tigers besieged

A Research Project Supported In Part By Your Society

Clear-cutting and poaching are twin gun barrels pointed at the Siberian tiger. With the collapse of the Soviet state, economically strapped regional officials seek hard currency by selling rights to enormous tracts of spruce, fir, and pine forest, known as taiga, to foreign corporations, which hire contractors to log them. North of the Sikhote-Alin reserve much of the Primorskiy Kray forest is tiger country—but not this moonscape, where a logging road connects two clear-cuts. Larger than Amazonia, Siberia's taiga contains a fourth of the world's timber reserves, and ten million acres of it is falling yearly.

Russia's borders with China and North Korea are now open, and poachers have easy access to markets there and in Taiwan for skins, bones, and genitals believed to have medicinal value. Bones, pulverized and used in "tiger wine," bring about a hundred dollars a pound.

Such was the likely fate of Lena, the first adult we collared, here anesthetized and inspected in June 1992 by Maurice Hornocker, at right, and biologists Yevgeny Smirnov, at center, and Igor Nikalayev. Five months later her radio signaled no movement. She had vanished. Colleagues found her collar under the snow and her four ten-week-old cubs nearby. Lena might have brought as much as $10,000 to poachers, who stalk Sikhote-Alin despite signs that read "Nature's Enemy: The Poacher."

DALE MIDDELLE

Tangled trail to safety

Four scared bundles of fur, Lena's cubs rest on a mattress under a table in a small cabin a few days after her disappearance. Outside the town of Terney, our headquarters near the main reserve, the cabin—which we secured against thieves or possible escape with two locks—became the cubs' fortress for six weeks.

We burned up the phone lines to Moscow and the United States seeking a home for the orphans. Meanwhile, to our sorrow, two of the cubs (above, with mouths open) died of defective diaphragms, an uncommon birth defect. Kathy, the project veterinarian, and field coordinator Dale Miquelle (top right) monitor one of the survivors while taking blood and tissue

DALE MIQUELLE

samples. Dale found a supplier for whole sides of beef, which were cut up with an ax and injected with vitamins and minerals for the cubs.

We finally contacted Omaha's Henry Doorly Zoo, and to our delight they agreed to accept the two cubs. Then came the daily delays and headaches in securing an export permit for our charges and an import permit so they could enter the United States. We were exasperated when official Russia shut down—first for New Year's, then for Russian Orthodox Christmas soon after.

At last Moscow's permit arrived. On January 10 the cubs (above) headed for a flight from Terney to Khabarovsk, and from there to San Francisco—we thought. Yet one more piece of paper was required in Khabarovsk, marooning the cubs, and us, there for a week.

There is hope

Nadezhda, "hope" in Russian, we named the surviving female cub, uneasily surveying her new snow-covered home in the Omaha zoo upon her arrival last January 18. Her sisters Vera ("faith") and Lyubov ("love") had perished, but the surviving male, named Khuntami for a landmark in the Sikhote-Alin reserve, will be at Nadezhda's side.

Visitors delight in closeup views of the cubs. They will increase the genetic variability in a captive-breeding program involving a network of zoos—more Siberian tigers now live in captivity (perhaps 800) than in the wild. Back in the Siberian forests is where our concern lies, for poachers still kill numerous tigers every year. We are fully committed to halting the tiger trade and to preserving the tigers' habitat. We still have hope. □

JAY DICKMAN (BOTH)

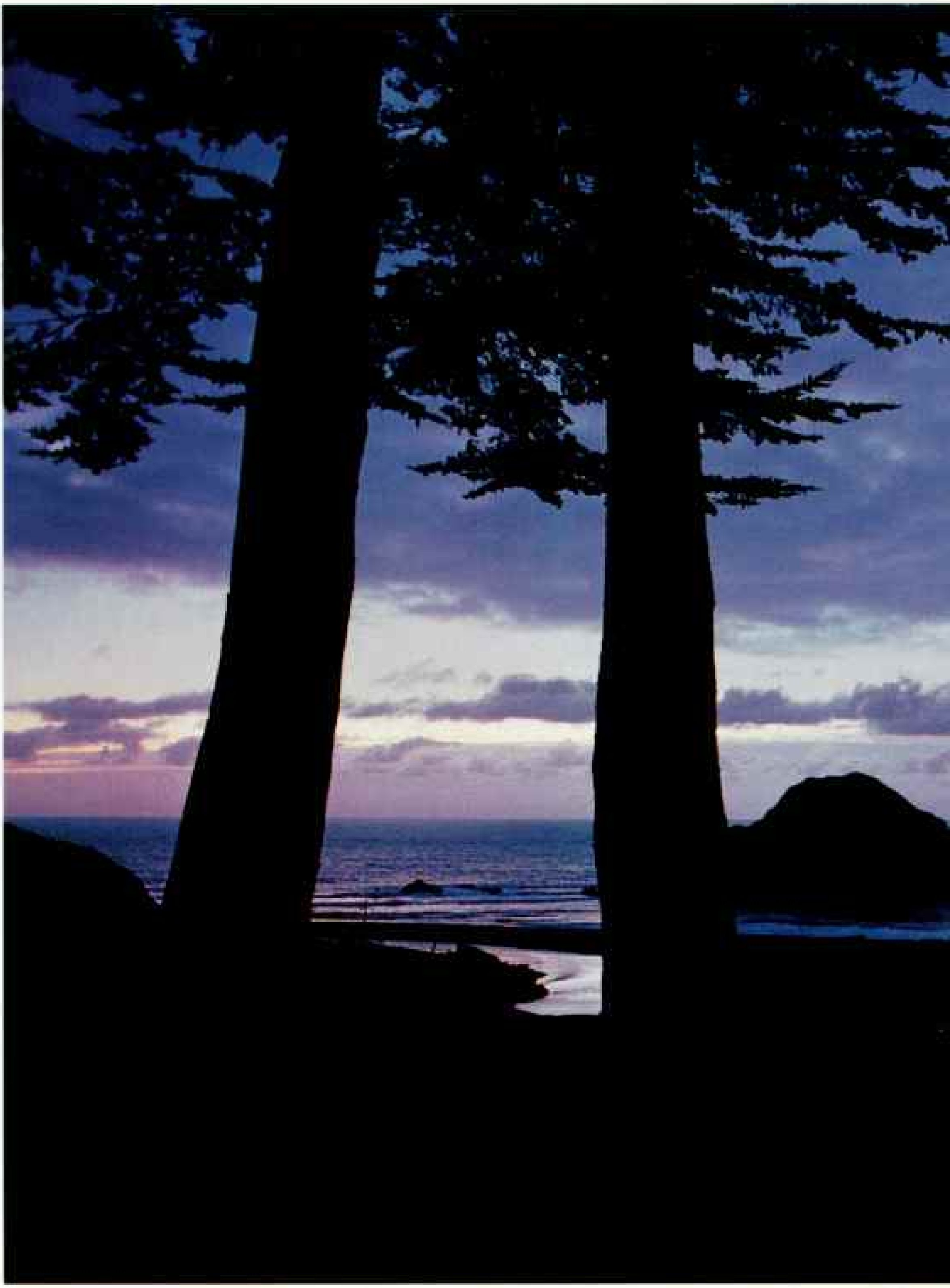
Benchmarks by which northern Californians measure their region's beauty, wood and water converge at Mendocino Headlands State Park, 140 miles from San Francisco. While wrangling with one another over how best to use the resources of coast, mountain, and valley, many loggers, fishermen, ranchers, and environmentalists believe that it's time for the state's sparsely populated northern third to cut loose from the rest of California.

By DAVID YEADON

California's

WELISSA FARLOW

North Face



Daylight fades on the continent's edge, home to innkeeper's daughter Molly Boynoff, 13. Molly's mother rode an early wave of urban refugees to the untamed Mendocino coast, fleeing the San Francisco Bay area in 1967. Cityfolk now fill the Elk Cove Inn on weekends, beachcombing by day and

MELISSA FARLOW

crowding the gazebo to watch the sunset, glasses of local wine in hand. Life's not always so serene for the 150 or so souls who live in the rustic town of Elk. They rely on ingenuity to survive, stringing together several part-time jobs and bartering goods and services with one another.

"It's a living room in the wilderness," says Petrolia High School principal Jeff Westergaard (above, at right), sitting in a tree 60 feet above the ground with students Lena Buhler and Shiloh Croy-Baker. The "couch tree" captures the adventurous spirit of the 270-acre private school on the "lost coast," an hour's drive over the mountains from the nearest public high school. The 22 students cook meals in a barn, take a six-week field trip each year, and maintain the solar panels and water wheel that generate campus electricity.

PHIL SCHERMEISTER

ONE GOLDEN EVENING, 110 miles north of San Francisco, I strolled the quiet streets of Boonville, a tiny community set amid the vineyards and orchards of the Anderson Valley. About a hundred years ago people in the area decided to invent their own language—Boontling. Some of the older residents of Boonville still speak it, especially if they're sitting around at the local café drinking a *horn of seese* (cup of coffee), munching on a few *loweesies* (soda biscuits), and telling a few *wheelers* (tall tales).

Boontling, they say, was dreamed up by adults who wanted to evade sharp little ears and indulge freely in gossipy *nonch harpins* (objectionable talk). It also meant locals could say what they pleased right in front of visiting *bright-lighters* (strangers, presumably from the big city). In traveling through this remarkable region, I came to realize that ever since the first settlers arrived in the gold-rush days of the mid-1800s, northern Californians have invariably spoken their own language, though no other town has yet gone as far as Boonville.

Northern California has always been a place apart, combining scenic splendor with the pioneering heritage of its people. Theirs is a stubborn independence linked with a spirit of community and a deep love for the soul of the land. All of this has widened the gulf between them and their ever expanding sister, southern California, whose political power and growing need for resources, many feel, have long overwhelmed the needs and interests of the north. And lately the northerners have begun expressing themselves very clearly, using words that the rest of California can understand. One of the most forceful words is secession.

Last June, 31 of California's 58 counties held an advisory vote on secession, and 27 opted for it. Secession has been an issue more than a hundred times since the state's creation in 1850. But this was the largest vote yet, an unmistakable signal that a complex web of problems and concerns has evolved into discernible fear and frustration.

More than a century of logging in the vast mountain forests here has endangered the prospects of the loggers almost as much as those of the spotted owl and the marbled

NANDY DICKON (BOTH)

murrelet; once rich salmon populations are suffering from dams, silting of streams, and damage to their spawning beds upriver. The fishermen are suffering in turn. And there is the ceaseless demand for water from the suburban sprawls of Los Angeles and other southern cities. In California 75 percent of the water originates north of Sacramento, while about 75 percent of the demand occurs south of it.

In "The Sierra in Peril," his Pulitzer Prize-winning series of newspaper articles, Tom Knudson passionately expressed the general alarm at the increasing environmental deterioration in this eastern part of northern California. He quoted a U. S. Forest Service spokesman's prophetic words: "The Sierra Nevada is really the region where California faces its destiny."

Northern California spread out before me as I stood on the crest of the Coast Ranges north of San Francisco. I was planning to travel the back roads—most of the roads are back roads—and visit the people who are struggling with these issues. I knew from a visit 15 years before that I would find generations of cattle ranchers, lumbermen, fishermen, miners, alternative life-stylers, Indian groups, and countless new settlers from elderly retired couples to burned-out yuppies to ambitious young entrepreneurs. As Darryl Young, a legislative representative of the Sierra Club California, told me, "Grass roots is the way to go here. That's what northern California's all about."

They live primarily in small settlements—major towns are few—scattered across a varied terrain. First come the great green patchwork patterns of the Sacramento Valley, embraced by the mountain arms of the Sierra Nevada to the east and the western Coast Ranges of Trinity, Klamath, and Siskiyou. Then the land rises abruptly, ridge upon ridge, to the soaring broken volcanic cones of 14,162-foot-high Mount Shasta, haloed by a strange lenticular cloud. Many religious sects have settled around its base, regarding it as one of the earth's vital "power centers." Most northern Californians see Shasta, at the least, as a powerful symbol of the region's identity.

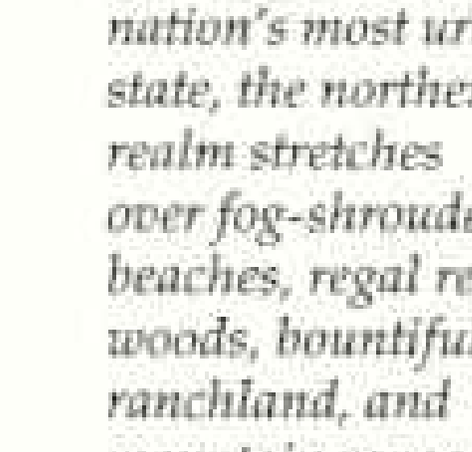
Beyond Shasta's high white flanks, the northeastern lava plateau stretches into ranching country. To the northwest the jumbled mountain ranges with their sinuous valleys cocooned in ancient Douglas fir, Jeffrey pine, and redwood forests surge down to one of the most dramatically beautiful coastlines in America—275 miles of soaring cliffs, headlands, and chiseled coves from Crescent City to Bodega Bay.

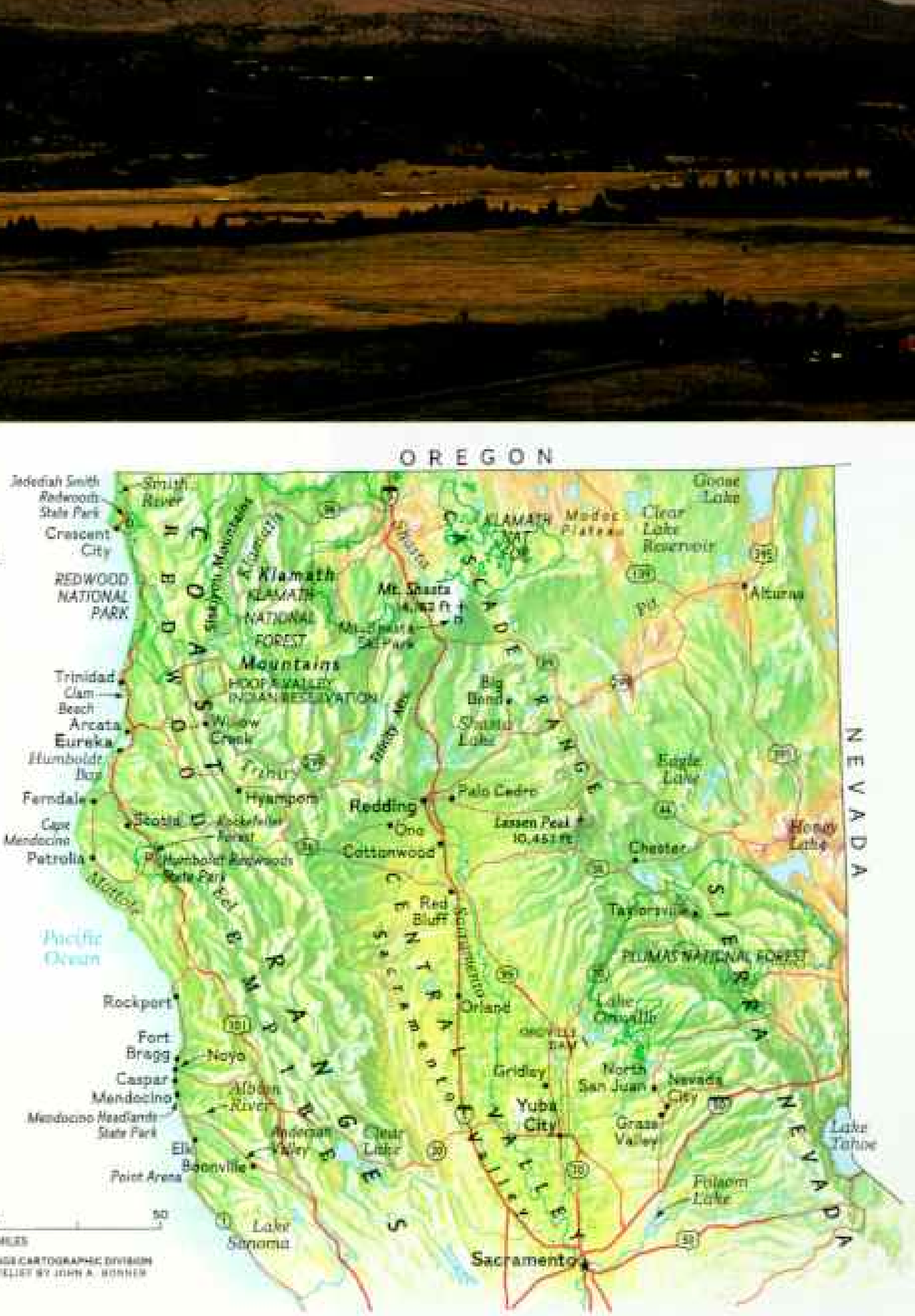
I began my journey on a clear-spun winter morning, bright as hammered silver, in the broad, black-earth farmlands of the Sacramento Valley. In the sleepy and slightly

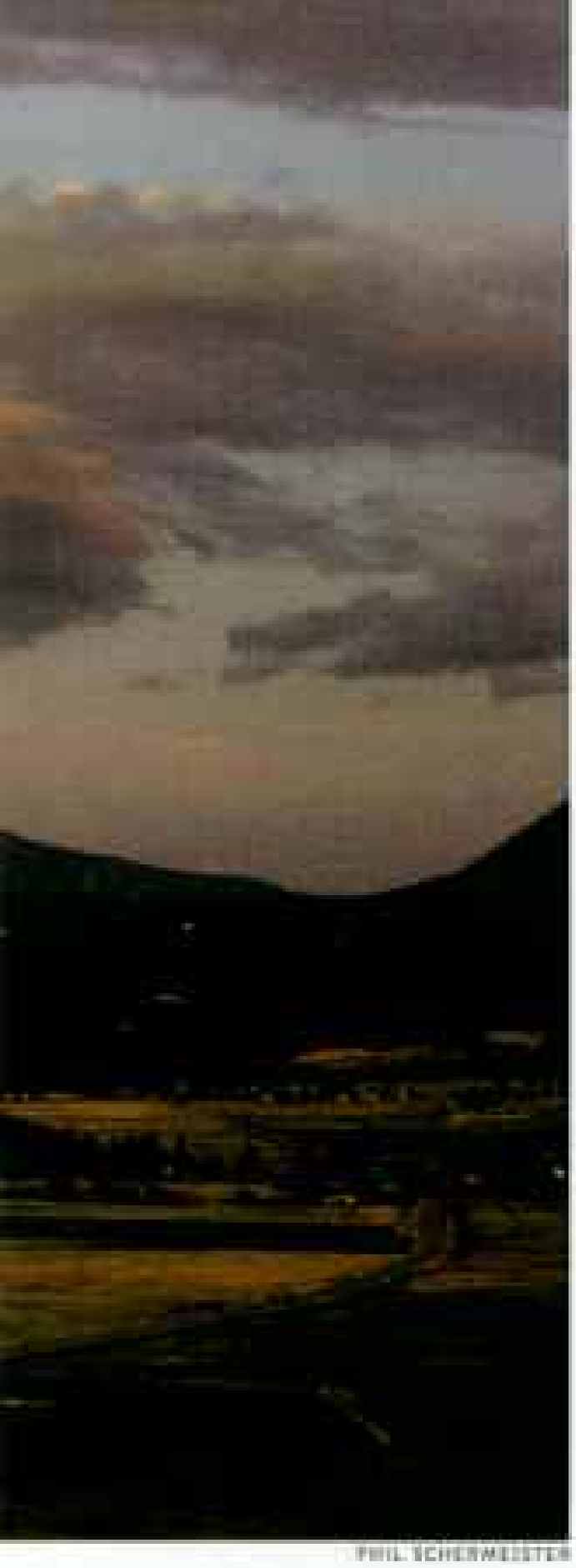
"Members and non-members only," warns the plaque outside Ferndale's sturdy Greek Investment Company, a café where retired dairy farmers—none Greek—gather daily to razz each other over rummy, 50 cents a game. The building survived a 1992 earthquake that slid dozens of houses off foundations. Residents pitched in to rebuild the town, touted by locals as the "Victorian Village" for its architecture.

Northern California

Rural crown of the nation's most urban state, the northern realm stretches over fog-shrouded beaches, regal redwoods, bountiful ranchland, and mountain ranges crossed by serpentine roads. Efforts to split these treasures from the rest of California are as old as the state itself.







PHIL SCHERMEISTER

"Lonely as God and white as a winter moon," wrote 19th-century poet Joaquin Miller of Mount Shasta, volcanic lodestar of northern California. Native Americans held that Shasta, said to have last erupted in 1786, housed the Great Spirit. Subsequent settlers have attributed all manner of magical powers to the geothermal giant, hatted with snow even when the Shasta Valley below bakes under a summer sun.

rundown old railroad town of Gridley (self-proclaimed Kiwi Capital of the U.S.A.), I paused to look in on Bill Burleson at the 112-year-old Gridley *Herald* (circulation 3,400). Like so many northerners, this 66-year-old third-generation publisher is a forceful man with plenty on his mind.

"Secession?" he said. "I'm all for it. The locals are all for it. We've got no voice in state government now. We need less regulations—too many damned regulations. We need to get to keep our own money."

When I asked about the water situation in the valley after six long years of drought, Bill scoffed. "Damned southern California, they'll drain us dry! If it wasn't for us, it'd still be desert down there. Look at this."

He pointed to a cartoon pinned on a wall entitled "HOW TO SOLVE SOUTHERN CALIFORNIA'S WATER PROBLEM." The sketch showed a gigantic lake filling the whole of California's Central Valley from Redding to Bakersfield, and a huge snakelike aqueduct pouring a limitless water supply into Los Angeles. "Secession," growled Bill, nodding his mop of silver hair emphatically. "It's the only way."

THE CATTLEMEN don't feel that frustrated gloom, up in the rich, undulating high country of Modoc and Shasta Counties. Every week the town of Cottonwood holds the largest cattle auction in the state. The chill morning air was thick and sluggish over the acres of cattle pens, and the bellowing of steers echoed across the hills. Norma's Branding Iron Restaurant was crammed with cattlemen and ranchers in Stetsons gulping great mugs of coffee and rib-eye-steak sandwiches the size of Frisbees. As they talked together, words rose slowly, deep from their chests. Row upon row of photographs on the walls honored generations of the region's cattlemen and cattlewomen. This was more than a commercial gathering place—it was a shrine to them all.

"You look around you and there's not a lot better places than this cattle country," said Wade McIntosh, an auction assistant, over coffee. "Maybe in some ways we're 20 years or so behind the times. We don't seem to get all those kinds of headaches like other areas. These guys, they're their own men up here. If there's troubles in the small towns—fires, people out of work, church needing a new roof—everyone helps out. They make it work as a community. What do they need secession for? They've already got it!"

I heard this same thing, in a different voice, from Mary Cole in Ono, a settlement in the rolling foothills of the Trinity range. Mary's Ono Store is a rough-cut lumber building with a worn hitching rail out front, a kind of country saloon and café complete with sawdust floor and steer horns nailed to the walls; a typical backwoods joint, with the exception of a flier pinned to the wall offering yoga lessons.

Born in Oklahoma some 60 years ago, Mary Cole moved here with her husband, Ken, in 1987 from southern California. She still describes herself as "a real Okie" with a glint of the determination that carried thousands of Okies to the state from the Dust Bowl in the thirties. As I munched on one of her locally renowned Ono burgers, she told me, "I'm staying. It's the only place to be for me. This is real special here, and us newcomers want to keep it just the way it is. We can work out our own problems." She smiled—a real Okie smile.

DAVID YEADON wrote on Britain's Pennine Way in the March 1986 GEOGRAPHIC. His book, *Lost Worlds: Exploring the Earth's Remote Places,* was released in June by HarperCollins Publishers Inc.

