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Crucibles of Creation
Volcanoes

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COVER: It's a big show off Hawaii's Big Island when molten lava from Kilauea flows into the cold Pacific, exploding on impact. Photograph by Roger H. Ressmeyer.

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Volcanoes

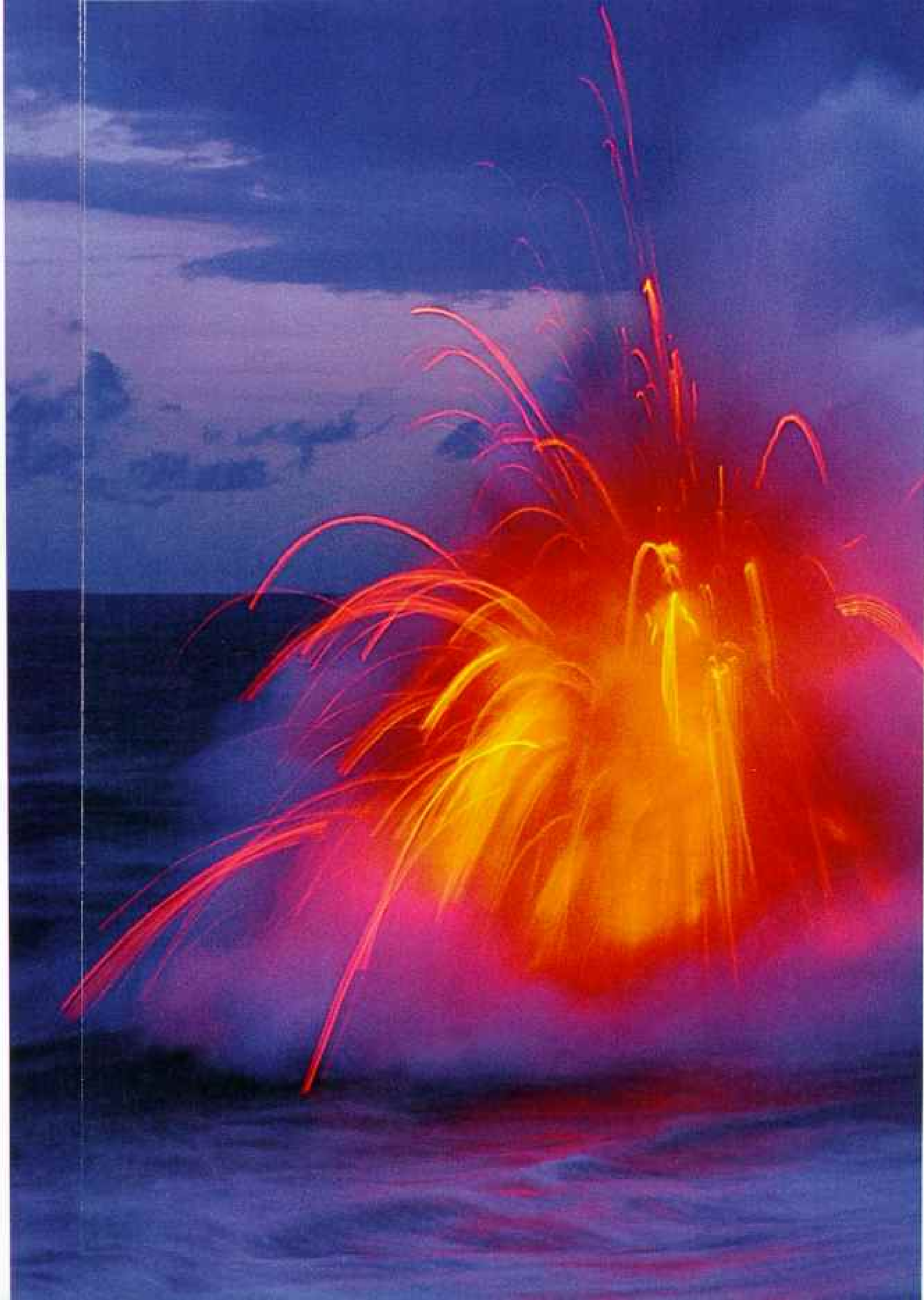
Crucibles of Creation

By NOEL GROVE NATIONAL GEOGRAPHIC SENIOR WRITER
Photographs by ROGER H. RESSMEYER STARLIGHT

DARKNESS CAME AT MIDAFTERNOON as my taxi crawled through Manila traffic. The driver flicked on headlights that glared off the wet pavement ahead. I had come to the Philippines to see an erupting volcano, but the explosions from Mount Pinatubo were 55 miles northwest of the capital. Surely, I thought, this murk must be the work of Typhoon Yunya, crossing this hapless island of Luzon at the same time.

But when I reached the Philippine Institute of Volcanology and Seismology, Director Raymundo Punongbayan instructed me on the wide-reaching power of volcanoes. "The typhoon brought clouds and rain, but volcanic ash from Pinatubo caused this darkness. The eruption today may be one of the greatest on record."

Satellite images and measurements of tephra, the solid material ejected by volcanoes, would prove him right. On June 15, 1991, the 5,770-foot mountain became a monstrous cannon, firing a shot with effects felt around the world. Sulfur dioxide was blasted 25 miles into the stratosphere, where it combined with moisture, creating a thin aerosol cloud that would girdle the globe within 21 days. Scientists, measuring the depth of the cloud by satellite observation, would calculate that 2 percent of the incoming sunlight would be deflected from the earth, leading to slightly lower temperatures, on average, around the globe.



Roiling clouds of superheated ash surge from Mount Pinatubo in the Philippines (preceding pages). Last year's eruption pumped two cubic miles of fine ash into the atmosphere during one of the century's biggest volcanic explosions. In a pyrotechnic display (following pages), molten lava explodes as it hits the ocean off Hawaii. Such outbursts laid the foundation of earth's continents and ocean basins four billion years ago. Volcanic gases formed earth's primitive atmosphere and seas. ALBERTO GARCIA, SABA (PRECEDING PAGES)

The volume of tephra hurled from Pinatubo, two cubic miles of material pulverized to a fine ash, could bury the District of Columbia to a level of 150 feet. But ash was not the only problem that day in Manila. Around 7 p.m. earthquakes hit. The exit of lava from the mountain had left a subterranean cavern that began falling in on itself, causing shocks. In the capital, light fixtures swayed overhead and chairs felt as uncertain as liquid. Ash fell like powdery beige snow. To keep grit from their eyes, pedestrians walked the streets with plastic bags stretched over their heads, pressing their noses sideways and giving them a macabre Halloween look.