Toasty ovens streak the windows with steam at the Mendocino Bakery & Cafe, centerpiece of village life. A mill town settled by New Englanders, whose 19th-century clapboard houses still dominate the landscape, Mendocino found new life in the 1960s as an artists' colony and haven for free spirits. Tourists now swarm the streets, drawn by more than two dozen inns and the town's reputation for imaginative restaurants.

MELISSA FARLOW

I started heading west over the mountains toward the coast. Oak-shrouded hills swirled all around me; cattle grazed in small, secluded valleys, and lopsided old cabins peeped from behind sprays of thornbush and manzanita. The January air was fresh and sweet, and all around grasses waved in the wind like pale soft hair.

Then things changed. Gentle hills gave way to a steeper, eroded landscape as I moved higher into the scrub-covered mountains. I heard the rasp of winter in the dried stalks and bushes. The road twisted erratically along the edge of precipices tumbling into shadowy canyons. No sign of cabins or cattle now or anything with real life in it.

A few minutes later there wasn't much life in me either as I became submerged in a furious and unexpected snowstorm. Reluctantly, and with great difficulty, I turned tail and crept around the southern end of the ranges, fighting rockslides and silt-laden floods in rainstorms that melted the hills like chocolate. Lightning cracked over the ridges. Finally I reached the safety of the coast.

Not ready for a llama's love, first grader Ryan Stephani spurns a nose-to-nose kiss in Palo Cedro. Veterinarian Betsy Adamson, at center, finds the gentle camelids helpful in teaching Redding area students about animal life. Local breeder Pat McCarthy, who sells llamas as pack animals and wool producers, says they're also soothing to adults. "Sometimes people come over when they're having a bad day," she says, "just to walk among my llamas and relax."

MENDOCINO sits atop its cliffs, a lacy frill of Victorian architecture against lines of dark pines. I had dreaded my visit here. Tales of coastal development had made me wonder what disasters might have befallen this tiny arts community, despite the zealously protective environmental regulations of the California Coastal Commission. But somehow, through years of community wrangling and battles with developers, the little village has held itself intact, charming and cozy as ever. A few more hotels and guesthouses perhaps, certainly a little more cutesy and commercial than I remembered from my earlier visit, but still recognizably Mendocino.

"We've managed to keep a real community spirit here," Christiane McLees, editor of the *Mendocino Beacon* told me, "despite the tourism, the developers, and everything else." With tourism one of the few real growth industries in northern California, small towns must fight hard to balance the pressure for development with their desire to retain community spirit. Mendocino, happily, is keeping that balance.

That evening I had a typically coastal California choice of activities. On the high-culture side a local theater offered a performance of *Ankoku Butoh* dance, the modern Japanese "dance of darkness." According to the flier on a community bulletin board, it is characterized by "almost no movement . . . an entranced meditation where the body is as an empty shell."

In the mood for something with a little more motion, I headed just over the rise to the bunched and squat village of Caspar. The Caspar Inn, an oasis of shaggy friendliness, was swaying to the sound of blues. The inn was celebrating its 13th anniversary in a bacchanal of boogie and bonhomie and spirited discussions among this mixed community of artists, poets, farmers, and old-time hippies (they like to call themselves "outlaws"). Peter Lit, the owner, sat with me by the chip- and

JOEL SARTORE

nut-strewn bar watching the furor and whispering, "It's wonderful, it's wonderful."

NEARBY FORT BRAGG seems to have less to celebrate. A workhorse kind of place set around the rocky cleft of Noyo Harbor, the town is fighting for its survival. Tight government restrictions on salmon and other fishing, coupled with a questionable future for its sawmills, have left the community confused and angry.

I saw a notice in the window of Perko's Koffee Kup café for a meeting of the Noyo Women for Fisheries. Sea lions barked a greeting as I parked my car by the Salmon Trollers' Hall, a one-story clapboard building on the harbor; there were piles of crab pots around and sad broods of salmon boats, all for sale.

Inside was a roar of rhetoric from a dozen wives of local fishermen ranging from young mothers to steely-eyed older matrons, all venting their frustration at the federal government's virtual shutdown of salmon fishing due to the badly depleted runs. Since 1978 the U. S. Department of Commerce has limited salmon catches off the Pacific coast. In 1992 came a complete ban on commercial fishing from Point Arena, north of San Francisco, to Florence, Oregon, and severe restrictions are likely to continue.

"Many women have had to take on the role of breadwinner in the family," said diminutive Cat Talbot, the no-nonsense president of the group. "It's hard to see your husband wandering aimlessly through the days,

wondering how he's going to make a living and keep his family together."

"Not so long ago, my sons, my husband, and I all fished together," said Printha Platt, her bright, sparrow-like eyes flashing with anger. "Now because of the restrictions he fishes alone, mainly crabbing. One son has gone up to Alaska, and I'm working at a local hotel.

"The problem is that these restrictions on fishing don't deal with the real causes," she went on. "Most of our salmon spawn hundreds of miles up the Sacramento River system, so how the valley farmers use the water there affects us directly. Bad timber practices also affect the watersheds of the coastal rivers—eroded land, silted streams, increased water temperature because of the removal of shade canopy; they destroy the spawning grounds. These are the kinds of problems that must be solved."

The women struggled to agree on plans of action, but their sense of impotence was palpable and their predictions dire.

My mind wandered in the overheated room. The previous night I had attended a full-house production of a musical, *Queen Salmon*, at a nearby community center. Typical of the thriving artistic creativity of coastal residents, this satirical piece was written, directed, and acted by locals and demonstrated that committee rooms aren't the only place for community outreach. This show portrayed the plight of the beleaguered fish and emphasized the need for fishermen, farmers, ranchers, lumbermen, environmentalists, and biologists all to cooperate to restore the streams. It also reinforced Printha Platt's call: "We've made sacrifices, but it shouldn't just be the fishermen," she had said firmly. "Everyone has to give a little and work together."

A start has already been made. Scott McDermid and Nat Bingham (grandson of explorer Hiram Bingham, who unearthed Machu Picchu) are trying to show how it can be done. They are out-of-work Noyo fishermen who now travel the Central Valley and coastal watersheds, trying to connect them.

Nat Bingham, a lanky, serious man with a ragged mustache and alert eyes, emphasizes that, for the benefit of the salmon, there needs to be sustainable-yield forestry by replanting in the coastal area to reduce erosion and sedimentation. He also says that farmers and ranchers should maintain a certain flow level

RANDY OLSON (RIGHT); MELISSA FARLOW

Tootling "Rubber Ducky" and "Anchors Aweigh," Erich Kruger leads the Humboldt State University Marching Lumberjacks in their annual soggy serenade to racers in the Trinidad Clam Beach Run. The chilly salt water cracks woodwinds and tarnishes brass, so the Lumberjacks leave their good instruments at home when wading into the Pacific. Humboldt State students swell the population of Arcata to 15,200—making it the second largest city, after Eureka, on the stark 300-mile coast (right) between San Francisco and Oregon.

JOEL SARTORE

Elder statesman of the groves, 77-year-old Hartley Bowmar carries a sack of oranges to a collection bin in Orland, at the northern edge of California's citrus-growing belt. Bowmar and his fellow pickers earn the minimum wage, with bonuses for high production and, he says, "free fruit and lots of exercise." Bowmar plans to keep working, zipping between Sacramento Valley groves on his motorcycle, "as long as I can still scurry up the ladder." He adds: "I never get tired of the smell of oranges. It's like perfume."

in the foothill streams of the Central Valley.

"I'm out there on behalf of the trollers," he told me, "talking to the valley people and getting them to work together. I explain that I am a food producer too, just like them, but I'm out of business this season because of what they're doing with their water.

"If that doesn't work [Nat tempered his words with a touch of irony], I remind them about the Endangered Species Act, and that some unique stocks of salmon are getting wiped out in their streams, and that their water use could get cut off. Usually then we get on fine.

"It's beginning to turn around," he said. "The salmon counts are rising; the spawning beds are improving. Things look promising, even though we've still got those problems with the big lumber companies."

I WAS HEADING toward lumber country as I made my way north toward the town of Eureka on Humboldt Bay. Whales were spouting in the heaving gray ocean, and the surf, whipped by chill winds, tore at black cliffs and coves. Brief shafts of sun gilded the bright scythes of seashore, and the grace notes of gulls echoed in the spume haze. Abruptly, the road left the coast just north of Rockport and wended upward through thickly forested valleys deep into the Redwood Empire.

I was among the mighty 300-foot-high,

A winter hayride is all work for ranch hands David Flournoy and Rick Littler, packing feed in Modoc County. Down in Red Bluff, heart of the state's cattle country, the Bull and Gelding Sale attracts cowpokes (below) from across the West. The Stetsons may not have changed in the show's 52 years, but other things have. Says manager Tyler Martinez, "This year one auction bidder was getting instructions from his boss on a cellular phone. That's the first time I've seen that."

JOEL SARTORE (BOTH)

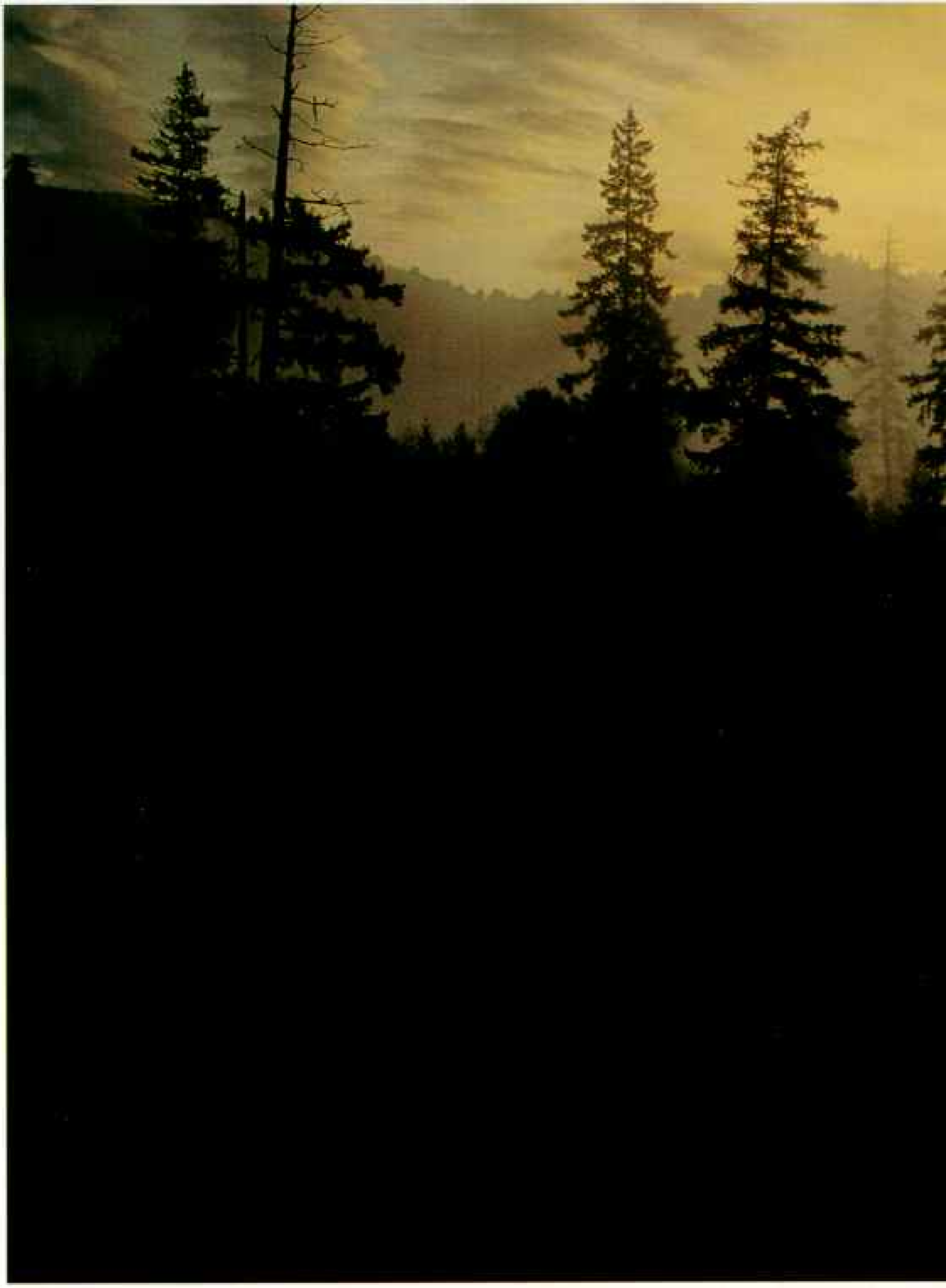
2,000-year-old monoliths, the giant *Sequoia sempervirens*, the tallest trees on earth. Before logging began here in the mid-1800s, these forests stretched hundreds of miles up the Coast Ranges into Oregon, a land speaking of itself proudly in sculptural oratory.

But during the past century, intensive logging has stripped most of these magnificent old-growth forests. Nearly all the remaining original stands of coast redwoods are now protected in 35 state parks and various federal reserves. This is largely due to early initiatives of the Save-the-Redwoods League, the Sierra Club, and the National Geographic Society (whose concern for the redwoods stretches back to the early 1900s), which led to the formation of Redwood National Park in 1968. Yet while broad legislation now guards the estimated 5 percent of old-growth trees still standing, clear-cutting continues on private lands in many mountain watersheds.

"The problem is not so much the lack of legislation," said Tim McKay, director of a nonprofit environmental group called the Northcoast Environmental Center. "There's plenty of that. But it's full of loopholes, and there's far too much fragmentation of state and federal policies. We need to establish large regional coalitions. Even Bruce Babbitt, the Secretary of the Interior, has stressed the need for better legislation reflecting the ecosystem approach. It's the only way to go."

For a while it seemed as if northern Californians almost took pride in fighting one another. But their love for this region—and perhaps a growing sense that they may all be equally at risk—has impelled them to try cooperating. Their goal, something new they call bioregionalism, is similar to the ecosystem approach.

Bioregionalism means that instead of separate groups struggling to protect their chosen fragment of the environment—the trees, the



Salmon-rich Smith River winds through a misty morning near the Oregon line. Salmon stocks are shrinking in most of northern California, victim of overfishing and the cutting of trees too close to riverbanks. Silt clogs the waterways, destroying spawning habitat. Redwood groves are protected

PHIL SCHERMEISTER

here in Jedediah Smith Redwoods State Park, one of 35 state reserves for the tall trees that draw moisture from winter rains and year-round cooling fog. In a delicate dance of nature, the fog is just as dependent on the redwoods. Without shade, heat from the ground would evaporate the fog.

fish, the water—they work together to preserve entire watersheds. It began with conservationists working at the local level and gained some muscle with the passage of stronger environmental legislation. Now, in the valleys of such rivers as the Albion, Eel, Mattole, Klamath, and Shasta, former adversaries have been moving into calmer coalitions.

Success at the local level has led to new awareness at the state level. Led by Douglas P. Wheeler, California secretary for resources, the state is framing new integrated planning strategies for its ten bioregions. The goal is to create a more coherent approach to solving environmental problems by coordinating the myriad, often contradictory agencies and programs. Or, to put it another way, to tailor the plans to fit these ecosystems. As Wheeler says, "to make the management systems align with natural systems. That way we wouldn't work at cross-purposes. We'd work jointly on the health of habitats."

"I want this tree to outlive me," says a man who calls himself Darkmoon and wafts a melody over the sound of chain saws 65 feet below. To keep loggers from felling the redwood tree on a ridge above Mendocino County's Albion River, Darkmoon remained strapped to his tiny platform for 33 days, eating food sent up to him on a line. The tree survived. Not so fortunate were trees in a Shasta County forest fire; in the aftermath, a lumberman hooks logs to a bulldozer to skid them down the mountain.

TO SEE some of the logging operations, I headed for Scotia by way of back roads through the towering trees of the Rockefeller Forest in Humboldt Redwoods State Park, up and over the high ridges, alongside the roaring Mattole River, and down to sheep-cropped salt meadows by the black sand beaches of Cape Mendocino. In this wild region, known locally as the lost coast, once embattled factions have aligned with the Mattole Restoration Council, whose members are restoring salmon spawning grounds, reforesting slopes to prevent sedimentation of streams, and urging sustainable timber harvesting.

The narrow road wound on northwards through more forested and mist-bound ranges into a verdant land of velvety fields around Ferndale, dotted with cows, tiny schoolhouses, and exquisite gingerbread homes. Here I understood once again the ardor and dedication of the local people who are working so hard to maintain what is left of this ancient grandeur and beauty.

Almost 40 lumber mills throughout northern California have shut down or reduced operations since 1990, and loggers blame the people they call enviros for the growing unemployment. Others insist that the real cause is poor forest management by government agencies and the huge lumber companies.

Many single out the 124-year-old Pacific Lumber Company in Scotia, praised by environmentalists before its takeover in 1986 by Charles Hurwitz and Maxxam, Inc. According to the company's critics, felling on Pacific Lumber's 195,000 acres of privately owned land rapidly deteriorated into an avaricious "cut and git" policy for quick profits.

John Campbell, president of Pacific Lumber, denies the charge. "We're just too easy a target," he said. "We only cut on 6 percent of our holdings annually. We feel besieged and hurt, but we're still in it for the long haul."

Outside the Pacific Lumber offices I strolled around Scotia, a true company town of cookie-cutter clapboard cottages set on immaculate lawns overlooking "The World's Largest Redwood Lumber Mill." I saw pickup trucks bearing crude bumper stickers: "SAVE A LOGGER—EAT AN OWL" and "I LOVE SPOTTED OWL . . . SOUP."

PHIL SCHERMEISTER (BOTH)

Nimble as a tightrope walker, "pond man" Ron Betts guides Douglas fir logs into the mill at the Pacific Lumber Company in Scotia. Layoffs in lumber, a downturn in salmon fishing, and state and federal crackdowns on marijuana farming have knocked the region's economy off-balance. In Red Bluff, laid-off mill worker Bob Houk visits the library twice weekly to struggle through reading workbooks such as "Finding a Job" with public services coordinator Cindy Byers. "I'm not stupid," explains 59-year-old Houk. "I just don't know how to read."

RANDY OCSEN (FACING PAGE); PHIL SCHERMEISTER

Although many residents seemed morosely reluctant to discuss the troubles of the logging industry, the ones who did talk to me admitted that "them damned do-good tree huggers" were not the only problem. Tighter environmental restrictions by federal and state agencies, they said, had been primarily a response to the destructive felling practices of the past. With some cut redwoods selling for between $10,000 and $15,000 apiece, it was too tempting to keep cutting. The recent worldwide recession has also been a factor.

There are positive signs too. For years some companies have espoused selective felling, introduced lighter machinery to lessen damage to the soil, and built fewer logging roads.

The Collins Pine Company in Chester, up in the shadow of Lassen Peak, is one example of the more careful approach. Larry Potts, the general manager, told me that for more than 50 years the company has practiced sustained-yield forestry on its 92,000-acre holdings.

"Our measure of success is to have our forest looking very similar in a hundred years to how it does today," Potts said. "There's no reason why logging operations can't survive despite all the new restrictions. Compared with the big boys of the industry, our landholdings are not large at all, so it's a matter of self-interest as well as environmental protection, and we're showing that it can be done."

Even relatively small efforts are a vital improvement on the old methods. Slashes of clear-cuts still scar the land. There was an aura of sadness about the forests; feeling it, I was reminded that the sense of the soul of these woods was what inspired so many groups to endless outcries and lawsuits against the logging industry. And I also remembered how John Muir had called his beloved Sierra the "Range of Light."

"Remember those words," journalist Tom Knudson had written. "For they are more than a vision of what once was, they are a dream of what could yet be."

From the edge of the vast Klamath National

Horsewoman of the north coast, champion endurance racer Lari Shea, at right, leads friends along Ten Mile Beach, north of Fort Bragg. Lonely coasts once were home to Native Americans; the remoteness helped keep out the Spanish missionaries who were changing Indian life in southern

HELUVA FARLOW

and central regions. Confined by mountainous terrain, the first northern Californians developed distinct cultures within the space of a few miles. Today northern Humboldt County houses the state's largest and most populous reservation—the Hoopa Valley, with 1,200 tribal members.

Skiers get traffic instructions at Mount Shasta Ski Park, California's newest winter resort. At Big Bend on the Pit River (right), nature boys Duncan, left, and Danean Christiansen need no reminder to take it easy, as they soak in a hot pool near the small trailer they share with their father. City kids might turn up their noses at the dirt roads and poor television reception in the secluded heights of Shasta County, but the 12-year-old twins say they love rafting, fishing, and swimming—and watching out for UFOs in the starry night sky.

PHIL SCHERMEISTER (RIGHT); JOEL SARTORE

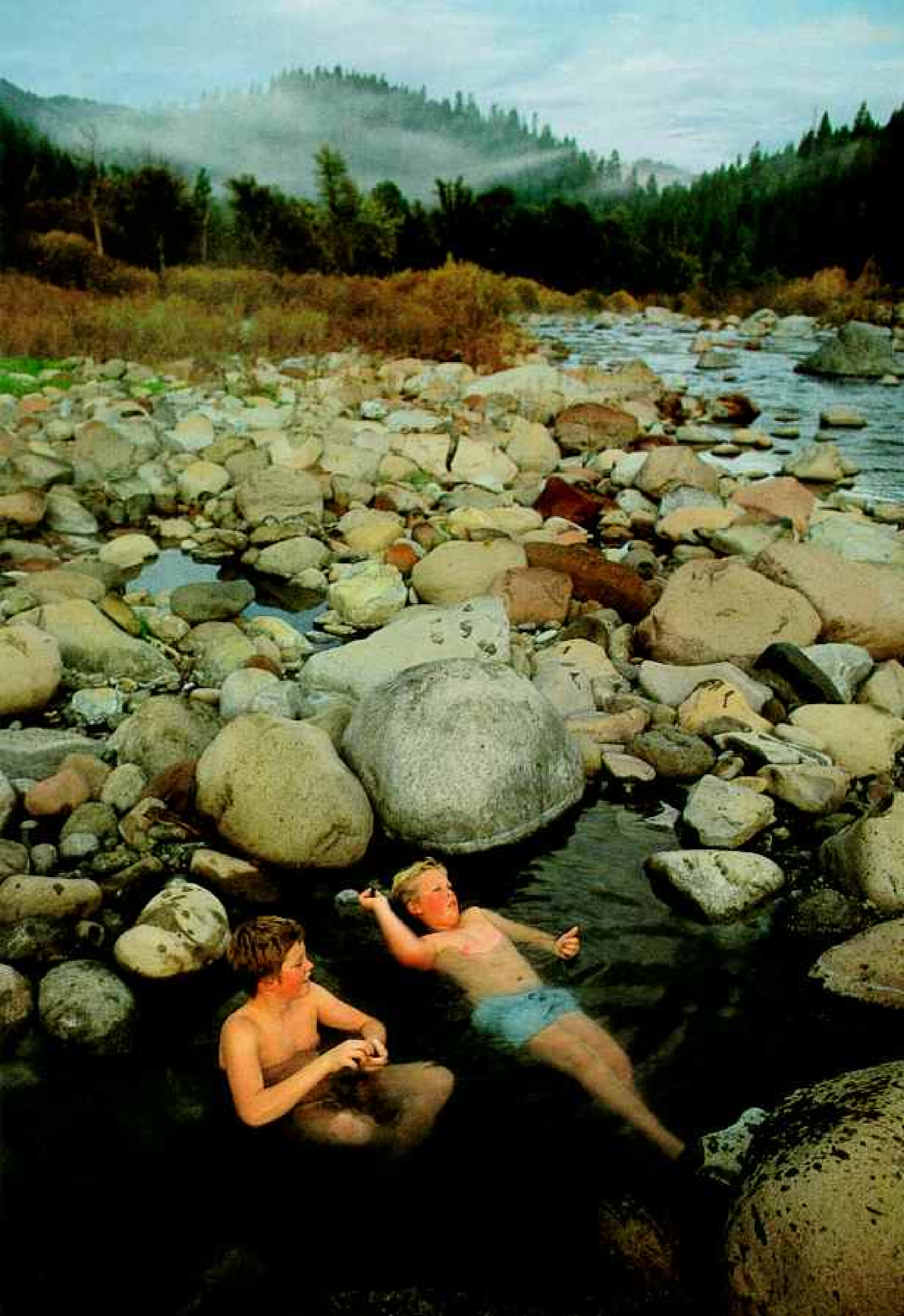
Forest, canyons and soaring ridges rise toward the summit of Mount Shasta. For many of the reclusive sects that have come here over the decades, the mountain is one of the earth's most mystical places. But Shasta has been sacred much longer than that.

The Hoopa tribe has lived in these parts for perhaps 10,000 years. North of Willow Creek, I visited the 1,200-member Hoopa Valley Indian Reservation. Jimmy Jackson, at 83, is one of the oldest members, and he held his wiry body erect with pride as he showed me the restored village of his ancestors, a sweathouse, and a series of cedar-plank dwellings built around sunken fire pits. By the prayer house he pointed out stone slabs inscribed with the tribe's 13-month calendar marked with moon phases, and he gently rubbed the huge river rocks set in the ground. "These are the doctor rocks," he told me. "They keep the medicine, the energy, for the dances we borrow from the White Mountain"—he pointed east—"from Shasta, where it all begins.

"We still perform the old dances," he continued as we wandered along the banks of the Trinity River in the heart of the reservation. "The White Deerskin Dance, the Jump Dance, all of them. We keep them going to keep everything right—the fishing, the hunting, everything. Using the medicine. You've got to get it right, you see. Keep the balance."

THE BALANCE is something all northern Californians seem to be striving for. The cry for secession is merely one passionate example of that. No matter how bad things get, people are determined to stay. They keep looking for new ways to make a living. Some of the ideas are typical of northern California—pragmatic and yet romantic, and somehow always in tune with the land.

Irl Everest of the U. S. Forest Service told me about a series of new projects they're working on to create jobs for families in rural areas. "We're giving grants for wildcrafting,



mountain gardens for herb growing and sales, and land-stewardship activities," he said. "You're talking about a very different kind of Forest Service here—helping communities help themselves."

I had even heard on the back roader's grapevine that families around Hyampom had worked with the Forest Service to develop a new livelihood. Apparently there's an increasing demand both in the U. S. and Japan for Jeffrey pine cones, herbs, and even broken, moss-covered branches for home decoration. Some former loggers were now beginning to make a reasonable living from such activities.

When I asked about the pinecones, Milt Mortensen, a onetime logger (and ax-throwing champion), told me happily, "It's working for us. The potential's here. My grandfather came to these mountains in 1892, and we're not planning on leaving. We're all hanging in and making it work."

On a good day Milt loads his old pickup truck with more than a thousand pinecones that he has gathered from around the towering trees. "At 24 cents apiece—that's $240—it's not a bad living," he told me. "Doesn't quite

JOEL SARTORE

Detoured by heavy snow, pronghorn antelope take to the open road over the Modoc Plateau. Independent-minded citizens of northern California face their own set of obstacles in the sprint for political and economic power—with or without the rest of the Golden State.

match the $40,000 a year a good logger made, but at least I'm still here—and happy!"

I found another traditional form of self-help flourishing in the hamlet of Taylorsville, high in the ranching and logging country of the Plumas National Forest. Seventy-nine-year-old Margaret Cooke and the 25-member Coffee and Sewing Group have been making quilts for years, which they sell to keep the church and community of 250 people together. The ladies, who range in age from 62 to 83, spend most of their spare time at home quilting, then come together for bees at the local Methodist church on Tuesdays and Fridays.

"Lumber-mill closings have hurt a lot of people," Margaret Cooke told me, "but the money we raise helps people out with groceries and bill payments. We're doing things our way up here. We've had our own kind of secession for years."

ON THE LAST LEG of my journey I drove through the gold country of the northern Sierra. Once prosperous mining towns and villages, places like Grass Valley and Nevada City, are now becoming commuter towns for cities in the Central Valley. Subdivisions and retirement condominium developments in the hills are replacing old miners' shacks hidden in the forests. There is even a freeway.

Yet the old northern California spirit is still alive. A few miles north of Nevada City is North San Juan, a raggle-taggle village set deep in the hills. Here an artist/organic farmer named Arlo Acton has been successfully resisting these changes. The town is still a tranquil, backwoods place of dusty silences, surrounded by dark forest fringed with ferns and by small fields of horseback brown earth.

"Just the way we want it to stay," Arlo told me. "I've been planting trees for 18 years to hold erosion, restore the balance, and bring the land back. It was a struggle at first, getting everyone together to hang on to what we love. It meant sacrifice, but now it's working. It's a kind of people-led grass-roots secession!

"Political secession—splitting the state—is not the real point. We've got too much to do to get our region in shape to think about issues like that. The vote drew attention to our problems. But now we've got to solve these problems ourselves. You see, it really starts with each person controlling his own destiny and working with the community. Balance, that's what it's all about."

Slowly, slowly the balance is being restored to this magnificent region of America. □

Lightning slices through rainy skies over Tucson, Arizona, in a five-minute time-exposure view from Tumamoc Hill. A regular feature of Arizona summers, such storms erupt when moist air flowing in from the Gulf of California collides with nearby mountains and is forced upward, where it condenses into towering thunderclouds.

LIGHTNING

NATURE'S HIGH-VOLTAGE SPECTACLE

By WILLIAM R. NEWCOTT Photographs by PETER MENZEL

NATIONAL GEOGRAPHIC EDITORIAL STAFF

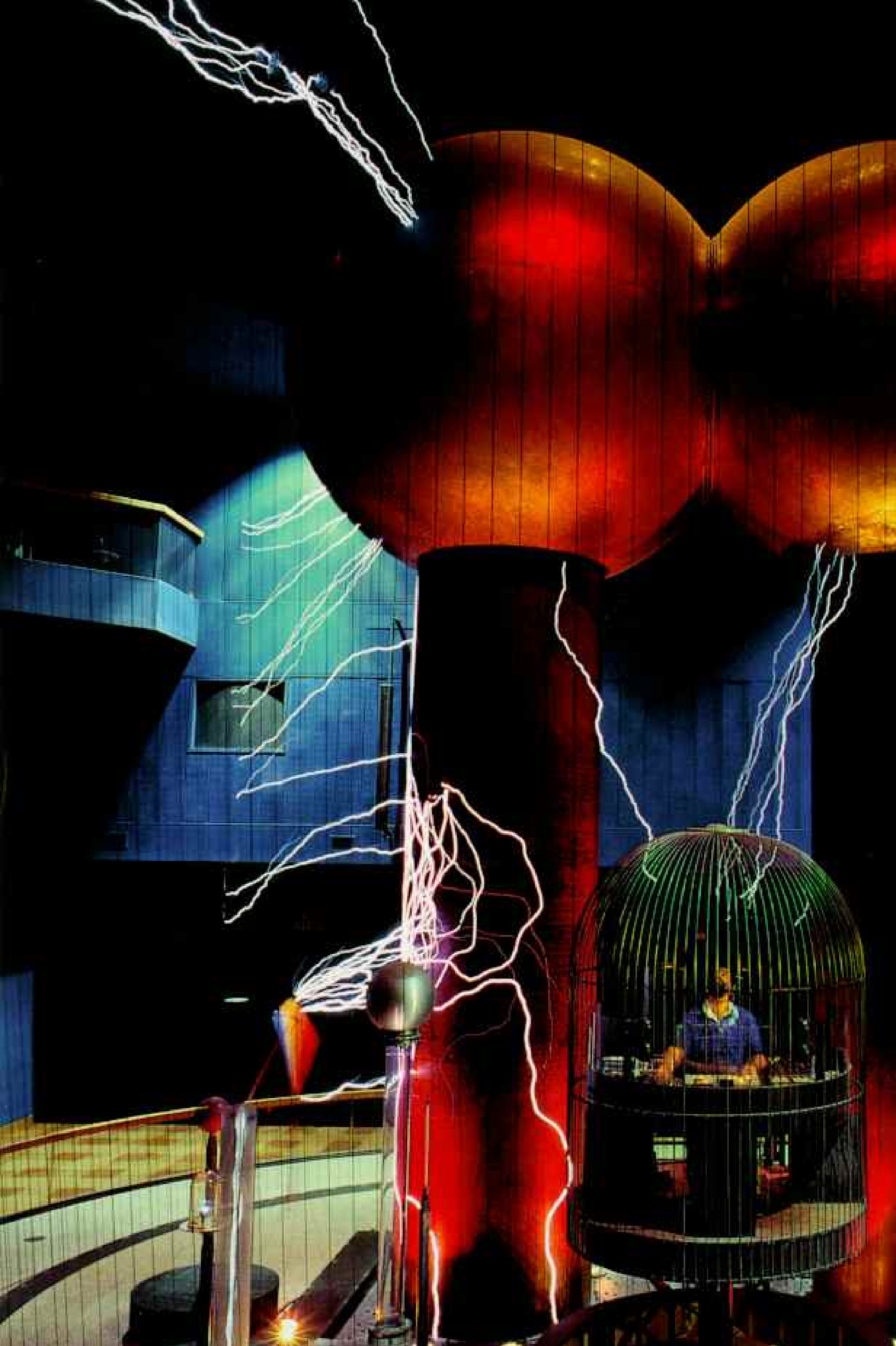
TSUYOSHI NISHIINOUE, ORION PRESS (FOLLOWING PAGES)

IT IS A RIVER of electricity rushing through a canyon of air. Careering as fast as 100,000 miles a second, lightning sears wild and unstoppable through twisted channels as long as ten miles.

Drag your shoes along a carpet. You become a thundercloud. Your scuffing pulls electrons from the fabric, giving you a negative charge. Reach for a metal doorknob. It, like the earth under a thundercloud, is positively charged. Since opposites attract, when you get close enough, zap—the excess electrons stream to the knob in a miniature bolt.

Volcanoes can create lightning with no storm in sight. Over Japan's exploding Sakurajima (following pages), friction from swirling ash particles generates electric discharges.

Fiery sparks (left) crackle from a metal tube held by Bill Wysock, who also lights a 40-watt bulb in his hands. He sits on a metal disk linked by a cable to a 1.5-million-volt Tesla coil, a transformer producing high-frequency currents that pass safely over the surface of his body. Low-frequency currents would pass through it, meeting resistance and causing injury.



SAFE BEHIND BARS

An oversize birdcage keeps operator Don Salvatore from being jolted by a 2.5-million-volt Van de Graaff static electricity generator at Boston's Museum of Science. The artificial lightning passes through the metal frame —a principle that protects motorists in thunderstorms. Grounded wires surrounding the exhibit serve as lightning rods to protect visitors. Physicist Robert J. Van de Graaff built this model in 1931.

Reaching toward thunderclouds, skyscrapers can initiate lightning. Branches streaking upward from an antenna atop New York's World Trade Center (below) typify ground-to-cloud lightning, common from tall buildings and mountaintops.

ENCOUNTERS AT GROUND ZERO

One lightning bolt and one 65-foot sycamore tree make a convincing argument against taking refuge under branches during a thunderstorm. Considered by experts one of the best pictures ever made of a lightning strike, the image at left was taken in 1984 by Johnny Autery of Dixons Mills, Alabama, from his pickup truck.

A remarkable detail in the photograph is a pair of upward discharges: one from atop the sycamore to the left of the main bolt and the other reaching from the television antenna of the farmhouse at left. Such discharges occur only in the area of a downward stroke.

"That little bolt took out one of the family's TV sets," reports Autery. "I guess if the big one had hit there, a lot worse would've happened."

Most trees survive direct hits with little damage as the current passes over their surface to the ground. After a decade, this sycamore still stands.

Golfers are prime targets for lightning—they tend to either stand in open grassy areas or huddle under trees. A scored pattern on the fifth green at Phalen Park Golf Course in St. Paul, Minnesota (above right), defined ground zero where four golfers were injured—one fatally—by a June 1991 strike.

When lightning tunnels into sandy soil, the heat often fuses it into the shape of the electricity's path. Called fulgurites after the Latin word for lightning, the formations can measure longer than 15 feet. This sample, from the Arizona-Sonora Desert Museum in Tucson, was dug up by a witness who saw lightning strike the ground in Arizona's Avra Valley.

© JOHNNY AUTERY (FACING PAGE); © MIKE MAGNUSON, WEATHERSTOCK (TOP)

IN THE LINE OF FIRE

Swimmers are sitting ducks for lightning, so at a water park near Tucson, manager Ed Arrighi (above, at left) keeps a watchful eye on a distant storm. He is aided by a lightning detector that can register unseen flashes in the clouds above.

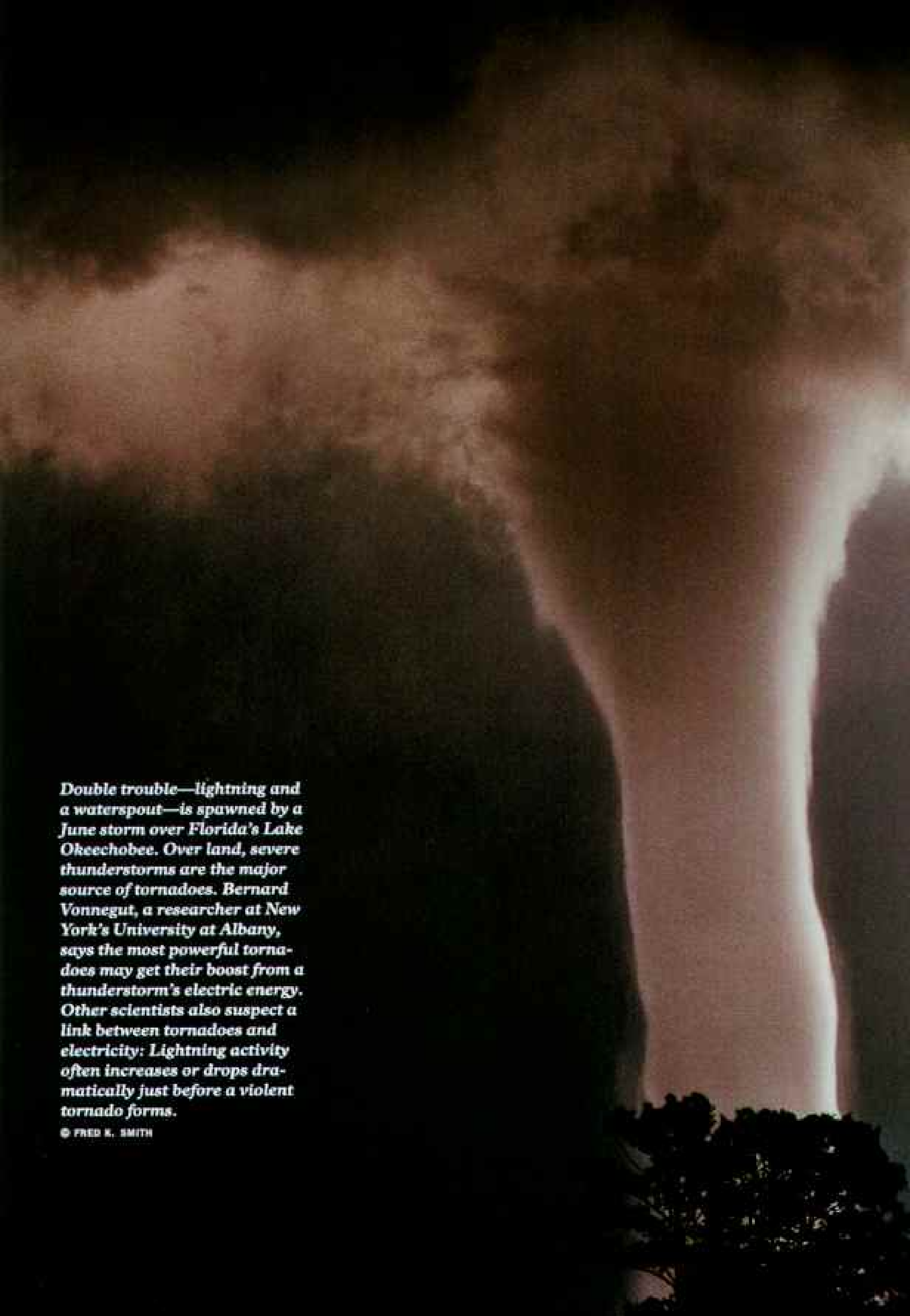
More than a year after lightning nearly killed him during football practice, Toy Trice (above right) still doesn't want to talk about it. Eyewitnesses in Burtonsville, Maryland, saw a bolt tear a hole in the high schooler's helmet, burn his jersey, and blow his shoes off. Toy's breathing stopped, but he was resuscitated on the spot.

About a hundred Americans die from lightning each year, yet survival chances are excellent if quick first aid is nearby, says University of Florida professor Martin Uman, one of the world's leading lightning experts. "The fact is, lightning isn't that good at killing you."

He and E. P. Krider, of the University of Arizona, invented a nationwide detection system that, on a computerized map, shows virtually every lightning flash as it happens. Such information enables scientists to plot lightning frequency over the

U. S. on maps like the one at left.

In the course of a year, the most intense concentration of cloud-to-ground lightning assaults central Florida, which has plenty of lightning's two major ingredients: moist air and sun-heated surfaces. In contrast the Pacific Northwest, which has very damp air but low mean temperatures, sees almost no lightning.



Double trouble—lightning and a waterspout—is spawned by a June storm over Florida's Lake Okeechobee. Over land, severe thunderstorms are the major source of tornadoes. Bernard Vonnegut, a researcher at New York's University at Albany, says the most powerful tornadoes may get their boost from a thunderstorm's electric energy. Other scientists also suspect a link between tornadoes and electricity: Lightning activity often increases or drops dramatically just before a violent tornado forms.

HOW LIGHTNING STRIKES

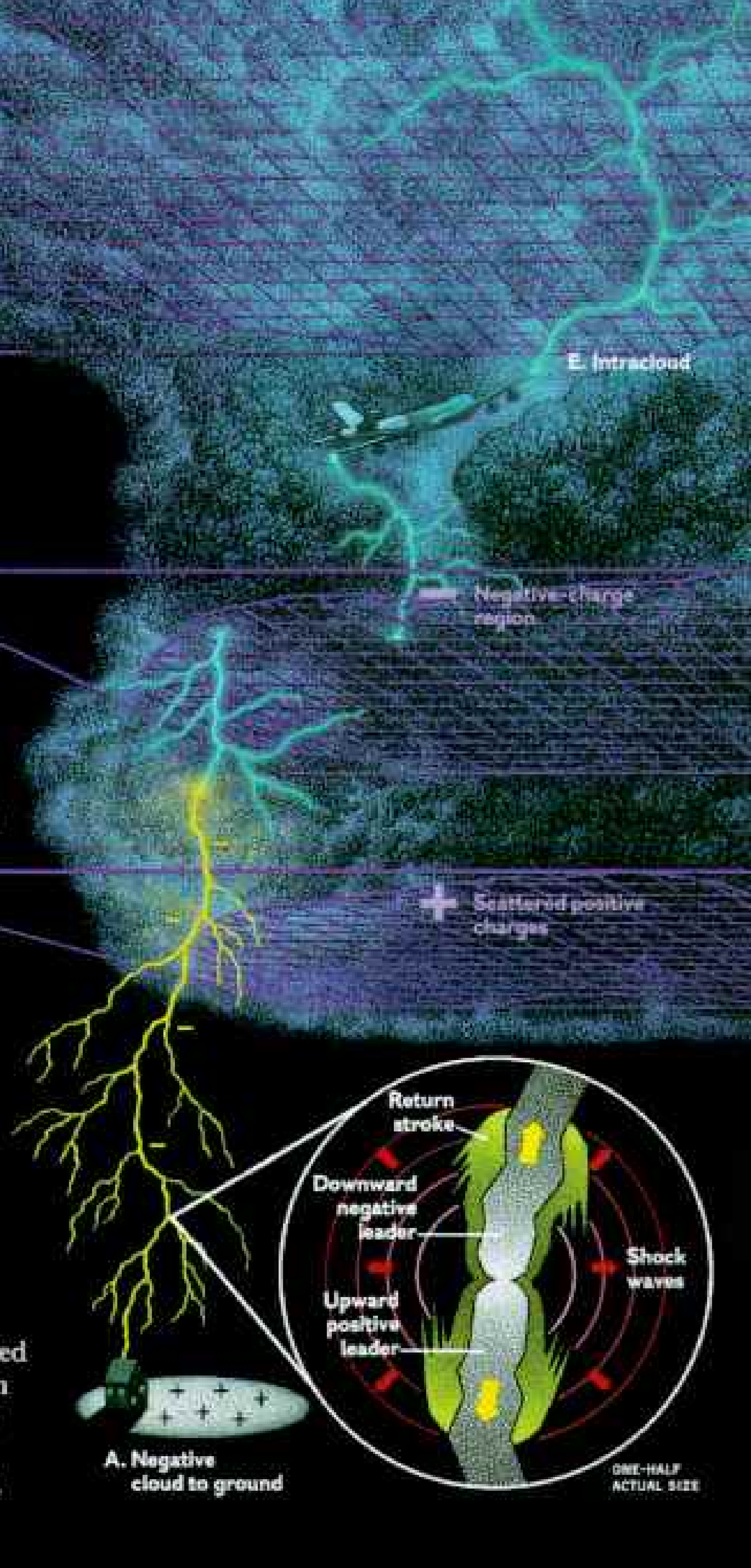
A cloud-to-ground lightning flash throbs with hundreds of millions of volts, more electricity than could be produced by all U. S. generators combined during that instant. Yet the flash is so brief that the electric energy where it strikes would power a light bulb for only a month or so. Virtually all lightning energy is converted into light, thunder, radio waves, and heat. The peak temperature of 55,000°F in the channel lasts a few millionths of a second—barely long enough to singe a victim's clothes.

As a thundercloud billows, rising ice crystals collide with falling hailstones (inset above). The hail strips electrons from the ice. The top of the cloud becomes predominantly positive and the bottom mostly negative, with scattered positive areas at its base (large diagram at right). Negative charges in the lower cloud induce a positive region, or "shadow," on the earth below. Static electricity builds, and a negative spark is launched from the lower cloud by a yet unknown trigger.

The descending spark creates jagged, branched channels; upward sparks sprout like weeds from the ground. When an upward and a downward spark meet (inset at right), the stroke we see spreads in both directions, superheating air and creating shock waves that produce thunder.

Blazing a Trail

Starting in the cloud (1), a negative stream of electrons emerges as a dim spark called a stepped leader (2). It jumps in 50-yard lengths (3), meeting a rising positive spark some 50 yards aboveground. Their paths form a channel (4) for the visible return stroke (yellow, 5). As the stroke ends, in-cloud discharges called J and K streamers (6) reach toward the channel. Sometimes another downward spark, called a dart leader (7), initiates a second return stroke.