Darkness in daytime, ash from the sky, ghoulish pedestrians, and a trembling earth. "Like the end of the world," murmured one Manileña. I made my plans to drive toward the mountain the next morning.

THE PHILIPPINES were among my first stops on a global survey of volcanism, that mysterious force that reminds us of our planet's molten past and present and touches some primal fear within all of us. Much about this force remains elusive, taunting. But in the past decade scientists have gained new understanding of the dynamics of eruption. They have been surprised by the individuality of volcanoes and found them to be even more unstable than thought, sometimes collapsing in huge landslides. They have been able to track the movement of magma underground. And they are now able to predict eruptions with increasing accuracy—thereby saving lives. Pinatubo, I would learn, was an example of this ability to predict.

With morning I headed north. A panicky phalanx of vehicles—automobiles, dump trucks, bicycles—streamed toward me on both sides of a highway covered with ash. Near the town of Angeles, 15 miles from the volcano, I talked with a family walking hurriedly, carrying bundles of clothes.

"Rocks this big are falling from the sky," said the young mother, tracing a grapefruit-size circle in the ash with a bare toe. "And mud flowed into our house!"

Although the blast transforms much of a volcano's liquid rock into ash, sometimes frothy lava is blown aloft and cools into clumps of sharp-edged pumice. These were the falling rocks she described. As for the mud, heavy rains can loosen the tons of ash dumped on the shoulders of a volcano. Then a cement-like slurry roars down streambeds in town-burying torrents called lahars.

A few miles farther I came to a barren landscape a mile wide where a lahar had swept across the road the previous night. The sludge had snapped power-line poles, obliterated fences and vegetation, and swept cars into a nearby field. Elsewhere pyroclastic flows—killer clouds of hot gases, pumice, and ash traveling at speeds as high as 80 miles an hour—had rolled across the countryside. The damage and death would continue as more lahars roared down the slopes without warning.

In the village of San Antonio that evening someone directed me to a boardinghouse operated by a woman named Carolyn. Lodging seemed unlikely when I arrived; refugees were streaming into the two-story frame structure and arranging bedding on the flat roof.

"We wouldn't think of charging them anything," said Carolyn, with a wave of her hand. "Everyone is just trying to get by."

The eruption was a nightmare, she said, the darkness pierced by strange-colored lightning . . . blue, green, even red. Silicates in the ash cloud may have caused the light show, refracting different shades of the color spectrum.

And now, continual earthquakes. "I worry about the house," she said. "It's not solid."

After Carolyn's nephews generously gave up their second-story bed for me, I worried too. A quake around midnight made the house sway and creak. I heard the rooftop boarders murmuring in alarm. When another, stronger jolt came later, I woke to the sound of someone yelling and suddenly realized that it was me.

The next day I joined a team of volcanologists heading toward Pinatubo. Five miles from the volcano we stopped to reconnoiter, standing in the rain on an almost featureless plain of gray, soaked ash. Around us rose pillars of steam, remnants of the deadly pyroclastic flows that had surged from the volcano. "It's there," said one of the team members, pointing toward a foggy grayness, "only it's hidden by clouds."

Tension hovered as thick as the fog as we continued toward the monster. But now the two days of driving in heavy ash burst the radiator of my four-wheel-drive vehicle. Almost gratefully I turned back, refilling the radiator from puddles of rainwater until it could be patched at the next town.

Pinatubo's toll: 42,000 houses destroyed,

Ghostly cast of a Pompeii citizen lies before Italy's Mount Vesuvius. Its A.D. 79 eruption buried Pompeii under 15 to 25 feet of ash and pumice, killing residents of nearby Herculaneum as well when the eruption cloud collapsed and sent hot ash down the slope. Vesuvius remains a threat.

100,000 acres of cropland swamped by ash, billions of dollars in economic losses, and nearly 900 dead. But the toll would have been greater had the mountain not been monitored and the eruption predicted. Some 200,000 people evacuated dangerous areas. I turned now to examining how the scientists had been able to get warning of the blast a month in advance.

Before 1991 Pinatubo had slept for centuries, the last eruption occurring about 600 years ago. The first hint of trouble came on April 2, when villagers noted small steam-induced explosions from vents on the mountainside. Scientists from the Philippine Institute of Volcanology and Seismology responded immediately and were joined in time by a team from the U. S. Geological Survey (USGS).

Seismometers were installed to measure movement under the mountain, tiltmeters to discern any bulging in the mountainsides. Airborne instruments analyzed escaping gases for sulfur dioxide. (A tenfold increase in sulfur dioxide in late May showed that juvenile magma was rising toward the surface—a danger sign.)

Field surveys and aerial photographs meanwhile revealed thick pyroclastic deposits ten miles from the volcano; this indicated that its eruptions in the past had been very violent, and this one was likely to be the same.

By June 11 ash emission and the doubling in size of the mountain's lava dome signaled an imminent explosion. The radius of evacuation was extended from the immediate vicinity to 15 miles.

The various monitoring devices were linked by telemetry to computers at Clark Air Base, then a U. S. facility. "There are no magic new machines," Paul Okubo, a USGS seismologist, told me, "only steady improvement in

Torrents of lava stream from a vent near the summit of Sicily's Mount Etna, whose frequent explosions have been recorded since 1500 B.C. In January 1992 the village of Zafferana lay in the path of lava from a new eruption. Dams were erected to slow

the lava flow. By May the lava was only a mile short of town; it was diverted into an artificial channel, where it cooled. Recently geologists projected another hazard: collapse of the steep-sided cone as the mountain slowly slides into the Mediterranean Sea.

Hard hats are mandatory for Japanese students at the foot of Sakurajima, one of the world's most active volcanoes and neighbor to 7,500 people. Annual volcano drills prepare residents for disaster. Across the bay, the busy port of Kagoshima (left) gets regular dustings of ash.

using what we have." The computers were a key—handling vast amounts of information quickly and merging it to form clear three-dimensional images on the screens.