4

Channel

5

Return stroke

6

J and K streamers

7

Dart leader

F. Intercloud

Lightning Anthology

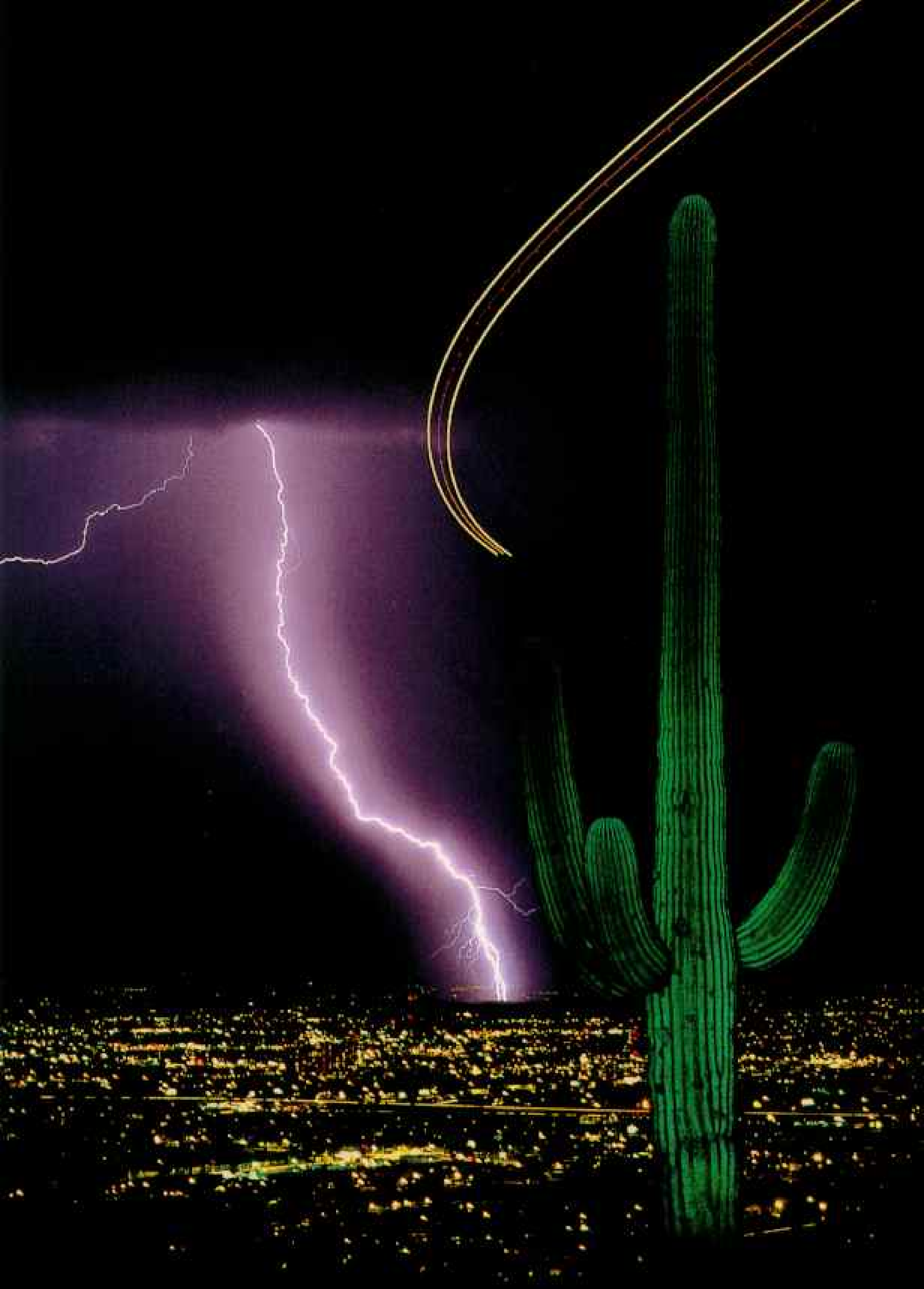
Both negative cloud-to-ground lightning (A) and positive ground-to-cloud lightning (C) connect negative cloud regions with the ground. Other types (B, D) link the top of the cloud and the ground. Lightning in and among clouds (E, F), a hazard to planes, is often seen from earth as sheets of light.

PAINTING BY EDWARD S. GAZSI
CONSULTANT: MARTIN A. UMAN, UNIVERSITY OF FLORIDA

B. Positive cloud to ground

C. Positive ground to cloud

D. Negative ground to cloud



FLIGHT INSURANCE

An airliner's lights trace a path around an intense summer thunderstorm, a routine maneuver for pilots on approach to Tucson International Airport.

On average, individual commercial jets are hit by lightning once a year and suffer only slight damage where the current enters and exits. Designed to meet Federal Aviation Administration requirements, the crafts' metal surfaces and framework provide safe paths for the current—even through vulnerable fuel lines and tanks. Airliners use special shielding to protect delicate electronic guidance equipment from the crippling burst of electromagnetic energy emitted by a lightning strike.

Before a new aircraft takes flight, its lightning protection designs are tested on the ground. At Lightning Technologies, Inc., in Pittsfield, Massachusetts, a 1.5-million-volt simulated strike zaps a scale model of the new Boeing 777 airliner (above). Repeated tests, with the model in different positions, reveal likely places for lightning to initially enter and exit the aircraft.

Planes with nonmetallic surfaces—which conduct electricity poorly and can thus suffer severe damage from a lightning strike—pose a special challenge for lightning protection. Lightning Technologies president Andy Plumer (below) holds two laboratory test panels made of carbon-reinforced plastic, used in aircraft construction. The sample at right was punctured by a simulated lightning strike. The test panel at left fared much better. Coated with a lightning-conducting copper mesh, it emerged intact, aside from some paint damage.

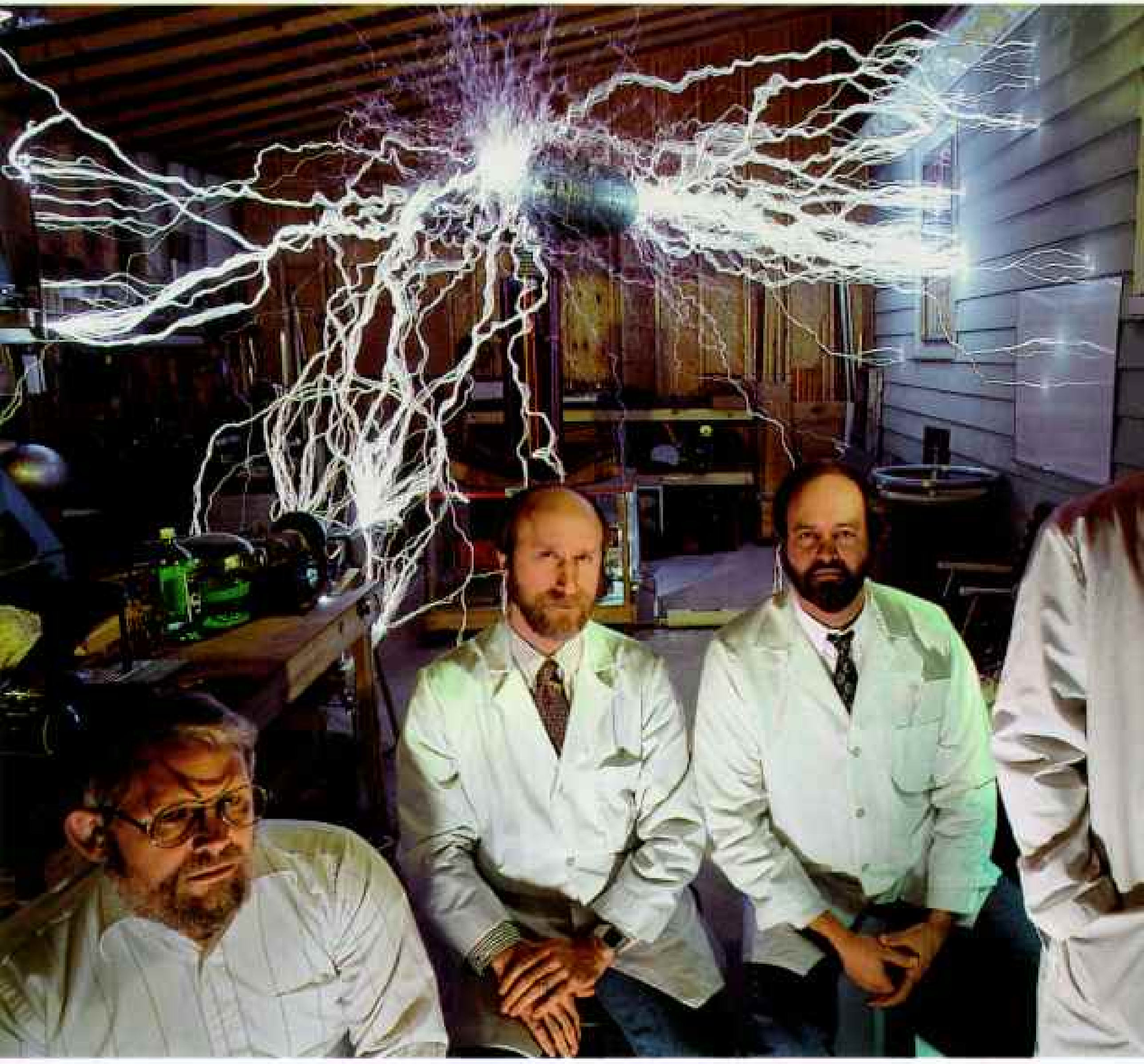
LOOKING FOR A CHARGE

Summoned by scientists who launched a three-foot-high rocket toward the belly of a passing thundercloud, a bolt of lightning crashes into Mosquito Lagoon near Florida's Kennedy Space Center (opposite). From the rocket's tail a spool of copper wire unwound, triggering the strike and creating an artificial path for the cloud's electric charge.

Sometimes experts go looking for lightning but simply can't find it. The New Mexico Institute of Mining and Technology and the U. S. Air Force co-sponsored a rocket-triggered-lightning study on New Mexico's South Baldy peak in the summer of 1992, but on many days dry weather grounded the rockets (right).

Rocket launches provide the best chance for scientists to measure lightning's electric current under somewhat controlled conditions. However, risks still loom: To eliminate the danger of the current following wires from the launch pad into the control trailer, the New Mexico scientists ignited rocket engines by blowing into a tube that was linked to a pneumatic switch on the pad.

Photography is another tool in the study of lightning, illustrating the numerous return strokes (above) that to the human eye appear as a single flash. A still camera panned from left to right with the shutter open reveals the first stroke of a flash to the right, with its characteristic branches, and some 20 subsequent strokes through the same air channel. Such repeat surges make lightning seem to flicker.



SPARKS OF GENIUS

"The neighbors think I've got an arc welder going in here," says Richard Hull (above), standing at the controls of a seven-foot Tesla coil assembly he built in a laboratory addition to his Richmond, Virginia, home.

Invented in 1891 by Nikola Tesla—an early pioneer of the radio—the coil generates sparks by storing small amounts of house current for roughly one-sixtieth of a second, then releasing it in high-frequency bursts.

Using a massive coil in Colorado in 1899, Tesla claimed to have simulated ball lightning—bright, floating spheres sometimes witnessed during thunderstorms but still not explained by scientists. Hull and fellow members of the Tesla Coil Builders of Richmond meet monthly to discuss such esoterica. "But basically the appeal is that you get to hurl lightning."

Wielding what he calls his lightning brush (above right), artist Dave Archer creates fantastic images of space nebulae in his San Rafael, California, studio. He spreads the paint on glass, supported by insulators, with an arc emitted by his 1.5-million-volt Tesla coil, then adds planets and other heavenly

bodies with traditional artist's tools. Paintings like his "Prismatic Passages" (right) sell for as much as $8,000.

Heavy rubber boots help ensure that Archer won't fry his feet for art's sake.

"Painting with a million and a half volts at close quarters, you need a gentle touch and some protection as well," he says. "It's like playing with a bundle of cobras."

Lightning

Fire and water mix at sunset over Tucson; some scientists speculate that lightning is more likely to occur in areas of heavy rainfall.

Lightning does occur without rain, however. It might even happen extraterrestrially. In 1979 the Voyager I spacecraft relayed images of what may be lightning in Jupiter's atmosphere. Scientists studying Venus are also seeking evidence of lightning. Since there is very little water in the Venusian atmosphere, lightning would provide convincing evidence of active volcanoes on the planet, a cosmic question that could be solved in a flash. □

CYPRUS

A Time of Reckoning

For millennia Cyprus has endured the conquests of foreigners besetting its rocky shores with the regularity of tides. In the 1950s the island's ethnic Greek and Turkish communities began to turn against each other, leading to a UN presence in 1964, four years after independence from Britain. Following a Greek-led coup and the landing of Turkish forces on the island in 1974, Cyprus split into two hostile enclaves. This year UN-brokered peace negotiations reflect a new urgency to resolve decades of bitter dispute.

GREEK CYPRIOT NATIONAL GUARDSMAN IN LIMASSOL (ABOVE LEFT); FISHING FROM THE JETTY AT THE PORT OF LIMASSOL.

Displaced women of Kythrea, a former Greek Cypriot village in northern Cyprus, gather in the divided capital of Nicosia to honor their long-missing men. Kept in mind like a festering wound, a claimed 1,619 unaccounted-for Greek Cypriots are presumed to have been killed by Turkish Cypriot and Turkish forces during the fighting in 1974. At a house in Turkish Nicosia (upper right), now called the Museum of Barbarism, caretaker Hasan Yusuf Güdüm shows visitors a photograph of residents who were killed by Greek Cypriot terrorists in a 1963 raid.

By TAD SZULC

Photographs by WILLIAM ALBERT ALLARD

TIME STANDS STILL along narrow Hermes Street, which slashes across the center of the Old City of Nicosia like a deep wound that has never healed. The silence of this hot autumn morning is oppressive. On both sides of the street, frayed signs proclaim in Greek and Turkish, *Bakery, Butcher, Pharmacy,* and *Hotel Olympus—Welcome!* But there is nobody here to read them. The sun does not reach the filthy pavement between the buildings. An emaciated black-and-white cat scampers out of my way. It is the only sign of life.

I know, however, that my every step is being watched by soldiers concealed on my right and on my left, Cypriot Greeks to one side and Cypriot Turks to the other, keeping vigil at their positions day and night. This mute confrontation in the capital of Cyprus and elsewhere along the United Nations buffer zone, which defines the country's two hostile domains, is the overpowering symbol of life on this Mediterranean island so endowed by nature and so rich in historical romance.

For almost 30 years a UN force has been stationed on the island to quell intercommunal violence; for nearly 20 years it has guarded the buffer zone to keep the fragile peace between the Cypriots.

The split was created in 1974, when Turkey sent in troops to avert Cyprus's threatened union with Greece, sweeping past UN peacekeepers. Within a few months, more than a third of the total population was displaced in the fighting as some 180,000 Greek Cypriots fled south and 45,000 Turkish Cypriots moved north, all becoming refugees within their own country. Today 600,000 Greek Cypriots in the south and 170,000 Turkish Cypriots and immigrants from mainland Turkey in the north remain apart, almost never permitted to cross to the other side.

But Cyprus is divided in another way. There is the sunny, relaxed world of Mediterranean beaches, where last year nearly two million tourists came to swim, sail, swing in the discos, and dine in the thousands of

Patrolling an invisible wall of mutual hatred that cuts across Cyprus, Canadian members of the UN peacekeeping force maintain their vigil in Nicosia. Responding to potshots, stone throwings, and hundreds of minor incidents a year, the UN keeps watch from observation posts (right) along a 112-mile-long buffer zone.

restaurants and cafés. The other reality is that of the Cypriots, who are striving to live normal lives in an abnormal situation.

"It's really surreal," a young University of Cyprus professor tells me in the lobby of a Nicosia hotel, as we watch a happy Swedish family on their way to the pool. "The tourists have the luxury of enjoying the beauty of our land, free to ignore our awful reality. But we Greeks and Turks are prisoners of our politics."

You rarely lose a sense of these deep divisions, but they are most vivid in Nicosia. During the years following 1974, the Greek Cypriot side became an economic success story, while the Turkish side, which is internationally isolated and economically strapped, remains something of a backwater.

On Hermes Street I lean against a shuttered storefront near a Greek Cypriot bunker protected by a tall wall of oil drums and barbed wire. A Canadian Army officer, wearing the blue beret of UN peacekeepers, waves me away. "I hate to tell you," he says casually, "but this house is booby-trapped, and I don't think you want to lean against that door."

I obey instantly, resuming my stroll through this no-man's-land in the company of photographer Bill Allard and three senior officers of the Canadian battalion. As we approach a Turkish Cypriot bunker, tense young soldiers point their automatic weapons at us and shout, "No photographs!"

Except for occasional shouting matches and shootings, Cypriot troops have not fought each other since 1974. The main task of the UN force is to control the buffer zone—which meanders crazily for 112 miles from Morphou Bay in the west to Famagusta Bay in the east, narrowing to a width of only ten feet here on Hermes Street—to keep an estimated 30,000 Greek Cypriot and 40,000 Turkish Army and Turkish Cypriot troops separated.

"Nobody gives up a bloody inch of ground on the cease-fire line," one of the Canadian

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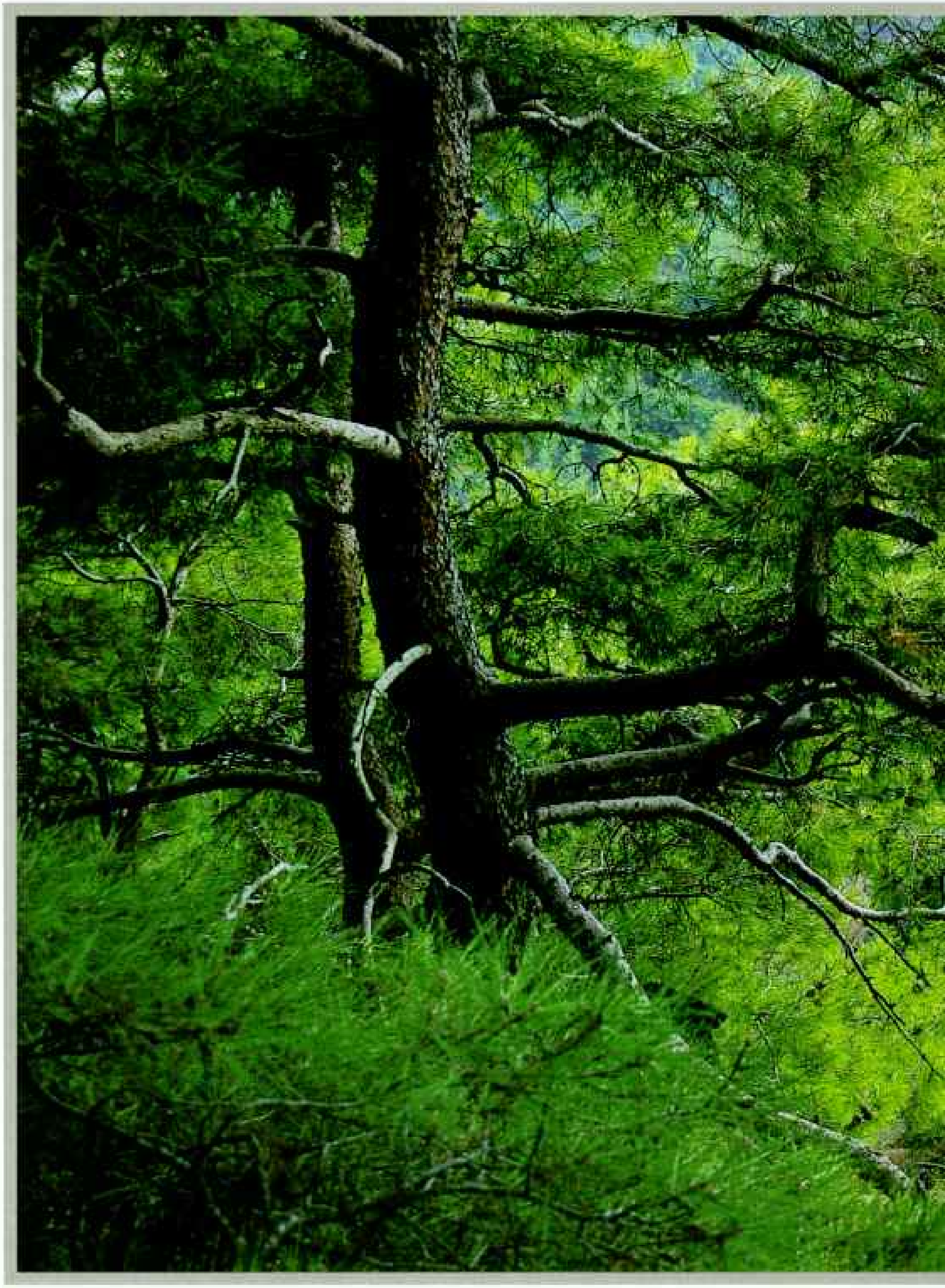
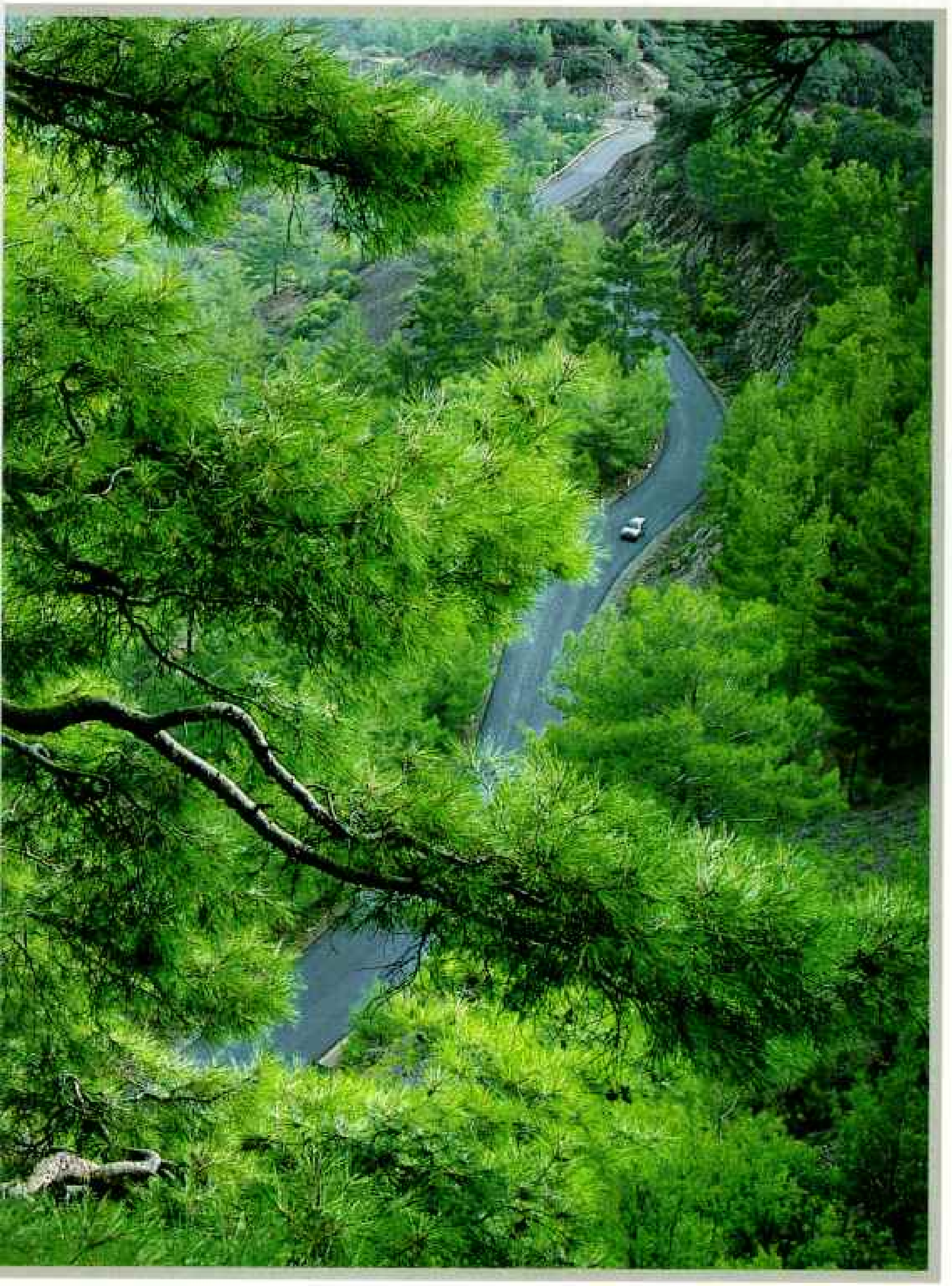


Cool green oasis rising from the sun-blistered central plain, the Troodos Mountains shelter villages, churches, and monasteries. Some date from the Byzantine Empire, when Greek Orthodox monks, icon makers,



and other ascetics sought solitude here. In winter the slopes of 6,401-foot Mount Olympus are thick with skiers, including members of Cyprus's Olympic ski team, carving turns high above the Mediterranean Sea.