One scientist remembered how tiny dots representing seismic jolts would appear on the computer screen, each heralded by a tiny *blip* sound. At first the dots were infrequent and at the fringes of the mountain. Then more dots appeared, rushing toward the lava vent, until the blips became an almost constant squeal—the volcano erupting!

With that blast, seismic systems became saturated, and scientific stations were either engulfed or had their telemetry links broken. They would be replaced in the following months, and in the summer of 1992 new pulses would threaten more eruptions. A year after the first explosions, seasonal rains sent more killer lahars roaring out of the uplands.

WE HUMANS have lived and died and been disrupted by volcanoes throughout history. In ancient times the natural phenomenon merged with myth, drawing its name from a Roman god, Vulcan, ruler of fire, forge, and hearth.

The first well-recorded eruption was that of Vesuvius in A.D. 79. It buried the Roman towns of Pompeii and Herculaneum on the Bay of Naples, killing 16,000 people.

The deadliest in historic times appears to have been Tambora in Indonesia: Its 1815 eruption claimed 92,000 lives. Twelve thousand died in the blast; the remainder, their crops and livestock destroyed, starved to death. Tambora's aerosol cloud lowered temperatures so much that snow fell in the United States in June, July, and August of the following year; it is remembered as "the year without a summer."

Other notable killers:

Krakatau, 1883, the Sunda Strait between Java and Sumatra. Created a tsunami a hundred feet high that drowned 36,000 people. The detonation was heard 3,000 miles away.

Pelée, 1902, Martinique. Sent a hurricane of hot gases into the town of St. Pierre, killing 30,000. Only two inhabitants survived—one of whom was safely imprisoned in a thick-walled jail cell.

Nevado del Ruiz, 1985, Colombia. A tidal wave of mud swept down from the volcano, smothering and crushing 23,000.

There are some 550 known active volcanoes on earth and some 500 million people living close to them. A dozen or two of these volcanoes are erupting at any moment. Scientists believe that about a hundred of the world's volcanoes need intensive monitoring, and maybe 300 careful watching.

In selecting which volcanoes to monitor, the experts admit a weakness: "A long-quiet volcano could still take an area by surprise," said

Searing ash and gases—a pyroclastic flow—extinguished the lives of Maurice and Katia Krafft (right) when Japan's Unzen volcano erupted in June 1991. The French volcanologists, whose fieldwork often put them in peril, had hurried to Japan to photograph the flows just after the eruption started. Incandescent avalanches still cascaded from the lava dome nine months after the Kraffts' deaths (left). Roaring down slopes with hurricane force, such pyroclastic flows destroy nearly everything in their paths. A subdivision (above), evacuated hours before the eruption began, was wiped out by flowing mud.

EXPLORER AGENCY, PARIS

Chris Newhall, who led the USGS team at Pinatubo.

Reported volcanic activity has increased in the past century, Dick Fiske, a research scientist at the Smithsonian Institution, told me. "But this is doubtless because reporting is better. In fact, there's no evidence that volcanic activity is increasing."

We would not want volcanoes to disappear, for they provide the lifeblood that keeps our planet vital. Just as our blood carries nutrients that feed our constituent parts, volcanoes do the same for the skin of the earth.

Magma contains the major elements required for plant growth—phosphorus, potassium, calcium, magnesium, and sulfur. When it is extruded as lava that hardens into rock, the weathering process that moves the nutrients into soil may take decades or centuries. But when the volcanic material is blasted out as ash, the fertilizing process can occur within months.

In Papua New Guinea an eruption centuries ago inspired native legends. One tells of a terror-filled "time of darkness" followed by a time when "plants grew at a great rate and gave unheard-of yields."

It is no coincidence that Java, one of the most volcano-ridden spots on earth, is also one of the world's most fertile areas. Driving along the island's spine of mostly dormant cones, I wound along slopes stairstepped with jeweled fields of rice, alive with men and women stooping, planting, hacking with curved blades, or plowing behind mud-colored buffalo. "With adequate moisture they get three crops a year," said my guide, Sutikno Bronto, an Indonesian volcanologist.

Magma simmering beneath our feet also yields energy. It heats underground water, which is tapped by wells to warm most of the homes in volcanic Iceland. Natural steam drives turbines that provide 7 percent of New Zealand's electric power, and accounts for one percent of U. S. energy needs.

Geothermal energy could provide up to 10 percent of U. S. power, said Patrick Muffler of the USGS in Menlo Park, California. But there's a limit. The supply, like that of oil, can be exhausted. Some experts have proposed drilling to fracture deep, hot rocks and then pumping in water to make steam. "But we can't yet drill right down to magma and use the heat," Patrick said. "The drills would melt on the way."

WE OWE VOLCANOES even more: They helped shape the lithosphere, the solid planetary crust on which we live. When the bombardment of earth by meteorites ceased four billion years ago, earth's surface began to cool, but radioactive decay kept the inner rock heated. As in a boiling teapot, heat currents carried lighter, gas-filled portions of the rock to the surface. There it sometimes melted and burst through the hardening crust as lava.

Carbon dioxide, water vapor, and other gases liberated by these eruptions hovered overhead to form earth's early atmosphere—holding in warmth from the sun, bringing the rain that created oceans.

Persistent outpourings of lava have drawn new faces on the continents and paved the ocean floor with cold, volcanic rock. Iceland and the Azores, among other islands, were built up from the seafloor in a process that continues today.

Even when the deep-welling material does not burst through, it may contribute to the movement of earth's tectonic plates, 20 or so sheets of crust that move slowly—at the rate of a fingernail's growth—but constantly. By one theory, massive plumes of mantle material rising from the inner earth may be diverted sideways upon reaching the hard crust, creating currents that pull the plates apart and set them drifting. Wherever they part, magma rises to fill the gaps. Such a gap-filling created the Mid-Atlantic Ridge, the volcanic underwater chain that runs from the Arctic Ocean nearly to Antarctica. Probably 80 percent of earth's volcanic activity is thus hidden from sight under the seas.

"You can compare the lithosphere to the Arctic ice packs, constantly heaving, breaking up, resealing, then breaking up again," said Don Anderson, who specializes in early planetary history at the California Institute of Technology.