Divided Cyprus

Three millennia of Greek culture have survived eight centuries of Norman, Genovese, Venetian, Ottoman, and British rule. Only the Ottomans, ancestors of the Turkish Cypriots, imported kinsmen in large numbers.

In 1960 Britain granted independence to its colony of 82 years, retaining sovereignty over its military bases. Free for the first time in modern history, Cyprus quickly succumbed to ethnic violence, and in 1964 the UN intervened. In 1974, after the military government in Greece instigated a coup against Cypriot president Archbishop Makarios III, Turkish troops swept across northern Cyprus. Later that year, with the collapse of the junta in Athens, Makarios returned from exile as the island split.

officers tells me. "They all cheat to move a bloody inch ahead, and it's our job to keep them honest."

The Greek and Turkish Cypriots may soon have to police themselves. It now takes 1,425 Canadian, British, and Austrian UN soldiers to keep the border intact, but their governments are tired of supporting the peacekeeping force—at a total cost of about 60 million dollars a year—because negotiations over the past three decades have repeatedly failed.

As a result of these problems, the UN force has been drastically cut back. Last December Denmark withdrew its contingent of 336, and the British, Austrians, and Canadians pulled out 322 soldiers. Canada's remaining 575 troops will be sent home this summer, leaving a skeleton force that some UN officials believe will not be able to prevent an outbreak of fighting if the Greek and Turkish Cypriots cannot come to an agreement. Given the danger, this spring the UN began looking for ways to rebuild the peacekeeping contingent.

I HAD COME TO CYPRUS to see how the Greek and Turkish Cypriots were living in their stalemate. With special permission to cross between the two sides, I moved from one world into another, each with its own culture, language, religion, and identity. As I visited Cypriots in their homes and workplaces, I realized that thousands of them cannot return to the houses where they were born, renew old friendships, worship in their former churches or mosques. They talk about 1974 as if it were yesterday, never forgetting the villages they left behind and the loved ones they lost in the war.

Still, it is almost incomprehensible to an outsider that the gentle Greek and Turkish Cypriots could be polarized for so long, for they are among the world's warmest, most generous, and best educated people. And despite the island's troubles, life goes on as it does anywhere else: Cypriots work hard, raise families, and partake of the daily joys of living.

On the eve of the Greek Orthodox Lent,

Medieval walls of old Nicosia, seen from the northeast, encircle both Turkish (foreground) and Greek Cypriot sectors. In honor of their independence day last October 1, officers of the national guard doffed their hats (below) at the president's residence before paying respects to former President George Vassiliou. This past February, Greek Cypriots elected a new president, Glafcos Clerides, who pins hopes for a resolution of the Cypriot deadlock on UN mediation.

villagers gather at great feasts before beginning their seven-week fast. One of my Greek Cypriot friends tells me about a local farmer at such a feast who burst into tears when he saw the abundance of kebabs, sausages, and lamb. "Why are you crying?" the host asked him. "Don't you like the food?" "No," the farmer replied, "I am weeping because I know there is no way I can eat it all."

My first night in Cyprus I discover the truth of this anecdote at a small restaurant in the Nicosia suburb of Strovolos. On the sidewalk outside the restaurant, people are eating, chatting, and playing guitars. It is the first of September and unbearably hot. I sit down with five Greek Cypriots who have just left their Nicosia offices. The three men quickly loosen their ties, call over the owner, a smiling, rotund woman who knows them well, and begin to order a dizzying succession of food. The woman bustles back and forth to the kitchen, bringing us onions, pickles, chick-peas, roast lamb, fried cheese, cucumber salad, figs, and melon. A guitar player wanders over to our table and smiles at my alarm. "This is a modest dinner for us Cypriots," he says.

A few weeks later, in the village of Pano Panayia, among the rolling vineyards of the southwest, I join a group of farmers lounging around tables outside a coffeehouse. They are middle-aged and dressed in work clothes and rubber boots. The noon sun bathes the slopes of the mountains rising around us.

Although only a fraction of the island's land goes to vineyards, wine is one of Cyprus's most important exports, and the men are talking about the harvest. "The wines of Pano Panayia are the best on the island," boasts a large man with a rough, weathered face. "And this year's vintage will be the best ever because of last summer's abundant rains," another one says with certainty.

Then they tell me that the rains came in answer to the villagers' prayers to St. Elias, the provider of rain. I ask them if the prayers always work. "Oh yes, sure they work," one of them replies, and they laugh as if I had asked the most ridiculous question.

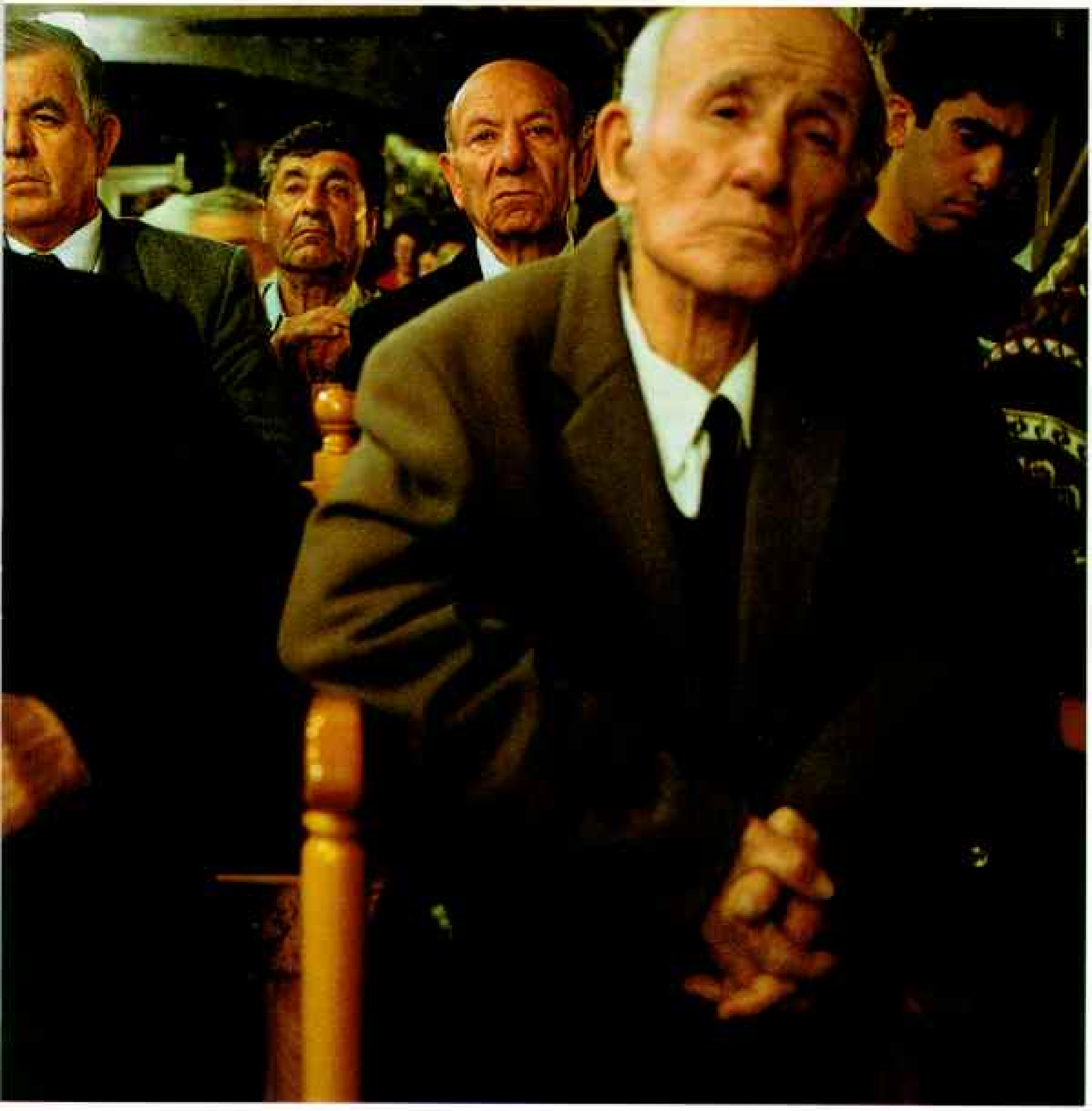
All over Cyprus I often had the feeling that I had stumbled into a scene unchanged by the ages, a place of crumbling monasteries and dusty mountain roads where donkeys plod along with baskets of fruits and vegetables.

High in the hills above the northern port of Kyrenia, I find a long, flat olive grove covered

with squat, gnarled trees. Some are more than 400 years old and are protected by waist-high enclosures. A Turkish Cypriot woman in her mid-30s is perched on a ladder against one of these trees, picking olives. I ask how many years she has worked here.

"Since I was a little girl," she replies. "But as you can see from the age of this tree, my ancestors of long ago were probably doing what I am doing today."

Cyprus is an island of contrasts. Politically it is part of Europe, but geographically it is in Asia, lying 40 miles off southern Turkey. Almost twice the size of Delaware, Cyprus has two mountain ranges that run east to west with



By informal tradition, male elders sit together during services at St. John's Cathedral in Nicosia. Archbishop Chrysostomos, head of the Greek Orthodox Church of Cyprus, holds the government of Turkey to blame for the island's political stalemate. Unless Turkish troops withdraw, he says, "it is not possible to achieve any just solution."

a plain called the Mesaoria between them. The larger of the two, the Troodos, lies in the south, rising to 6,401 feet on Mount Olympus. Ancient monasteries and vineyards are scattered through the foothills, but the upper reaches are desolate. Snow covers the range in winter, and hardy visitors can ski in the morning and drive down to the coast at Paphos for an invigorating afternoon swim.

The smaller Kyrenia Range stretches nearly a hundred miles along the northern coast. Turkish Cypriot villages and medieval castles grace the hillsides, and dark green olive groves drop down to the aquamarine sea.

Because Cyprus is situated strategically in the northeast corner of the Mediterranean, the island was always considered a prize by more powerful lands. Ancestors of today's Greek

Cypriots emigrated from mainland Greece about 3,000 years ago and developed a flourishing trading center. Since then Cyprus has been ruled by Phoenicia, Assyria, Egypt, Persia, and the Roman and Byzantine Empires. The Lusignans, a French noble family, governed during the Crusades, and the Venetian Empire held sway in the 15th century. The Ottoman Turks, forebears of the modern Turkish Cypriots, dominated the island for 300 years before they ceded control to the British in 1878.

Until the waning years of British rule, Cypriot Greeks and Turks coexisted somewhat peacefully, although the Greeks occasionally rioted in favor of *enosis* (union) with Greece, and the Turks agitated for partition.

In the 1950s Greek Cypriots fought a guerrilla war for enosis, and as a compromise Britain agreed to grant Cyprus independence. Nationalist leader Archbishop Makarios III was elected president in 1960, while the Turkish Cypriot minority was given the vice presidency and minority political representation.

But after barely three years the government disintegrated amid mutual charges of bad faith. Severe fighting between the two sides erupted in Nicosia and spread throughout Cyprus. UN peacekeeping troops arrived in 1964 and spent the following ten years mediating conflicts.

In 1974 a Greek Cypriot faction, backed by the military regime then in power in Athens, initiated a coup against the Makarios government, which had turned away from the concept of enosis. Turkey, fearing that the island would become part of Greece and that the lives of Turkish Cypriots would be endangered, invaded. After Turkish troops gained control of 37 percent of the country, a cease-fire was declared. That cease-fire line is today's UN-patrolled buffer zone.

Since then the Greek Cypriot majority has governed the southern part of the Republic of Cyprus, while the Turkish Cypriot minority has run the north with substantial economic and military support from the mainland. Following the division, international airlines agreed not to schedule flights to northern Cyprus under an economic embargo requested by the republic. In 1983 Rauf Denktaş, the Turkish Cypriot leader, exacerbated tensions by proclaiming a separate state, the Turkish Republic of Northern Cyprus, which remains unrecognized by any country except Turkey.

Religious festivities attract visitors and street vendors each September to the village of Omodos in the wine-growing region of the south. Though most of Cyprus's 600 villages were affected by the 1974 hostilities, those in the south lost fewer people than those in the north, where entire villages of Greek Cypriots were uprooted. All told, some 180,000 fled south, while 45,000 Turkish Cypriots moved north.

IT IS SUNDAY MORNING in the dusty mountain village of Platanisteia, set among the great vineyards of southern Cyprus. Only 36 elderly Greek Cypriot refugees, nearly all from the northern village of Eftakomi, live here, herding sheep and tending lemon trees. Just before eight o'clock a bell rings at the one-room schoolhouse, and a dozen old villagers shuffle into the classroom, where the walls are decorated with pictures of Jesus Christ and the Apostles. It is time for Mass. One by one, people kneel in front of the makeshift altar, a simple table with a big, black radio on top. The village is too small to have its own priest, so this radio broadcast of the regular Mass from Nicosia is the next best thing. I sit on a narrow bench with the worshipers, who murmur prayers with the people on the radio. The choir from St. John's Cathedral in Nicosia sings through the speakers and music fills the room. Some of

the men and women have tears in their eyes, others gaze at the radio, and they all sit very still. When Mass ends, each person stands and makes the sign of the cross. A man picks up the radio, and everyone files out.

Outside I strike up a conversation with an aged, outspoken peasant, Kyriakos Psaras, who complains about the villagers' poverty, lack of running water, and life without a priest. He tells me that years ago he saved enough money to send two of his children to college in Long Beach, California.

"The children own two fast-food restaurants," he says with a toothless smile, "but I prefer the view from my village." I understand as we sit in silence together and take in that view, looking out over the soft gray slopes at the Mediterranean, which sparkles blue and purple in the strong sunlight of a summer morning.

I am reluctant to leave this quiet corner of the island, but soon I strike out up the southwestern coast to the village of Pachyammos, where Greek and Turkish Cypriots fought 29 years ago. Pachyammos somehow survived. I walk down a hill to the sea and meet Father Theodoros Papamichael in front of St. Raphael Church, and he invites me in.

Inside, the Mediterranean is framed by the rear portal. Three artists on scaffolding are painting a large mural of ferocious Turks torturing Greek Orthodox saints and priests. A young girl—St. Irene—is boiled in oil, a saint is beheaded with a long saw, a priest is dragged by his beard, and another saint is clubbed to the ground by three wild-eyed Turks.

St. Irene, St. Raphael, and St. Nicolaos were martyred on the island of Lesbos in 1463, Father Papamichael says, explaining that it happened after the Ottoman Turks had captured Constantinople, now Istanbul, as the Byzantine Empire collapsed.

A new generation of Cypriots often react with cynicism to their parents' political vendettas. In the north, where young Turkish Cypriots blow off steam in a disco in Kyrenia, and in the south, where a contestant waits backstage at the Miss Cyprus contest in Limassol, young people tend to blame politicians for the island's agonies.

I ask the priest whether there is any link between the theme of the mural and contemporary problems on Cyprus. "Oh no, this has nothing to do with politics," he replies softly. "It is based on history, and it is God's truth."

MANY CYPRIOTS are farmers whose families have worked the same land for generations. And most Cypriots who work in the cities live in small villages. This abiding attachment to land and family explains why the Greek Cypriots who fled south in 1974 long to return to their native villages.

Stavros Pikis, a white-haired farmer who remained the headman of his Greek Cypriot community when they moved south, invites me for a drive to see his former home, the village of Acheritou. Resting just beyond the buffer zone amid citrus groves, it is now inhabited by Turkish settlers from the mainland. We stop at Pikis's lemon grove near the zone—here no more than a dirt road bordered by a barbed-wire fence—and gaze across.

"We still keep coming to this spot to look at our old homes, to remember, to pray," he says. "It is very heartbreaking, but we must do it. We must never forget."

With great pride, Pikis takes me into the orchard, where the air is sweet and the fruit hangs ripe and yellow. But the old man's pride leaves him as he talks about the painful loss of much of the grove. "When I come to work here, which is almost every day," he says, "I can see a Turkish family from the mainland working just a stone's throw away, across the barbed wire, on what used to be *our* field."

I ask him if he ever speaks to them. "No, we have never talked," Pikis replies resignedly.

Across the line, though, Turkish Cypriots also mourn the loss of their homes. East of Nicosia in the small town of Lysi (Akdoğan to Turkish Cypriots), I meet Mustafa Ahmet Özgünel, owner of a coffeehouse. In 1974, at age 17, Mustafa fled his native southern village of Platanisteia. This morning, as we talk over sweet Turkish coffee and soft drinks, I mention to Mustafa that I had recently visited Platanisteia. His eyes light up, and he grows

Graffiti on the seawall at Limassol, Cyprus's major port, recall that Cyprus was the birthplace of Aphrodite, Greek goddess of love. At Limassol in A.D. 1191 crusader Richard the Lion-Hearted rescued and

married his betrothed, Berengaria of Navarre, whose storm-tossed ship had been forced ashore here en route to Jerusalem. Today, with 2,300 ships under its flag, Cyprus ranks sixth among maritime nations.

excited. "Is the big fountain still there on the village square?" he asks. "Who owns all the sheep and goat herds? My parents had animals there." I answer him as best I can, and Mustafa sighs. "Oh, it was such a nice place," he says sadly. "But they wouldn't let us stay there. Now we're a world away from it."

Too much time and too many peace talks have passed for Stavros or Mustafa to have much hope for a homecoming. Negotiations conducted by UN Secretary-General Boutros Boutros-Ghali in 1992 again failed to break the deadlock between the two Cypriot communities. Under current UN peace proposals, Turkish Cypriots would return a portion of the occupied territory and repatriate most of the 30,000 Turkish troops. Greek Cypriots are demanding the repatriation of thousands of the Turkish immigrants, and although nothing is likely to be resolved soon, the settlers are afraid they will be sent back to the mainland.

I meet one of them, Yaşar Günes, in the hilltop village he calls Esentepe, where you can look across the Mediterranean and see the jagged outline of the mountains of Anatolia rising from the horizon. Yaşar was 11 years old when his parents brought him from a village near the Black Sea to Esentepe, where he grew up to become a veterinarian's aide. He married a local girl, built a house, and had three children. He has devoted his life to his village. Now Yaşar wonders what will happen to him and his family if they are sent back to Turkey. "We are human beings too," he says. "Where do we fit into all these plans?"

Leap of faith: A bungee jumper puts her trust in an elastic cord at Nissi Beach, a resort outside Ayia Napa catering largely to Scandinavians. Engine of the south's booming economy, the tourist industry last year drew almost two million visitors and more than a billion dollars. Before 1974 the north shore was the more popular destination. Today, with only modest facilities for tourists, Turkish Cypriots earn less than half the income of their rivals.

OLDER GREEK AND TURKISH Cypriots grew up together. But today's Cypriot teenagers have no memory of the events of the sixties and seventies, and few of them have ever met or even seen Cypriots from the other side.

One September evening I am invited to dine with a Turkish Cypriot businessman, his teenage daughter, and three of her college friends on a balcony overlooking the lovely old harbor of Kyrenia on the north coast. Behind looms the massive Pentadaktylos, the five-fingered peak of the Kyrenia Range. Lights from houses and restaurants dance on the water among the dark shapes of fishing boats, and the sound of singing and conversation from the Saturday-night crowd along the quay floats through the warm air.

But even on this pleasant evening my friends want to talk about politics. The conversation drifts along. Then I ask the women, who are home on vacation from London University, how they feel about Greek Cypriots.

"You must understand that we don't hate them," one of the women, with liquid brown eyes, replies. "They hate *us!*"

"Have you ever met one?" I ask.

"Yes," she replies, "but only in London, never here."

Young people I spoke to on both sides believe that their leaders are too old, too intransigent to unify their country. And everywhere, students, intellectuals, refugees, and farmers tell me that Cyprus's politicians are responsible for its problems.

In the south such opinions are directed in particular against Rauf Denktaş, who refuses to moderate his demands for equal political representation and separate sovereignty,

along the lines of the Swiss cantons, for the Turkish Cypriot part of a federated state. An effusive man, he minces no words when we sit down to lunch at his official residence in Nicosia. "The Greeks destroyed our partnership years ago," he says. "For us there is no return to pre-1974 days, when we were treated like animals and told we were rebels." Then he reads me a statement he had recently made to the local press: "I shall not conclude an agreement that will take Cyprus back to the pre-1974 period—even if they cut off my hands."

George Vassiliou, then president of the Cypriot republic, sees the turmoil of the 1960s somewhat differently. "Independence came as a compromise, but unfortunately it was a compromise in which nobody believed," he tells me in the beautifully manicured garden of his official residence in Nicosia. (After my visit Vassiliou narrowly lost an election to Glafcos Clerides, a veteran Cypriot politician.)

"If the coup d'état [for enosis] hadn't happened," he adds, "an agreement could have been signed between the Turkish Cypriots and the Greek Cypriots, and Cyprus would have been a very, very happy country today."

By any standard Cyprus should be a happy country, considering its natural beauty and its peoples' characteristic love of hard work and civilized living. For on this island, where wheat and barley, olives and carobs grow in abundance, Cypriots once plowed the fields and celebrated life side by side.

One afternoon in a coffeehouse in Pyla, an exceptional village where Greek and Turkish Cypriots are permitted to live as before, Eleni Meleagrou, my interpreter, mentions her father, a well-known Greek Cypriot doctor. Overhearing us, a Turkish Cypriot comes over. Tears fill his eyes. "Your father took care of my family," he says. "I haven't seen him in 20 years. Please give him my love."

I get my chance to convey that message when I visit the doctor, Yannis, at his office in Nicosia. He is delighted to hear that his former patients are thriving. His brown eyes light up as we talk, even though he is 73 and has been seeing patients since early morning. Tall and ramrod-straight, he has practiced medicine for nearly half a century. "My grandfather had very good relations with the Turks, from whom he bought a lot of land," he says, leaning back in his leather chair and stretching his long legs. "They used to bring their flocks into my grandfather's fields after the harvest, and he allowed them to graze. When I came as a young doctor, the word spread in the village that his grandson was back as a physician, and the old people who knew him started coming to me. It was the typical loyalty and friendship of the Turks."

THE CYPRIOT REPUBLIC's side of Nicosia is an expensive city—a can of soda often costs two dollars. Steel-and-glass office buildings line broad boulevards, expensive European cars jam the streets, and fashionably dressed youths crowd the doorways of boutiques, discos, and cinemas.

Nineteen years ago almost no one would have predicted the extraordinary economic recovery of the republic. More than a third of the population had lost homes and property, and many Greek Cypriots had emigrated to make their fortunes elsewhere. But other entrepreneurs, attracted by government incentives and a budding export industry, stayed and helped turn the economy around by the late 1970s. Today the republic has a per capita income of about $12,000—on a par with Israel, higher than Greece or Turkey, and nearly four times that of the Turkish Cypriot north.

Tourism provides a third of the republic's foreign revenues and a quarter of its employment. Last year a record number of nearly two million tourists—three times the population—crowded the chain of hotels, restaurants, bars, gift shops, and fast-food stands that clog the southern coastline from Paphos to Ayia Napa. While tourism has helped the economy, rapid growth has threatened the island's wildlife and water resources.