Where ocean plates collide with continental plates, the ocean crust dives below the lighter continental mass. Geologists debate what happens to the subducted crust after that, but many surmise that the subducting seafloor bursts back into our world as recycled volcanic rock. This would help explain the Ring of Fire—the area of active volcanism that rims the Pacific Ocean Basin and of which Pinatubo is a part.

Brimstone-covered Vulcano, an island off the west coast of Italy (and mythical workshop of the Roman fire god, Vulcan), is now a laboratory for geologists. Probes of the volcano's fumaroles reveal increasing temperature and gas output, suggesting that an eruption could be at hand.

Sometimes a puzzling hot spot of magma rises from deep within the earth, a blowtorch-like column a hundred miles deep. The Hawaiian Islands resulted from such a hot spot; they are the tops of a range of volcanic mountains built up from the seafloor by thousands of lava flows. The flow continues.

"TOURISTS ALWAYS WANT TO SEE the red stuff," said USGS geologist Tari Mattox as she led me along a stream of basaltic lava flowing from a vent in Kilauea. We were on Hawaii, the Big Island, formed from the tops of five volcanoes. The temperature of the red stuff was about 2000°F. It flowed like cherry syrup; then as it cooled it hardened into swirls as black as the ponytail spilling from the back of Tari's billed cap.

The lava's performance seemed neat, even elegant. But Tari warned that it could be dangerous. Some lava vanished into natural lava tubes, formed when the surface of a lava river cooled. "You can break through a tube if you don't watch for thin spots!" she said. We followed one tube two miles to the shoreline, where the lava poured out into the sea. Geologists call this a fire-hose entry.

Later Tari donned a heat-resistant balaclava and thick gloves to retrieve a lava sample from a "skylight," a break in the top of one of the tubes. Laboratory analysis would determine the temperature at which it flowed, a clue to future volcanic activity.

Kilauea is the most studied volcano in the world. Recently seismologists were able to follow the movement of subterranean magma so closely that they could position themselves to watch it break through the surface.

Hawaiian volcanoes pour out lava in rivers

of *pāhoehoe* (puh-HOY-hoy) and in a thicker version called *'a'ā* (AH-ah). The ooze builds huge, rounded volcanoes shaped like warriors' shields. Kilauea's shield is 50 miles long, 15 wide. Its summit caldera—created when the volcano collapsed in on itself—is an oval-shaped depression measuring 2.5 by 2 miles.

The difference between an explosive volcano and a drooling one like Kilauea lies in the viscosity and gas content of the magma. Killer volcanoes hold magma that is thick and sticky, the gases under great pressure—so the magma explodes when released. Kilauea's magma, thinner and holding much less gas, effuses in fountains.

If Hawaii's volcanoes do not explode, they have shaken the earth in the past—with humongous gravity landslides. In the 1960s James Moore, then head of the Hawaii Volcano Observatory, took a careful look at a map of the seafloor off Molokai. This map, based on simple echo soundings, showed remarkable variety in depth. Dr. Moore theorized that the seabed was littered with huge blocks and that these blocks had once been part of the volcanic island and had slid into the sea. In time, more advanced sonar imaging proved him correct.

But he was astounded at the extent of the slides around all the Hawaiian Islands. "They include debris avalanches more than 125 miles long," he told me. "Some individual chunks are the size of Manhattan Island. One collapse 100,000 years ago caused a thousand-foot-high tsunami off the island of Lanai."

The avalanches are adjustments: When the build-up of lava gets too heavy and steep for a mountain, part just slides off. Kilauea continues to extrude lava, and so the Big Island is growing—by 319 acres in the past six years. A major landslide should be expected every 100,000 years, Moore told me.

"But smaller slides occur during the building stage, and they can be dangerous," he added.

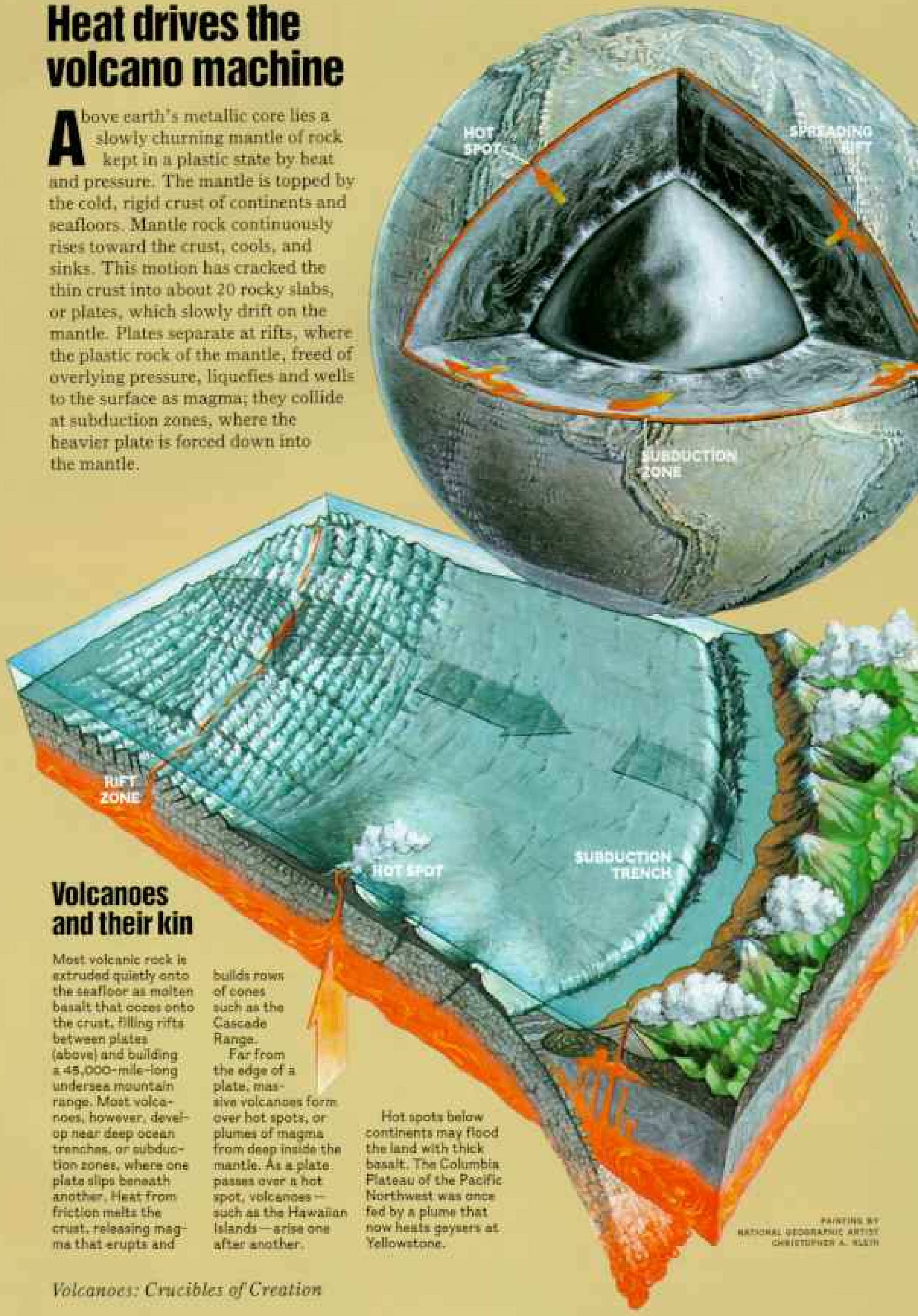
In 1975 the south flank of Kilauea slid 20 feet toward the sea after being jostled by an earthquake. To Fal Allen, then a 14-year-old Boy Scout camped at seaside with his troop, it was a horror never to be forgotten.

"The second of two big earthquakes came during the night," said Allen, now a Seattle brewer. "A wave eight or ten feet high rolled in, and I was dragged out to sea, mostly underwater. When the water calmed, I had to fight my way to the surface through branches and brush so thick I walked over them to get back to shore. When light came, we could see that the land had *(Continued on page 28)*

Sealed for safekeeping, volcanic moon rocks at a NASA laboratory in Houston, Texas, are examined by astronaut-geologist Harrison H. Schmitt (top, at left) and curator James L. Gooding. Orange soil caught Schmitt's eye during his Apollo 17 mission. Analysis showed beaded glass (above), thought to have cooled quickly from fountains of lava. Elsewhere in the solar system, Jupiter's moon Io jets sulfur and lava sheets blanket Venus, while Olympus Mons volcano on Mars is probably extinct.

Heat drives the volcano machine

Above earth's metallic core lies a slowly churning mantle of rock kept in a plastic state by heat and pressure. The mantle is topped by the cold, rigid crust of continents and seafloors. Mantle rock continuously rises toward the crust, cools, and sinks. This motion has cracked the thin crust into about 20 rocky slabs, or plates, which slowly drift on the mantle. Plates separate at rifts, where the plastic rock of the mantle, freed of overlying pressure, liquefies and wells to the surface as magma; they collide at subduction zones, where the heavier plate is forced down into the mantle.



Volcanoes and their kin

Most volcanic rock is extruded quietly onto the seafloor as molten basalt that oozes onto the crust, filling rifts between plates (above) and building a 45,000-mile-long undersea mountain range. Most volcanoes, however, develop near deep ocean trenches, or subduction zones, where one plate slips beneath another. Heat from friction melts the crust, releasing magma that erupts and builds rows of cones such as the Cascade Range.

Far from the edge of a plate, massive volcanoes form over hot spots, or plumes of magma from deep inside the mantle. As a plate passes over a hot spot, volcanoes—such as the Hawaiian Islands—arise one after another.

Hot spots below continents may flood the land with thick basalt. The Columbia Plateau of the Pacific Northwest was once fed by a plume that now heats geysers at Yellowstone.

PAINTING BY NATIONAL GEOGRAPHIC ARTIST CHRISTOPHER A. KLEIN

Volcanoes: Crucibles of Creation

Pinatubo's plumbing

What caused the eruption? Scientists believe that an earthquake in July 1990 allowed buoyant basalt from the upper mantle to squeeze into the magma chamber, which was filled with viscous dacite. That injection energized the simmering reservoir and created a fluid, gas-charged magma called andesite. This magma soon rose toward the surface, building a new dome on the northeast slope that corked the system. Pressure in the magma chamber built up rapidly. Remelted dacite rose after the andesite but ran into a clot of older domes. Probing its way to the surface, the magma finally found a clear conduit. Gas exploded from the lava, and the volcano blasted skyward, destroying the newest dome.

PAINTINGS BY NATIONAL GEOGRAPHIC ARTISTS WILLIAM H. BOND AND CHRISTOPHER A. KLEIN

Ember on the Ring of Fire

The Philippines originated as huge volcanoes built up from the ocean floor. The island of Luzon alone has 13 active volcanoes, some only a short drive from Manila, a city of 6.7 million people. The pattern of volcanoes around the rim of the Pacific Ocean is called the Ring of Fire.