But many beaches remain unspoiled. On a Sunday afternoon I drive up the southwest coast toward Paphos in search of the mythical

birthplace of Aphrodite, Greek goddess of love. I see a small beach to my left with two huge rocks rising out of the calm water. It is said that she sprang to life here from a spray of sea. I remember Homer's *Hymn to Aphrodite:*

I will sing of stately Aphrodite,
gold-crowned and beautiful,
whose dominion is the walled cities
of all sea-set Cyprus.
There the moist breath of the western
wind wafted her over the waves
of the loud-moaning sea. . . .

A few people swim between the rocks, and several others bask in the hot sun. I notice a

Harvest of tradition: Turkish Cypriot olive growers on the north coast beat branches with sticks to bring down the fruit. Turkish Cypriots control most of the grain-growing Mesaoria Plain, while Greek Cypriots remain the major wine producers.

man with cropped gray hair playing with a little girl in the sand. I stop to chat, and he introduces himself as Captain Vladimir Leontiev, a former shipmaster from Odessa, Ukraine, now resettled in Cyprus. He tells me his granddaughter, Anna, is two years old. Leontiev runs a company in Limassol that reflags ex-Soviet ships with Cypriot colors and provides Russian crews for shipowners around the world. Some 2,300 merchant ships fly the Cypriot flag, he tells me, and Cyprus has the world's sixth largest merchant marine.

Then, as we watch the setting sun silhouette Aphrodite's rocks above the blue-green water, Leontiev tells me he has traveled around the world, has even lived in Monte Carlo, but enjoys life in Cyprus more than anywhere else. "I am happy here," he says. And he stands up, takes his little granddaughter by the hand, and leads her down the beach for a swim in the sea.

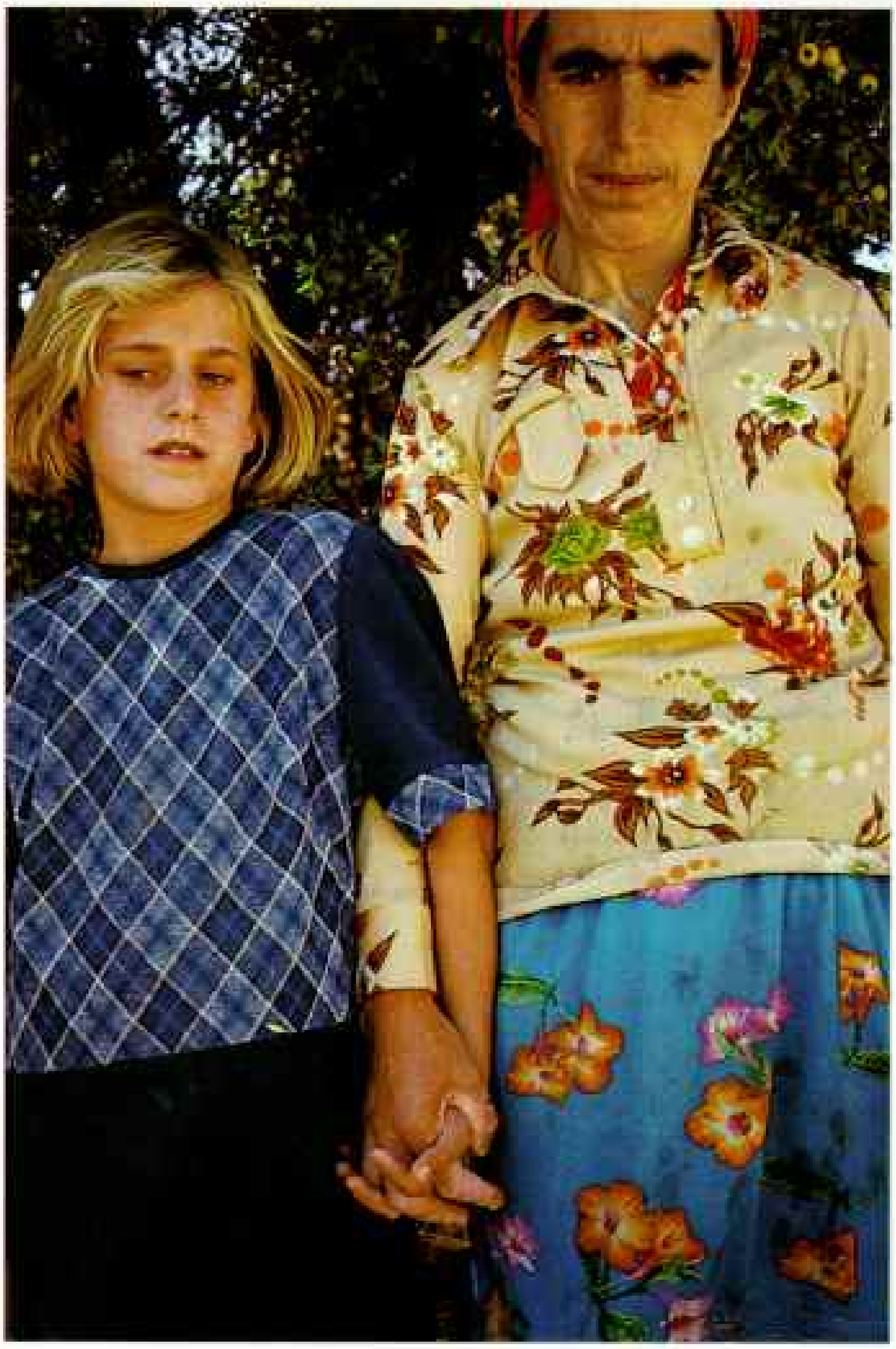
ON THE REPUBLIC's independence day, October 1, then President George Vassiliou throws open the gates of his residence and invites his people in to celebrate the occasion. A band plays Viennese waltzes while servants offer wine and appetizers to the guests.

Vassiliou tells me that the republic must develop beyond tourism. He believes Cyprus can become an important international financial center like Hong Kong or Singapore. Attracted by tax incentives and the island's excellent geographic position and communications system, a thousand foreign companies and banks have already established offshore branches there.

But what about northern Cyprus? With an international embargo against airline flights and foreign investments, the Turkish Cypriots have to rely on subsidies from the mainland. While they receive only a fraction of the number of tourists who visit the south, an increasing number of visitors come every year from Turkey, Germany, and Britain.

In Kyrenia and Famagusta, well-off Turkish Cypriots and tourists enjoy the good life. Expensive sports cars park in front of the leading hotels and discos in Famagusta. In Kyrenia, British couples in evening dress often stand on the terrace of the art deco Dome Hotel to watch the moon rising over the sea.

One night I join a Turkish Cypriot couple at a restaurant in Famagusta to celebrate the wife's birthday. A musician is playing an organ on a small dance floor surrounded by tables. Turkish Cypriot students sing along as the organist plays "When the Saints Go



Back-cracking massages give relief to Turkish Cypriots in the vaulted Korkut Baths of northern Nicosia. East of the city thousands of mainland Turks, like this mother and daughter, till the fields of Mesaoria—many on farms abandoned by Greek Cypriots during the 1974 diaspora. Resented by some native Turkish Cypriots, an estimated 40,000 such immigrants arrived from Turkey in the 1970s. Largely unskilled, they have not integrated well with the island's more educated Cypriot population.

Weary with history, a courtyard in Nicosia echoes with the footfalls of parishioners going to church. Thirty years of UN peacekeeping have barely cooled the resentments here. Cypriots on both sides will need the gift of tolerance to mend the rift between them.

Marchin' In" and plaintive Turkish love songs. The owner, Mr. Hussein, races back and forth, bringing us fried octopus and wine, wishing my friend a happy birthday, and telling jokes. He leans over and speaks to me as if he is about to reveal a great secret: "My patrons call me the plant doctor," he says. "They bring me their dying plants, and I talk them back to life!" A blond belly dancer gyrates for the small crowd.

Then a very large Turkish insurance executive in a business suit stands up from the audience and sings to us in a baritone voice. He begins to dance with surprising grace, leaning almost to his knees, moving his arms in slow, flowing gestures. The gregarious Hussein applauds his performing customer, who has charmed us all.

AS MY CYPRUS JOURNEY ends, I cannot help thinking what a paradise the island would be if its citizens could settle their enmities and live together again. But turmoil is nothing new here. The ruins of Salamis, a city founded by the Greeks on the eastern coast around 1100 B.C., are testament to that. People lived and worked here and played their games in the gymnasium, whose great stone columns stand silent, as they have since Arabs invaded in the seventh century A.D.

I wander around the ruins, bathed by the scent of pine and eucalyptus, and listen as the sea pounds away. The grass is overgrown; the place seems neglected.

A more recent ruin, dating from 1974, pulls me back to the buffer zone in Nicosia. Something about the appearance of this building, the former French Embassy, has intrigued me from the first time I saw it weeks before. I convince a UN officer to escort me there.

Inside, broken glass and plaster cover the floor, and I notice newspapers and documents strewn about in every room.

I pick up a copy of *Le Monde* dated July 20, 1974, the day the Turkish Army landed in northern Cyprus. I find a copy of the *Journal Officiel* from March 4, 1964, the day the UN Security Council authorized the first peacekeeping force. The dry climate has preserved the papers perfectly, and nobody has bothered to collect them over the long years.

Time stands still in Cyprus. When, I wonder, will it move forward once again? □

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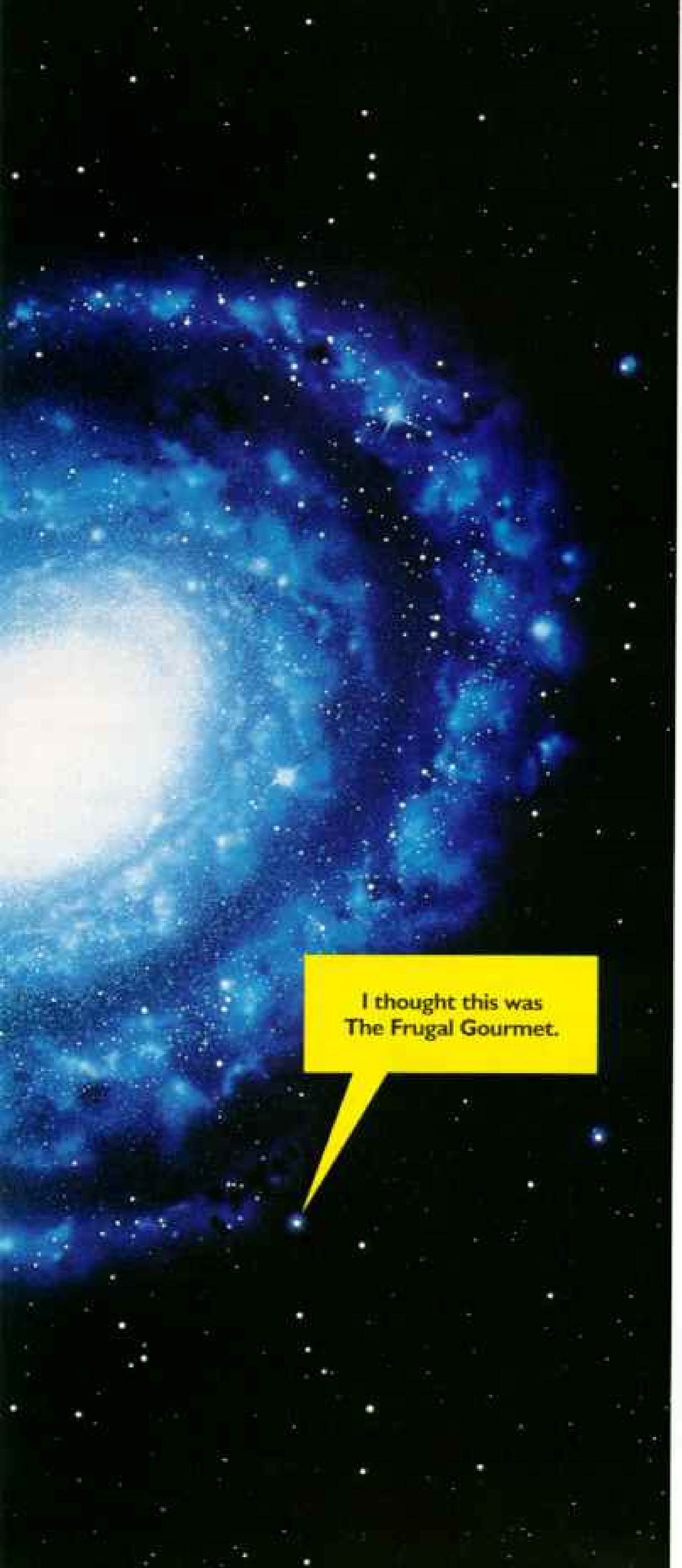

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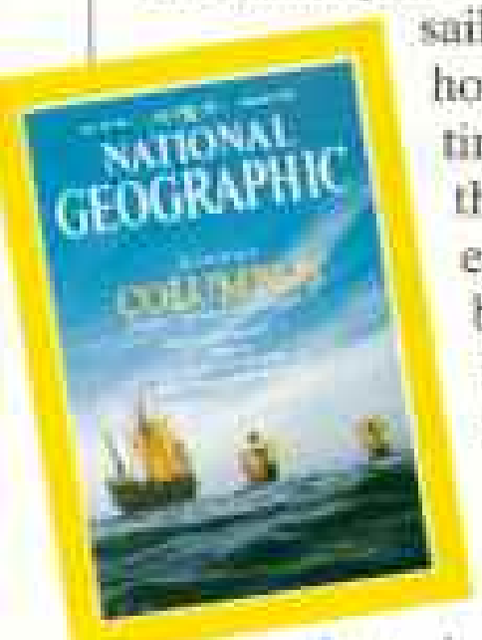
Report from the President

Keeping Pace With a Changing World

For the January 1992 cover of NATIONAL GEOGRAPHIC we pictured reproductions of Christopher Columbus's ships sailing toward the horizon. It was a fitting start for a year that saw the Society embark on a number of journeys into uncharted territory.



If ever there was a year that tested our ability to keep pace with a changing world—and to help our members keep up as well—it was 1992. In those 12 months we revised our world map five times. A map of Ukraine produced by our Cartographic Division (above right) demonstrates the wholesale revision required when that former Soviet republic altered 90 percent of its place-names. Such rapid-fire changes only underscore geography's essential place in our lives as citizens of planet Earth.

The National Geographic Society's declared mission is to increase and diffuse geographic knowledge—not only to our 9.7 million members in nearly 200 countries but to the untold additional millions whose lives we touch. To fulfill our mission, we tell the story of the changing world through publications, television programs, atlases, maps, lectures, and exhibits. We support research and exploration in scientific geography. We sponsor classroom programs and teacher training, and we produce educational materials designed to create geographic enthusiasm in youngsters. One of the most exciting of these products is a new CD-ROM children's world atlas.

PRESIDENT GROSVENOR TEACHES A LESSON ON WATER AT OYSTER ELEMENTARY SCHOOL IN WASHINGTON, D. C. MARK THIESSEN

Let me share a few highlights of Society activities in 1992:

NATIONAL GEOGRAPHIC MAGAZINE—You hold in your hands the Society's flagship publication, which reaches some 44 million readers every month. In 1992 the magazine was honored with two National Magazine Awards from the American Society of Magazine Editors, for general excellence and for photography.

NATIONAL GEOGRAPHIC TELEVISION—Second only to the BBC, we are the world's largest producer of documentary films. Six of our films won Emmys in 1992, adding to more than 550 TV awards garnered since 1965.

NATIONAL GEOGRAPHIC BOOKS—Nowhere is our growing international presence more evident than in our Book Division. Foreign editions of our books were published in nine languages in 1992—among them Chinese, Japanese, Hebrew, and Thai. At home we produced 15 new or revised books for adults and children.

National Geographic, July 1993

RADIO PROGRAMMING—Our first coproduction with National Public Radio, "The Unheard World," aired over NPR's 450-station network in June 1992.

COMMITTEE FOR RESEARCH AND EXPLORATION—Two hundred fifty grants were made for research in areas ranging from paleoanthropology to ecology. The results of these and other research projects are published in our scholarly journal, RESEARCH & EXPLORATION. The Society recently awarded its 5,000th research grant, to Rosalind Alp for her work with chimpanzees in Sierra Leone.

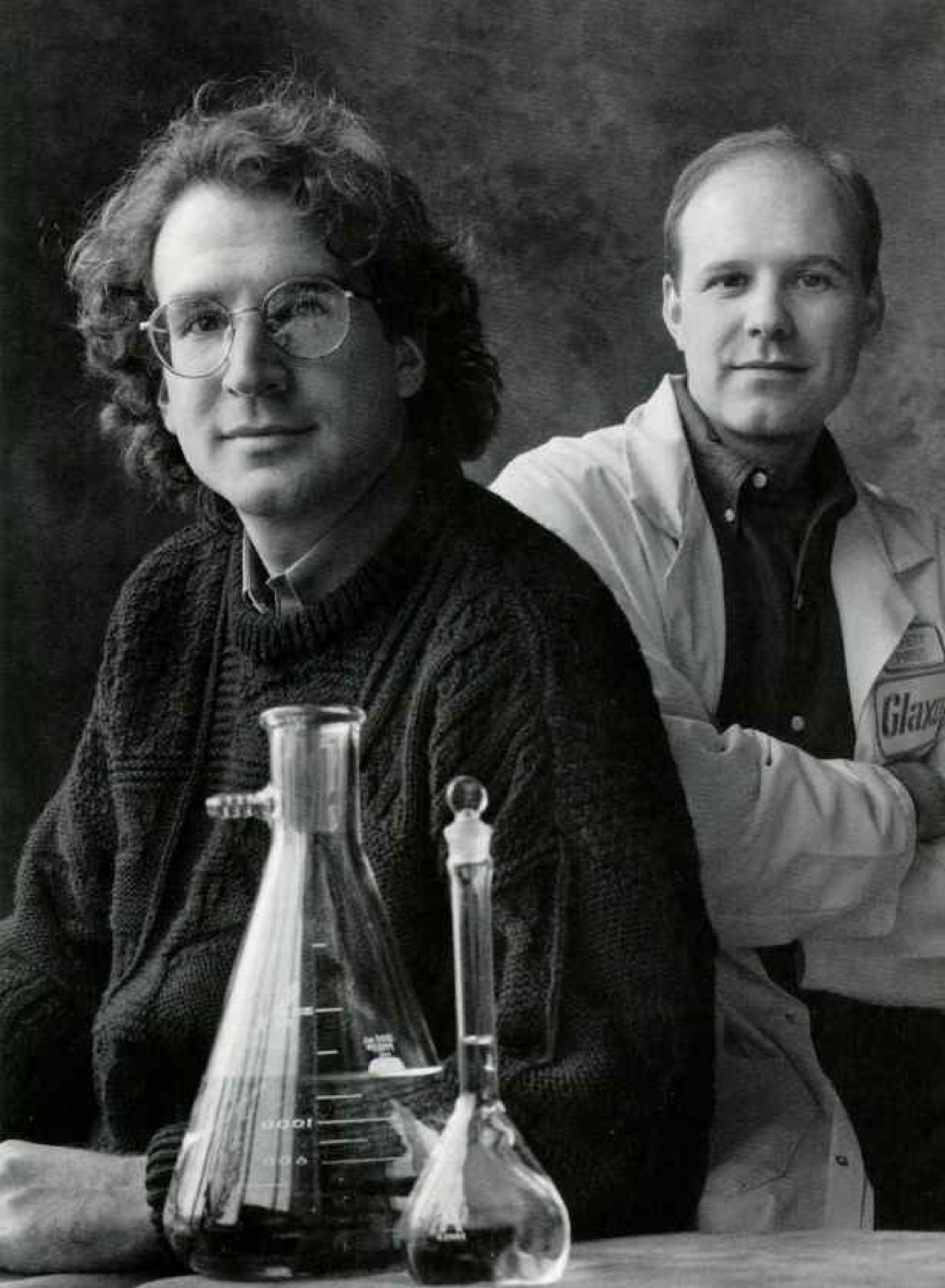
EDUCATION PROGRAMS—Nearly 1,500 teachers attended more than 60 Society-sponsored geography workshops and institutes around the country in 1992. Many of the workshops were conducted by statewide geographic alliances. The Geographic Alliance Network, created by the Society, is made up of educators committed to the advancement of geography in the classroom.

NATIONAL GEOGRAPHY BEE—Last year nearly six million students participated in this enormously popular annual contest, our fourth.

More than ever, in 1992 the Society pooled the resources of its diverse divisions for projects with a common theme. Society-wide coordination last year resulted in a series of Maya projects, including a major magazine article, a new book, a TV Special, and an exhibit in Explorers Hall at our Washington, D. C., headquarters. Nearly all divisions of the Society have joined to advance a major undertaking, "Geography of Fresh Water: A National Geographic Initiative." In addition to pieces in National Geographic WORLD and TRAVELER magazines, the GEOGRAPHIC will produce a 13th issue in November, devoted solely to the subject of fresh water.

If you would like more information on the Society's 1992 activities, please write: 1992 Report, National Geographic Society, 1145 17th St. N.W., Washington, D. C. 20036-4688.

Gilbert M. Grosvenor



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Forum

After the Soviet Collapse

Having spent 30 years teaching Soviet politics, I was enormously moved by Mike Edwards's articles (March 1993). I thought the most poignant moment was the former Moscow professor's comment, "I want to live in a normal country. A very common country." Here in the United States we have just undergone a transition in government from one political party to another. Even a disgruntled Bush voter like myself can appreciate the normalcy of our transition. May it become a common thing in Russia too.

WILLIAM J. PARENTE
University of Scranton
Scranton, Pennsylvania

Your title "A Broken Empire" is hardly accurate, since most of the Russian Empire conquered by the tsars and held by the former Soviets remains in place. All of Siberia, the former Soviet Far East, all of Central Asia outside the Muslim republics, and even the formerly Japanese Kuril Islands are still under Russian domination. With about 6,593,000 square miles the Russian nation is still the world's largest political unit.

JOHN H. CHAMBERS
Isabela, Puerto Rico

It is hard to accept that the present Ukrainian government denies other nations the right that it demands for itself. President Kravchuk stated that the borders of his country would not be subject to discussion, thus accepting the legacy of the Molotov-Ribbentrop pact. By that agreement between the Soviet Union and Nazi Germany, Romania was deprived of the provinces of Bessarabia and Northern Bucovina, which became parts of the Soviet Union. Ukraine still holds Northern Bucovina and three counties of southern Bessarabia, proof of an arrogant imperialistic attitude.

MIHAI RADU POPESCU
Lund, Sweden

The section on Ukraine might have mentioned the reestablishment of a Ukrainian Orthodox Church in place of the Russian Orthodox Church, whose jurisdiction has been repudiated by Ukraine. Eastern Orthodox Christianity has had strong roots in Ukraine since the acceptance of the Christian faith over a thousand years ago.

ZENON V. WASYLIW
History Department, Ithaca College
Ithaca, New York

National Geographic, July 1993

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As I read about the demise of the Soviet Union, I reflected on my sister and grandfather, whom I never had the pleasure of knowing. They as well as two million other Polish citizens were taken from their homes and sent to the far reaches of the Soviet Union in 1939-40.

Tens of thousands died of exposure and starvation. When the survivors were "acquitted" of their crimes in 1941, they went to Uzbekistan and Russia, many to join the Polish Army being formed. Those who did not survive, including my sister and grandfather, lie in mass windswept graves in the former Soviet Union. I for one do not lament its breakup.

RICHARD J. WIDERYNSKI
Long Beach, California

Former U.S.S.R. Map

My business affairs have frequently taken me to the Republic of Kyrgyzstan. Your map note states that it is poor in oil and gas, but the Ferghana oil fields are partly on Kyrgyz territory, and one of the largest recent finds is located in its Naryn district. You also say the country is "beset by ethnic rivalries," but it has been touted by our State Department as having one of the best human rights records in the world.

Kyrgyzstan has an abundance of hydropower. In other capitals of the former Soviet Union one may face no electricity or hot water; it's never a problem in Bishkek.

SCOTT HORTON
New York, New York

Ogallala Aquifer

How fascinating to have an article that mentions the ethnic Germans of Kazakhstan (pages 29-31) in the same issue with one on the Ogallala aquifer. My mother's people, the Volga Germans, fled Russia in the 1870s to escape religious and ethnic persecution, and many emigrated to the Great Plains of the U. S. and Canada, bringing their wheat-farming expertise. Many settled on top of the Ogallala, where they also had a tremendous impact on the sugar beet and vegetable industries.

MARK KELLEY
Hereford, Texas

As one who was raised over the Ogallala aquifer and later farmed and worked there, I congratulate Erla Zwingle on a balanced article. It is good to note that much of the hysteria entering conversations over groundwater when I was doing graduate research in the area in 1979-81 has been replaced with pragmatism.

STEVEN T. FRICK
Mission, Kansas

I was born and lived in northwestern Kansas until I was seven years old; I am now 61. Last year my dentist was surprised at how few cavities I have. He

asked where I spent my first five years. When I told him, he remarked, "That will do it—the Ogallala is a natural source of fluoride."

KEN GROOM
Kent, Washington

Easter Island Unveiled

The undersigned feel that your article on Easter Island will injure and scandalize Thor Heyerdahl. Concerning the so-called secret family caves, it asserts that Dr. Heyerdahl persuaded the natives to open the caves and sell the contents. The fact is that the natives themselves told him about the caves and offered to sell Heyerdahl the stone carvings. To the extent that these caves and their contents were forgeries, the natives themselves are to be blamed, not Heyerdahl.

The article also refers to Heyerdahl's "gullibility" concerning the carvings, but it was hard even for trained archaeologists who accompanied him to ascertain what was genuine and what was not.

When it comes to the question of South American influence on Easter Island culture, the answer is hardly as unambiguous as the author puts it. Only continued and objective archaeological research can give the answer.

PROFESSOR ARNE SKJØLSVOLD, DR. PHILOS.
DIRECTOR ØYSTEIN KOCK JOHANSEN, DR. PHILOS.
The Kon-Tiki Museum
Oslo, Norway

Dr. Skjølsvold was one of the archaeologists on Thor Heyerdahl's 1955-56 expedition. Since then, he has returned repeatedly to Easter Island, conducting archaeological fieldwork. Dr. Johansen has also been part of the archaeological team.

Thor Heyerdahl's theories as to American Indians in the Pacific may be wrong, but it takes more than a swashbuckler to cross part of the Pacific on a balsa raft or the Atlantic on a reed boat.

F. J. BUZEK
Rhoon, Netherlands

The article did not deal with *rongo rongo* boards, the wooden tablets covered with hieroglyphic signs, reportedly the only known writing developed in Polynesia. These tablets as a cultural achievement arguably overshadow even the *moai*. If the boards were not created by the forebears of the present islanders, then the door to Rapa Nui history still stays ajar.

ORVO AST
West Hill, Ontario

There is little new information about these tablets, featured in the January 1962 Geographic.

I write with regret to inform you that the venerable Amelia Tepano Ika (pages 70-71) died this past December. With her died a treasure of ethnographic information. Those of us who study the complex history of these remarkable Polynesian

people are grateful for the scholarship of the younger Rapa Nui generation. They have learned from Amelia and cherish what she taught.

JO ANNE VAN TILBURG
Malibu, California

Reclaiming a Lost Antarctic Base

As an ardent proponent of properly managed wilderness, I had difficulty with the objective of retaining, let alone restoring, the East Base in Antarctica. My feeling is that each expedition that has deposited buildings and equipment should, once the mission is complete, remove these materials and restore the purity of the land. We failed to remove our trash from the East Base in 1948; it is time to do it in 1993. It clearly is not a "monument" in my mind's eye.

JOHN F. LANCE
Deer Lodge, Montana

East Base was never "lost." They've known where it was all along. Abandoned, yes; lost, no.

STEPHEN E. CROWELL
Golden, Colorado

Finn Ronne's 1940-41 expedition was one of several explorations in the South Pole region. Richard E. Byrd had picked Ronne for his 1933-35 expedition; Ronne served as a dog-team driver and maintained skis, bindings, and sledges for it. His father, Martin, had served with Amundsen in 1911 and was a sailmaker for Byrd when Byrd built Little America. In 1933 Ronne found his own name printed over his father's 1929 ice-tunnel bunk there. As Byrd recalled, Ronne then said, "The old man must have known I'd come down."

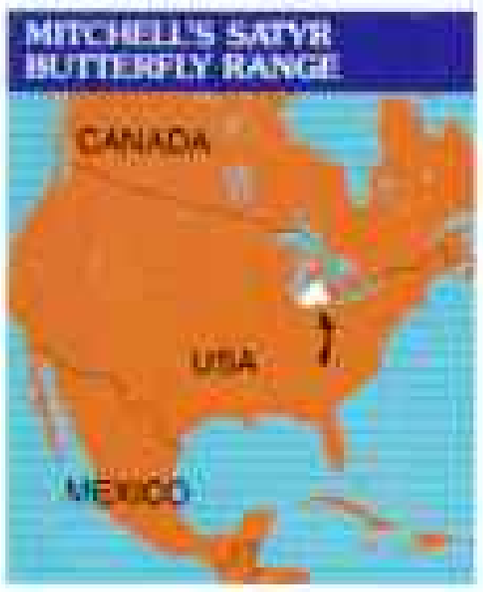
GEORGE M. NIEDERMAYER
Maple Shade, New Jersey

I noticed among the abandoned medicines on page 124 a vial labeled Prontosil, which is a dye. In 1932 it was observed that Prontosil had curative properties against streptococcal infections in mice, and shortly thereafter it found widespread use in humans. It wasn't until 1937 that it was realized that once in the tissues, Prontosil divided into two parts, one of which was sulfanilamide. By 1939 similar drugs known as sulfonamides were synthesized and became the first antibiotics for common use. By the time of the 1940 expedition, Prontosil had been displaced in drugstores by its active component, pure sulfanilamide. It's a bit odd that this obsolete drug was brought along. Probably the sulfanilamide was used up, leaving Prontosil for archaeologists to puzzle over.

H. PETER METZGER
Boulder, Colorado

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.

WILDLIFE AS CANON SEES IT



Mitchell's Satyr Butterfly

Genus: *Neonympha*
Species: *mitchellii*
Size: Wingspan, 38 – 44 mm
Habitat: Wetland fens in Indiana and Michigan, USA
Surviving number: Unknown
Photographed by Larry West

A Mitchell's satyr butterfly weaves slowly through the sedges, landing frequently but never leaving its wetland habitat. On the wing for just a week in July, this prize specimen is especially vulnerable to butterfly collectors, who have already eliminated some populations. For the protection of this rare species, the few remaining sites are patrolled during the butterflies' brief flight period. To save endangered species, it is essential to protect their habitats and understand the vital role of each species within the earth's ecosystems. Color images, with their unique ability to reach people, can help promote a greater awareness and understanding of the Mitchell's satyr butterfly and our entire wildlife heritage.

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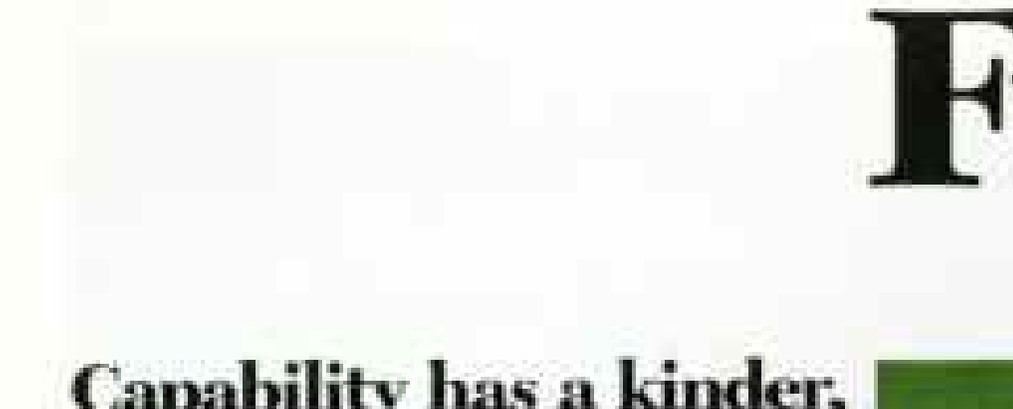

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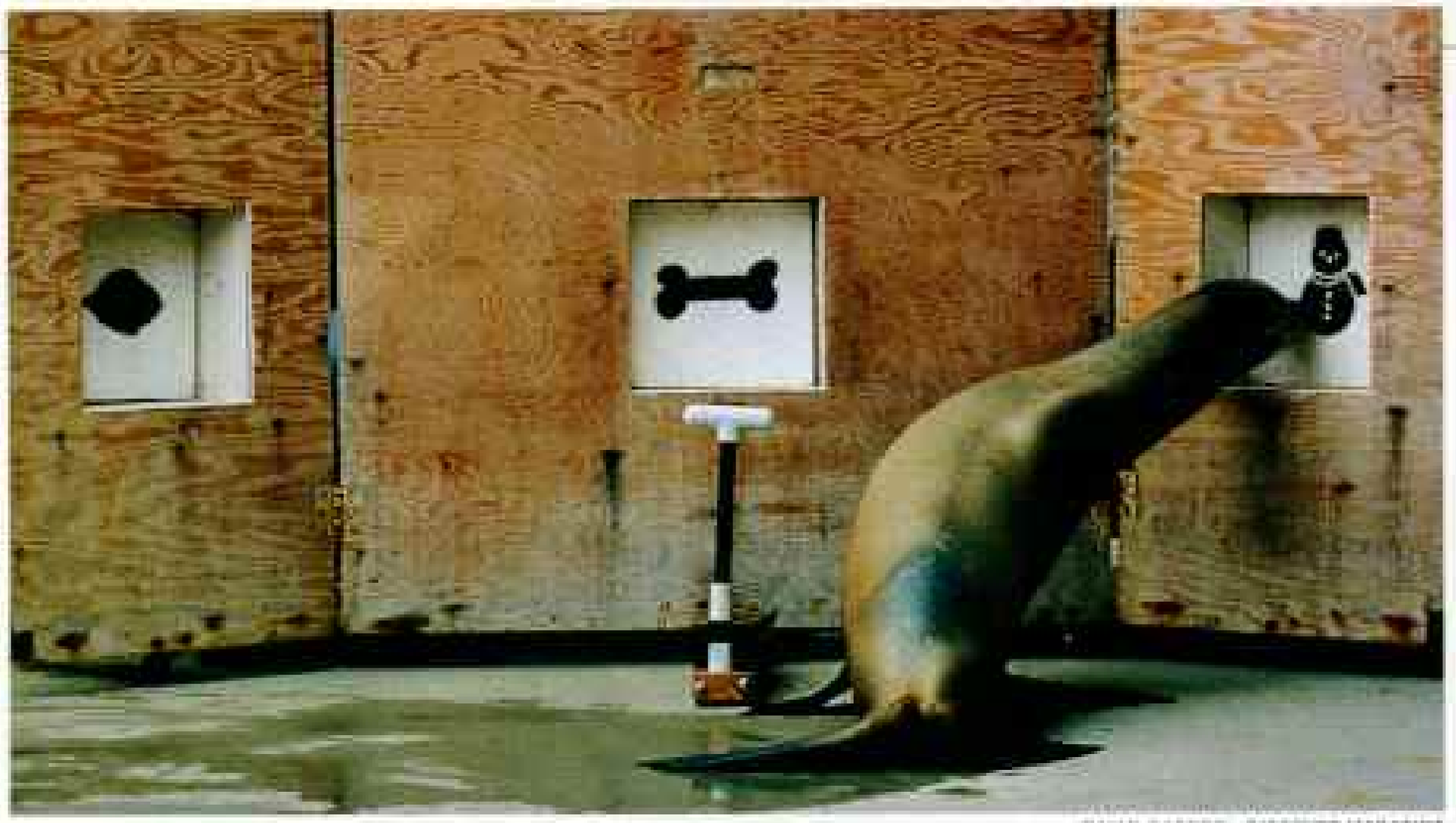
Geographica



DAVID BARNOR, DISCOVER MAGAZINE

Sea Lions That Make the Right Connections

Aboard the expanding raft of animals involved in language studies, two female sea lions—Rocky (above) and Rio—are demonstrating that the easily trained marine mammals can perceive and understand relationships between unlike objects.

Ronald Schusterman, an animal behaviorist with the University of California, Santa Cruz, and California State University, Hayward, has set up tests that include silhouettes of objects unveiled in arbitrary groups of three. First he teaches the sea lion, with a food reward, to match one item, for example scissors (A), to a second item such as a bone (B). In the second set, as seen above, he requires the animal to match the bone to the snowman (C) and not to the fish. The key test comes in the third set, comprising the snowman, the scissors, and a previously unseen item: Will the animal make the leap that the snowman and the scissors are equivalent (C = A)?

Rio made similar connections in 16 out of 18 tests. Rocky is still learning.

Schusterman believes that the ability to make such associations is "a prerequisite for linguistic competence." Other animals, yet untested, may "think" this way too.

Clues to the Temblor That Shook Puget Sound

An earthquake that jolted what is now Seattle about a thousand years ago raised Puget Sound beaches more than 20 feet, generated a powerful wave called a tsunami that buried tidal marshes in sand, and may have caused major landslides.

What's more, the enormous quake was centered not in some deep oceanic fault, as was true of other more recent Seattle temblors, but in a shallow rupture below the city. Scientists long ago concluded that a Seattle fault existed; new studies documenting the earthquake that occurred about A.D. 1000 suggest that the fault may still be active.

Robert Bucknam of the United States Geological Survey found raised beaches south of the Seattle fault but stable terrain at Winslow north of it. Brian Atwater, also of the USGS, located two sites where sand-covered marshes mark the path of a tsunami. Other researchers found landslides dated back to about a thousand years ago.

But the most dramatic clues to the major quake came from the growth rings of Douglas firs found at two sites 15 miles apart. Landslides swept several trees into Lake Washington and a tsunami dumped another at West Point. The trees all died at the same time—between fall of one year and early spring of the following year.

National Geographic, July 1993

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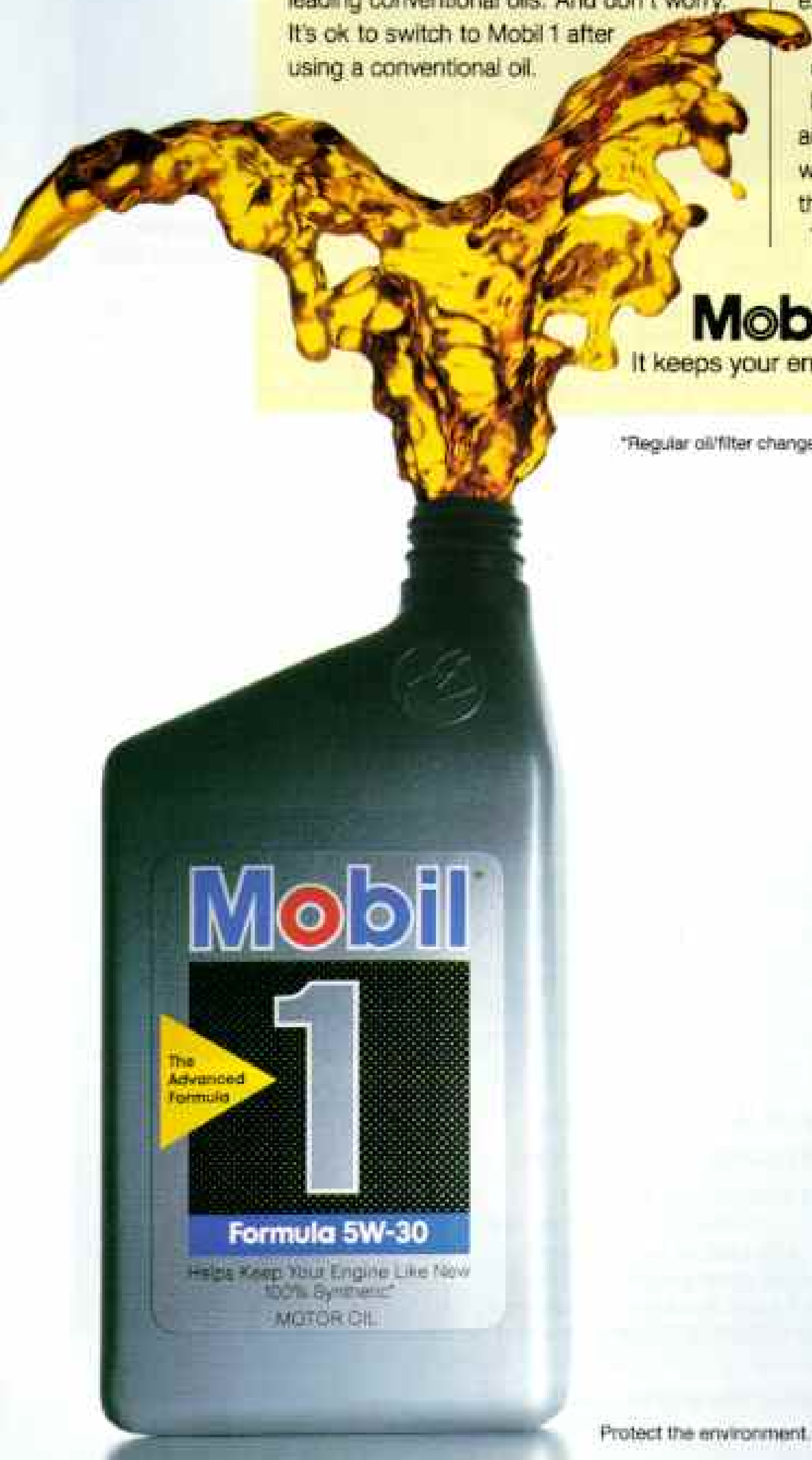
Too bad it can't work for people.



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Geographica

Sending a Little Truck on a Journey to Mars

Every few days in Pasadena, California, Donna Pivirotto takes a tiny six-wheeled truck called Rocky 4 to the sandbox to play. But she is no child, and this vehicle is no toy. Developed by the Jet Propulsion Laboratory, Rocky—just 25 inches long and weighing only 15 pounds—is a test model of a vehicle destined for a 1996 flight to Mars. There, directed by earth-bound controllers, it will wheel out of a landing module (below, in background) and analyze the composition of rocks, send back images of the landscape, and drop a seismometer to measure Marsquakes.

NASA planners had hoped to send large, mobile robots to collect rock samples during a series of

JAMES A. SUGAR

flights in the Mars Rover Sample Return Program. But such rovers became prohibitively expensive, and the development of miniature technology and advanced software led the space agency to switch to this small version. "We were working on scale models for a big rover, and they became the real thing," says Pivirotto, JPL's micro-rover manager, whose sandbox simulates Martian terrain. If all goes well in 1996, later Rockys may stow rocks on other vehicles for return to earth.

PETE SOUZA

A Brighter Future Ahead for Maine's Micmac

Federal recognition—along with health and social-welfare benefits and $900,000 to buy land—has finally come to a migratory Indian band whose ancestors, new research shows, fought in the American Revolution.

Most of the 25,000 to 30,000 Micmac live in Canada, but some 700 eke out a living in northern Maine, following the blueberry and potato harvests and selling baskets, such as those crafted by Donald Sanipass (above). However, they were unable to document a historical presence in Maine until nine years of research by Dutch anthropologist Harald Prins established their roots and paved the way for recognition.

The Micmac have a new sense of self-respect, says Mary Philbrook, tribal leader of the Aroostook Band of MicMacs, which has contracted for group medical and social services and is studying land purchases. "More doors are open to us than were before," says Philbrook. "Our ultimate goal is to become economically independent."

Site of Wildlife Photos to Remain Forever Wild

"In 1906 George Shiras 3d . . . walked into my office with a box full of extraordinary flashlight photographs of wild animals," wrote NATIONAL GEOGRAPHIC editor Gilbert H. Grosvenor about the 74 black-and-white images that caused a sensation when they appeared in the July 1906 issue.

Shiras, a onetime Pennsylvania congressman, had taken pioneering photographs—in the wild, many at night—of deer and elk, porcupines and pelicans, raccoons and butterflies. He found many subjects on family property on Michigan's Upper Peninsula.

Recently Phyllis Reynolds, widow of Shiras's nephew, Max Reynolds, Jr., donated 1,700 acres to the Nature Conservancy. She calls the site "the best-kept secret in the Upper Peninsula. It hasn't been used for anything but family recreation." And, as in 1906, it is still home to a host of wildlife.

—BORIS WEINTRAUB

BOTH BY GEORGE SHIRAS 3D, NGS COLLECTION

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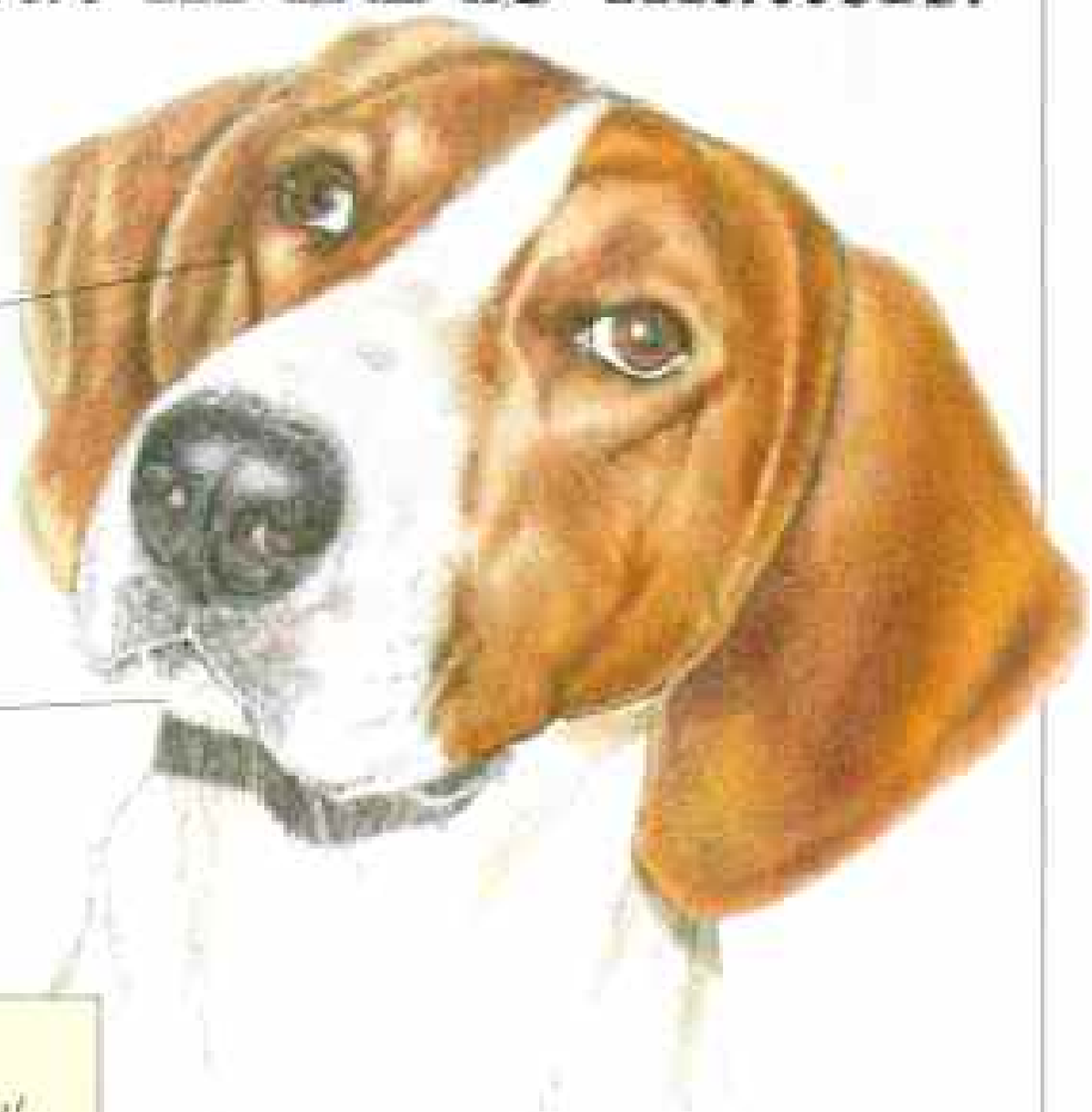
MOTOROLA

A thorough examination of why the more meat in IAMS matters.