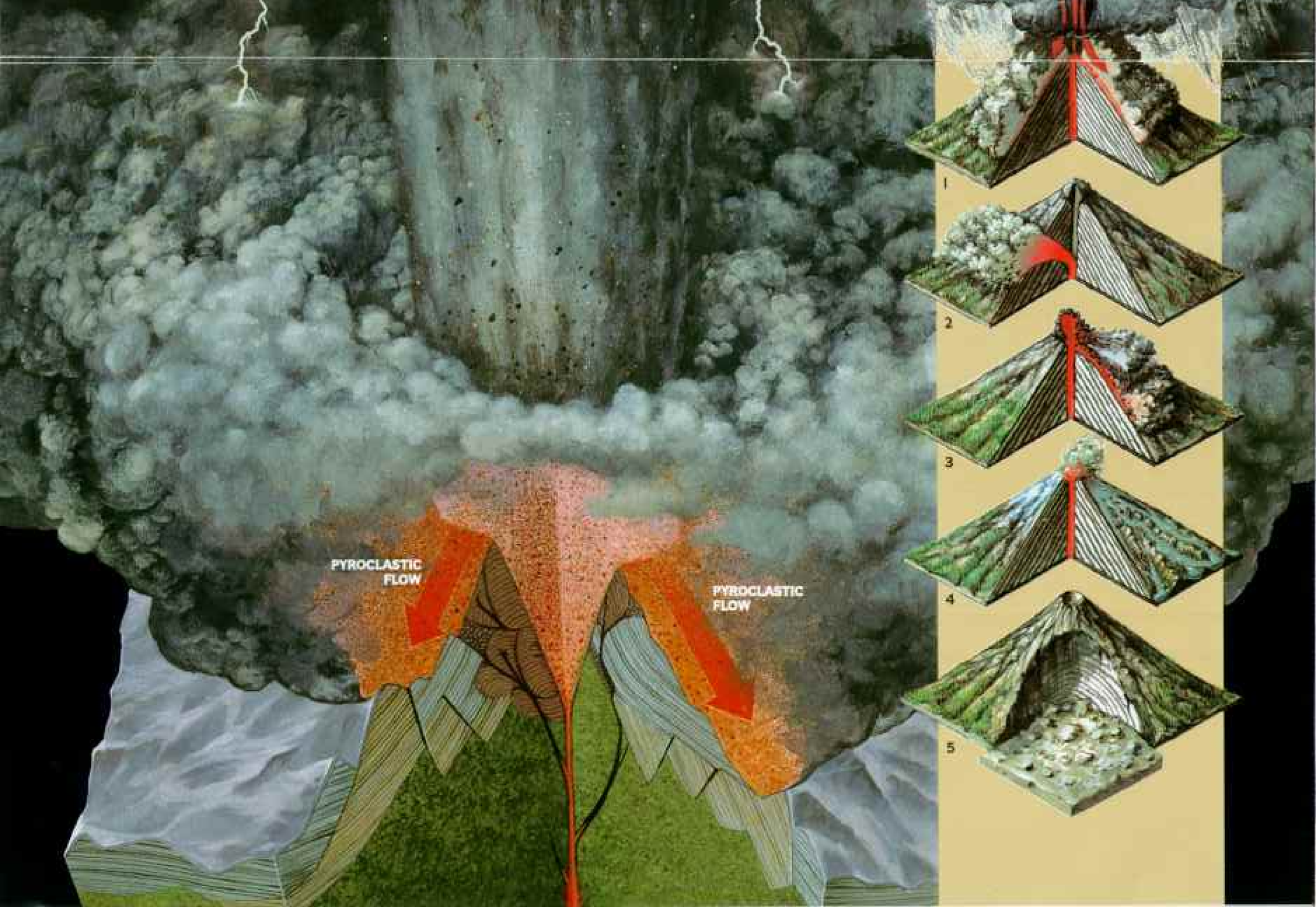
The big blow

At midnight on June 14, the mountain began to spew deadly clouds of 1500°F gas and ash (below). Columns of ash blasted into the atmosphere, eventually reaching 25 miles high. Earthquakes came so fast and strong that they appeared on seismometers as one. At dawn on June 15 a huge blast blew out the side of the mountain. By 2 p.m. the sky was black with ash and falling chunks of pumice. More pyroclastic flows swept down the slopes, filling 650-foot canyons and spreading outward as far as 11 miles. The new ash from Pinatubo (depicted at right in a painted microscopic view) was a jumble of bits of old volcano, bubbly pumice and glassy shards from new lava, sulfur-rich anhydrite, and crystals of hornblende from deep inside the magma chamber. The 1991 eruption shut down in early September, but the loose ash will remain a deadly threat for years to come—every time rain turns it into unstable slurry.

MAGNIFIED 125 TIMES

How volcanoes become killers

Majestic cones can turn into lethal monsters. Towering columns of ash collapse (1), raining hot rock on the mountain, burying whatever lies below, as at Vesuvius. Unexpected landslides, like the one at Mount St. Helens in 1980, unleash devastating lateral blasts (2). Lava domes cave in, releasing 1500°F pyroclastic flows (3), as at Unzen. Lahars, rivers of water-soaked ash (4), smother towns and fields, as they did at Pinatubo and Nevado del Ruiz, in Colombia. A cone can build so steeply that it can't support itself and so collapses in huge landslides (5) that send debris miles downslope—a process discovered in Hawaii. Flowing lava rarely kills, but it can cause widespread property loss.