Look your dog in the eye. Iams, with more meat protein, helps keep eyes clear.

Notice what your dog likes to eat. Because, instinctively, dogs crave the taste of meat. So you and your dog should like the fact that Iams contains more meat protein.

Evaluate the look and feel of your dog's coat. A luxurious coat and healthy skin result from a diet rich in meat protein and fat.

Observe your dog's level of activity. Because, generally speaking, when a dog looks and acts healthy, he is. Energy and proper muscle development come from a balanced diet high in protein. And the simple fact is, there's more meat protein in Iams than even the leading supermarket or specialty dry dog food.

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Fergie on a rock

by

Ann Crump, painter

The Nikon N6006 is a serious SLR that almost anyone, anywhere can pick up anytime and have fun with.

Case in point, one Ann Crump, watercolorist and oil painter from Belvedere, California.

In other words, she's not a professional photographer.

Yet, using the N6006 and a 28mm Autofocus Nikkor lens, she and her three-year-old pug Fergie have created nothing short of a masterpiece.

Or at least one killer dog picture.

The N6006 is why. It focuses automatically in light as dim as a single candle, or you can focus manually.

It selects the proper exposure automatically, or lets you do it.

You can select from a Spot Meter, a Center-Weighted Meter, or the Nikon Matrix Meter, which reacts instantly when the action is moving fast or the light changes unexpectedly.

Here, the built-in flash automatically brightened the foreground while letting the sun shine through in the background.

Maybe you thought a picture like that was too difficult.

Fergie, ordinary dog. Ann Crump, regular person. They took a walk with the N6006 and some beef chunks. Art happened.

The N6006: autofocus, built-in fill flash, interchangeable Nikkor lenses. Call 1-800-NIKON-35 for a free booklet.

Well, Ann Crump did it with just one hand, while holding a dog biscuit over her head.

Quite a picture in itself.

The Nikon N6006 is controlled by a convenient dial and a simple multi-button keypad. An LCD readout clearly shows you what you're doing. Press any two buttons on the keypad and the camera reverts to totally automatic.

It forgives you, instantly.

With Focus Tracking, the N6006 can even keep moving subjects, such as cars or bikes, in focus.

Its motor advances the film fast and rewinds automatically.

You can choose from twenty interchangeable autofocus Nikkor lenses. Nearly seven out of ten pros who use 35mm use Nikkor lenses.

In other words, the N6006 is not a toy.

It's the camera designed for people with dogs to walk, kids to chase and a job to go to.

See the N6006 at authorized Nikon Dealers. Just look for this symbol. For more about the N6006 and the benefits of the exclusive Nikon MasterCard, call 1-800-NIKON-35.

And somewhere in between all that, pictures to make.

Well, with the N6006, it's not any harder to use a Nikon. It's not any harder to take the kind of pictures you've always dreamed of instead of just plain old pictures.

After all, the shot above was made by an ordinary person using an extraordinary camera.

Could it *possibly* be more beautiful?

Nikon

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GOODYEAR

NATIONAL GEOGRAPHIC MAGAZINE

Roberta J. Nichols, Ph.D
Ford Environmental Engineer

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At Ford Motor Company, responsibility for the environment goes hand in hand with building quality cars and trucks. That's why we're already building vehicles that meet California's strict emission standards for the late 90's.* It's also why we're the first U.S. manufacturer to build a car with CFC-free air conditioning and why we'll soon have a fleet of electric vehicles on the road. At Ford Motor Company, we take our responsibilities seriously.

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*1993 TLEV 1.9L Ford Escort and Mercury Tracer. Available in California.

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THE ALL-NEW TOYOTA COROLLA

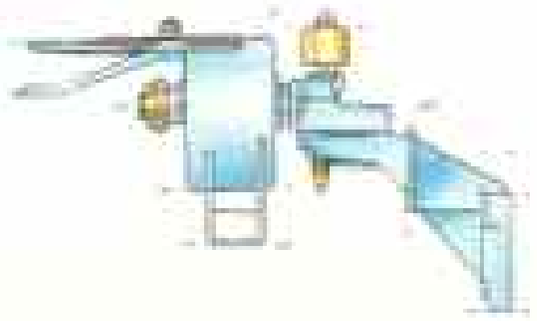
Introducing the brand-new car with the familiar name.

You don't tinker with an original, unless you're convinced you can make it better. That was the challenge we faced with the 1993 Toyota Corolla. We looked at interior space, and managed to find an additional 5.4 cubic feet. That equates to more front, rear, head and leg room. Next, we sought to make the Corolla quieter. So we employed a hydraulic engine mounting system and added vibration-dampening materials to reduce noise to extremely low levels. Of course, safety was a top priority. Which is why the new Corolla is constructed with high-strength steel, and comes with a driver-side air bag,* standard. Anti-lock Brakes are available as well. In fact, if you take a look at the new 1993 Toyota Corolla, what you'll see is a brand-new car. But you'll have the security of knowing it's still an original. Call 1-800-GO-TOYOTA for a brochure and location of your nearest dealer.

Corolla

Corolla has been satisfying drivers in America for over 25 years. And now more Corollas are built in America than ever before.

A driver-side air bag is standard equipment on all 1993 Corollas.*



This device is a liquid-filled engine mount, which reduces vibration and keeps engine noise to a minimum.

"I love what you do for me."

TOYOTA

*Always use your seatbelt. Driver-side air bag is a supplemental restraint system. Buckle Up! Do it for those who love you.

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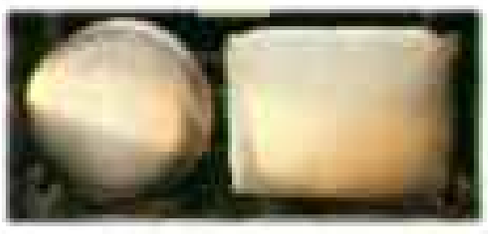
Buckle up—together we can save lives.

FORD CROWN VICTORIA

You can't deny the quiet authority of its streamlined shape. Or the subtle drama of its V-8 performance. And there's no mistaking the understated elegance of its interior. But the quiet environment inside a running 1993 Ford Crown Victoria remains unmatched. A silence of the 24-karat variety.

Quality engineering and a bit of untraditional thinking have created a vehicle that marries contemporary style and refined handling with the customary full-size requirements of room and comfort. And the Crown Victoria adds safety features like a standard driver and available right-front passenger air bag supplemental restraint system.



Air bags, in conjunction with properly worn safety belts, are one of the most effective restraint systems available.

The 1993 Ford Crown Victoria. When it comes to luxury and quiet, think of this as the sedan with the golden touch.

HAVE YOU DRIVEN A FORD LATELY?

Ford

Earth Almanac

Mass-spawning Groupers Ravaged by Fishermen

"Fishing moon," people in the Caribbean call the full moon of December, January, and February. In the Gulf of Honduras the full moon has long worked its magic, drawing Nassau groupers in incredible numbers to spawn at their favorite reef.

In 1988 astonished divers found themselves in water turned white by the milt and eggs of 10,000 of these 15-pound fish. For the next two years divers from a resort on Isla de Guanaja gathered to watch the groupers return for their brief spawning frenzies, then vanish.

Although the divers tried to conceal the location, secrets are hard to keep on a small island. In February 1990, local fishing boats arrived and tore into the spawners. By January 1991 the fish population had been reduced to about 500. Although the Honduran government quickly passed a law against fishing the site during spawning, enforcement has been difficult, and the grouper population is recovering slowly, if at all.

NANCY SEFTON, PHOTO RESEARCHERS

TAN NASCIMBENE

Better Refrigerators: the Cold Facts

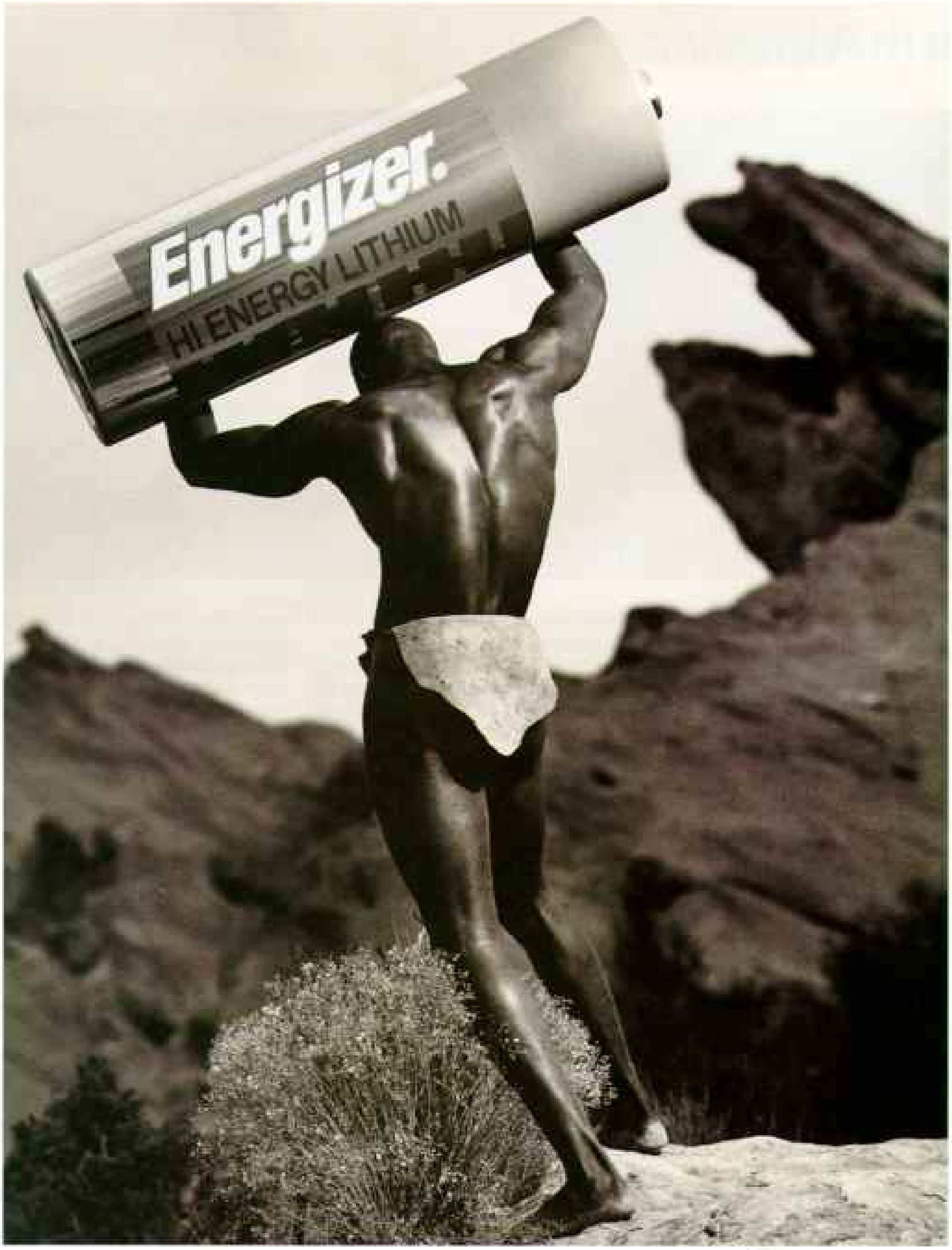
One-fifth of the electricity used in the average U. S. home feeds the steel box that dominates the kitchen. The nation's 110 million refrigerators tax utilities and increase their harmful emissions: the iceboxes also release pollutants.

Power plants would produce 115 billion pounds of carbon dioxide a year running those appliances and they would eat 77 billion kilowatt-hours of electricity—if all were 1993 models. Many are older, so the true figures are higher. In addition, 275 million pounds of ozone-depleting chlorofluorocarbons (CFCs) used as a refrigerant and in insulation are time bombs in current models.

But much more efficient refrigerators will hit the market within the next year or two. Sparking improvements are 24 utilities that sponsored a contest to build the best new prototype. The two finalists are Frigidaire and Whirlpool, and the winner, soon to be announced, will collect 30 million dollars. Key innovations will doubtless include a vacuum-sealed insulation system, better door gaskets and compressors, and improved refrigerating and defrosting cycles.

"We call the new technology 'the golden carrot' because of the incentives," says Mike L'Ecuyer of the Environmental Protection Agency. If current models were that good, carbon dioxide emissions would drop by at least 28 billion pounds. Power consumption—and consumers' bills—would drop by 25 percent. And by 1996 all new models must be CFC free.

National Geographic, July 1993



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Earth Almanac

JIM RICHARDSON

Military Eyes in the Sky Aided Sandhill Cranes

Fighter pilots and conservationists teamed up for four years to zero in on half a million sandhill cranes. Each spring the cranes (above, behind Canada and greater white-fronted geese)—migrating from Texas and Mexico to Canada, Alaska, and Siberia—roost on Nebraska's Platte River.

At night, flocks of thousands of cranes gather in the river. Biologists needed a way to find them in the dark and learn what parts of the river they preferred. In 1988 U. S. Fish and Wildlife Service biologist John Sidle contacted the Nebraska Air National Guard, whose pilots were flying night missions in Phantom jets using infrared sensors.

"The sensors detected the birds' body heat," says Sidle. He found that cranes prefer channels about 500 feet wide—channels that are shrinking because of a multitude of dams and diversions.

Can Nauru's Scars of Wealth Be Healed?

For Nauru, earth's smallest independent republic—with one of the world's highest per capita incomes—the party is nearly over. Within the next decade the last scoop of phosphate, a rich fertilizer base, will be gouged from the eight-square-mile Pacific island. Nearly 90 years of mining have turned 80 percent of Nauru into a lunar landscape of bare coral pinnacles (below). For a population nearing 10,000—a fivefold increase in 50 years—income soon will flow only from investments.

An engineering plan calls for restoring the island by removing the pinnacles, mixing remaining phosphate with limestone, and recontouring, at least a 150-million-dollar job. Nauru wants Australia, its former chief administrator, to pay a third for the environmental damage it allegedly caused. Australia has refused, arguing that the most damaging mining took place after Nauru's independence in 1968. The International Court of Justice will decide the case.

RICHARD EASTWOOD, AUSTRALIAN PICTURE LIBRARY

Fuel Pellets May Take the Heat off Landfills

Burning trash to generate electricity has a drawback—toxic fumes, which is why many incinerators have been shut down, pressuring overcrowded landfills.

Now a Texas chemist has developed a process to convert solid waste into pellets that can burn safely as cheap fuel, help clean up emissions from industrial furnaces, and free up landfills.

Kenneth Daugherty of the University of North Texas compresses trash into pellets and adds a binder—lime—that minimizes poisonous gases. When the pellets are burned with coal in power plants, the lime reduces sulfur dioxide, a pollutant released by coal. One South Dakota utility is using the pellets, but other states require expensive testing, discouraging their industries from following suit. Tougher air-pollution standards may be the catalyst for this innovation that could help make the solid-waste problem go up in smoke.

—John L. Eliot

National Geographic, July 1993

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The tradition of

Sweet Grass Basketmaking

The basket ladies sit bathed in sunlight, their brown fingers deftly working coils of pale grass into intricate yet sturdy baskets. These women and the wares displayed at their feet have come to symbolize the open-air markets of Charleston, South Carolina, but they represent much more. Woven into each basket is 300 years of tradition, and a skill born far beyond the horizon.

In the early 18th century, plantation owners used African slaves skilled in rice cultivation to work fields along the southern Atlantic coast. The transplanted Africans built dikes, then planted, harvested, and processed the grain. Rice soon became a principal crop of the region.

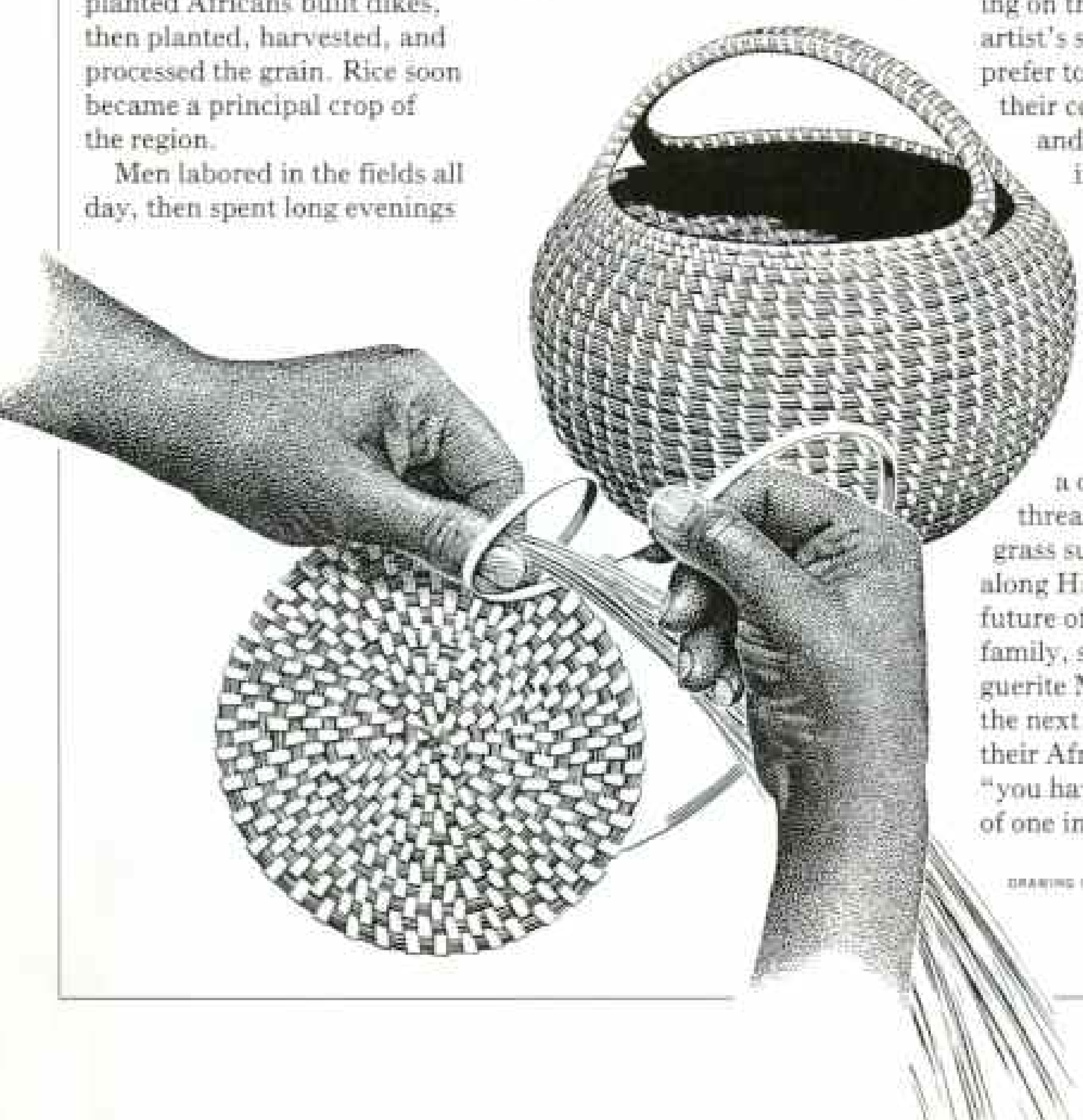
Men labored in the fields all day, then spent long evenings making baskets, which were needed by the hundreds for winnowing, storing, and transporting rice. The slaves used black rushes for a basket's foundation, forming a coil and simultaneously stitching it with ribbons of oak or palmetto. Rather than weaving the ribbons into the basket, they sewed them in with a "bone"—an awl made of animal bone used to separate the rushes.

The "rice kingdom" did not last. It was devastated by the Civil War and suffered a final blow from severe storms 30 years later. But basketmaking endured, passed from generation to generation, particularly on the coastal islands of Georgia and South Carolina. Work baskets were often used to carry produce to market or for storing household goods.

Demand for the baskets grew in the 20th century, and women took up the craft. By the 1930s they were selling baskets from family stands along Highway 17 northeast of Charleston, near Mount Pleasant.

Today artists from 300 families offer baskets that fetch anywhere from a few dollars to more than a thousand, depending on the basket's size and the artist's skill. These days they prefer to use sweet grass for their coils instead of rush, and filed teaspoon handles instead of animal bones, and their work has earned a new audience, thanks to exhibits at the American Craft Museum in New York City and other collections.

Coastal development, a concern for many artists, threatens both the sweet grass supply and the stands along Highway 17. But the future of the art lies within each family, says basketmaker Marguerite Middleton. To nurture the next generation's interest in their African heritage, she says, "you have to have a committee of one in the home."



DRAWING BY NGS ARTIST WILLIAM H. BOND

Who Says You Need An Ocean To Study One?

Not Melany Nussbaumer. She's the creator of Project Oceanscope and a teacher at Riverside Middle School in Saluda, South Carolina.

Her sixth grade students benefit from a wide range of interactive lessons Melany has created based on the marine environment.

In one exercise, the students recreate the ocean floor in their classroom. Then, using cut-out drawings they've made themselves, the kids place the various arthropods, bivalves, fish, and mammals in their proper "home" on the ocean floor.

In another, the students begin to understand the ocean's complex food web by playing different species in the marine environment and acting out the roles of each.

For bringing the ocean to her students, State Farm is honored to present Melany with our Good Neighbor Award, along with a contribution of $5,000 to her school.

The State Farm Good Neighbor Award was developed in cooperation with the National Science Teachers Association.

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On Assignment

JEFF FOSTER

"His breath would wilt flowers," says photographer MICHAEL NICHOLS of this walrus, which eats 80 pounds of fish a day in the Tacoma, Washington, zoo. To Nichols zoos stand, on the moral scale, between wilderness and entertainers who use captive animals. "Writer Cliff Tarpy and I set out to show zoos' positive changes. Zoos are now a leading method of educating about the natural world, but some have a long way to go."

For his next assignment, Nichols is headed for Congo's Ndoki rain forest, one of earth's most isolated regions. "I may wish the animals were in cages," he jokes. "It could take weeks just to get one picture."

The human species and its discontent is the theme of our article on Cyprus. There photographer WILLIAM ALBERT ALLARD (below left, at right) and writer TAD SZULC inspect a bullet-torn village, a reminder of the 1974 civil war.

MARIANNE SZULC

Wrapping up his 23rd GEOGRAPHIC project, Allard recalls arriving at Society headquarters as an intern in 1964: "I was fresh out of school, with a wife, four kids, and an interesting portfolio." He was soon traveling to places as distant as New Zealand and as close as Pennsylvania, where he produced an intimate view of Amish folk. Allard has written as well as photographed seven articles, including his home-state tribute to Minnesota's lake country.

Fluent in five languages, Polish-born Szulc served for 20 years as a foreign correspondent for the *New York Times*—for which he broke the Bay of Pigs story in 1961. He has since written 15 books. After covering "nearly every major political story of the past 30 years," he found Cyprus particularly tough. Sorting out the claims and counterclaims of the island's partisans, he says, was "like swimming in lentil soup."

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who see the world

in everything but

-black and white.

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