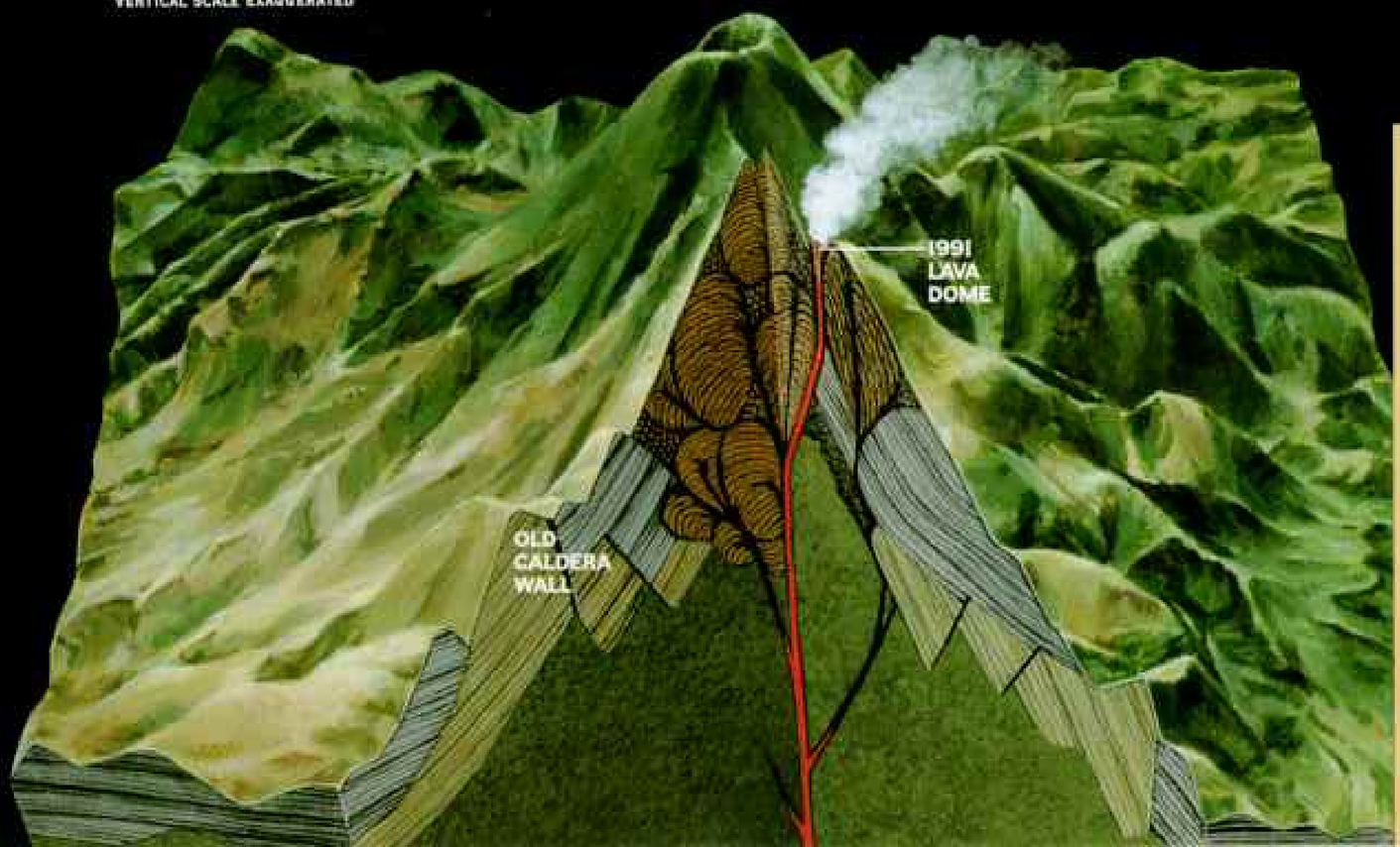


Pinatubo: ready to blow

Quiet for 600 years, Mount Pinatubo was an innocent-looking peak in central Luzon. Then in April 1991 vigorous steam eruptions, swarms of shallow earthquakes, increased sulfur dioxide emissions, and rapid growth of a lava dome heralded a powerful eruption.

Scientists from the Philippine Institute of Volcanology and Seismology, later joined by a team from the U. S. Geological Survey, monitored the events and called for evacuation of nearby villages. A series of minor explosions began on June 12.

VERTICAL SCALE EXAGGERATED



Eve of eruption

Pinatubo sits in the center of a three-mile-wide caldera, a depression from an earlier eruption that had made the volcano collapse in upon itself (tilted blocks at left). A new cone formed —a dome of thick clumps of dacite rock overlain by layers of ash-flow deposits. Geothermal vents on the north side of the mountain gave the only clue that the volcano was still active. On April 2, 1991, steam and ash erupted from the site. Monitoring instruments were quickly installed.

SHAWN G. HENRY, SABA

A pall of ash covered Pinatubo's flattened slopes (above) in late June 1991. A look into the new caldera eight months later (below) revealed steaming fumaroles. Rain had collected into a lake. Along with ash Pinatubo ejected 20 million tons of sulfur dioxide, the main ingredient in the reflective droplets that painted dawns and sunsets a Pinatubo pink. Sulfuric acid also created an "aerosol parasol"—a shield that blocks sunlight and may lower global temperatures by one degree for several years. Pinatubo reawakened in July 1992, and lahars have continued to ravage the countryside—40,000 more people had lost their homes by September.

Pinatubo's eruption laid waste hundreds of square miles, killed nearly 900 people, and disrupted the lives of 1.2 million more. Most damage came from lahars, floods of rain-soaked ash, after typhoons hit Luzon in July 1991. A 16-foot-high dam (above), built in a gorge in 1982 to restrain such torrents, was overtopped by the lahars, which then scoured out the channel beneath to a depth of 60 feet. Bridges, power lines, waterworks, and 110,000 homes were destroyed. Cement-like ash collapsed the roofs of thousands of structures (right) and shut down nearby Clark Air Base.

Some 650,000 Filipinos were left without income (above right). An early estimate put losses at 440 million dollars; cleanup and rebuilding may top 10 billion. Another big eruption, as was recently forecast, can only add to the strain on the badly damaged economy.

In a huge effort, 200,000 people were relocated, many to refugee camps. Today 20,000 people remain in tent cities, where more than 500 have died of disease and exposure. Most of them are Aeta tribesmen who worshiped the volcano and hunted on its slopes.

Losses might have been worse, but the effective monitoring network and early evacuation saved thousands of lives. One especially convincing tool to roust unwilling residents was a videotape showing rampaging lahars and pyroclastic flows—the kind of damage that their apparently quiet volcano might cause. The tape had been made by Maurice Krafft, who was killed just days before Pinatubo's eruption by a pyroclastic flow in Japan.

VAN CAPPELLEN, SARA (ABOVE); SHAWN G. HENRY (BELOW)

(Continued from page 18) actually slid into the water, and the tops of palm trees were sticking out of the ocean." The tsunami drowned a Scout leader and a local fisherman.

HOT LAVA RARELY KILLS PEOPLE. It usually destroys only houses and other property that cannot be readily moved. An exception occurred at the volcano Nyiragongo in eastern Zaire in 1977, when two side vents popped open in the erupting cone. The weight of lava above caused lava to gush freely from the vents, and for a few hellish hours rock flowing almost like water engulfed villagers, their livestock, and wild elephants on the slopes. At least 70 people died.

Particularly lethal in eruptions are the pyroclastic flows (PFs), glowing clouds so hot they consume anything in their paths. PFs are formed by the collapse of lava domes or by blasts that blow out the side of a mountain or explode skyward, then fall back to earth and spread for miles.

In the spring of 1991 French volcanologists Maurice and Katia Krafft went to the town of Shimabara, Japan, to film small pyroclastic flows breaking loose from the lava dome on the peak of Unzen. There they teamed up with young Harry Glicken, a lanky, likable geologist who had moved to Japan to be near frequent volcanic action. On June 3 the three of them walked up an eroded valley partly powdered with PF ash. Japanese newsmen also clambered over the slopes.

From later reports we learned that a loud crack like the sound of a lightning bolt came from the mountain. Lava around the top—gray on the surface but red hot underneath—broke loose and fell down the mountain. The tumbling movement energized the lava into a fragmentized cloud of killer heat. The three volcanologists plus journalists, cab drivers, and farmers died instantly as the heat rolled over them. The toll: 41.

Loss of Glicken and the Kraffts stunned volcanologists, a fraternity fascinated by what many call living geology.

"Harry was always so distracted by his science that he left trails of car keys, gloves, and tools on volcanoes," remembered former roommate Steven Brantley of Cascades Observatory in Vancouver, Washington. The popular French couple, a friend of theirs told me, once said they knew well the risks at volcanoes and were prepared for the possibility of dying on the slopes of one.

I arrived in Japan five days after the tragedy. An Osaka newspaperman, Satoshi Tsujino, offered to drive me to a view of the valley down which the killer PF had rolled. From what we considered a safe distance, about two miles, we looked at the talcum of PF ash. Then Satoshi decided to head back toward town.

Just as we started away, I shouted: "LOOK!" A gray ball grew just below Unzen's peak. We watched it blossom into a billowing PF cloud 200 feet high and race downslope. "I think . . . we must go now," said Satoshi.

As we sped away in his van, I watched the cloud bottom out at the foot of the mountain, glance off a slope, then climb a thousand feet in the air. Later, on a helicopter ride, I saw that the cloud had scorched spring foliage to a dirty brown and set homes afire.

ONE OF THE MOST DESTRUCTIVE forms of volcanic behavior has only recently received scientific attention. This is the collapse of volcanic cones—the phenomenon that littered the seafloor off Hawaii. The 1980 explosion of Mount St. Helens in Washington State served as a sharp reminder.*

After centuries of sporadic ejections of lava and ash that built its scenic cone, St. Helens was jarred by earthquakes caused by magma moving upward—and the north flank collapsed. In such events the debris rolls farther than physics would seem to predict, perhaps fluidized by snow or groundwater caught up in the churning movement. Debris from St. Helens flowed 15 miles down the North Fork of the Toutle River. Thirty-five hundred vertical feet of material slid nearly 80,000 feet horizontally! The collapse was followed by a pyroclastic blast that scythed down trees 17 miles away. Some 60 people died.

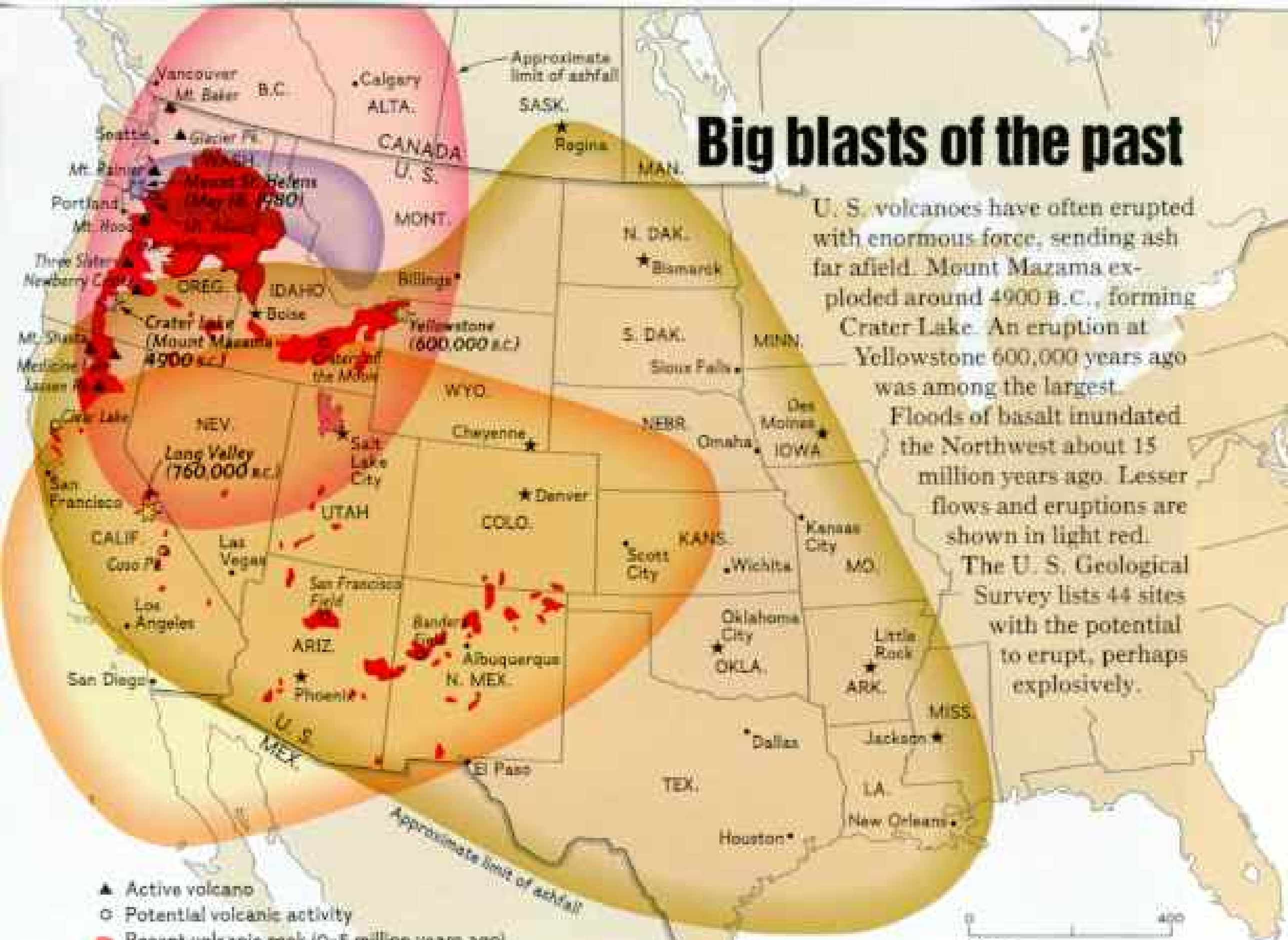
"After St. Helens, geologists all over the world began to see more clearly the signs of previous volcanic collapse," Steven Brantley told me. One example of such recognition came in Mexico.

Smoldering Colima in Jalisco state is considered that nation's most dangerous volcano, but we know now that it is only an upstart cone

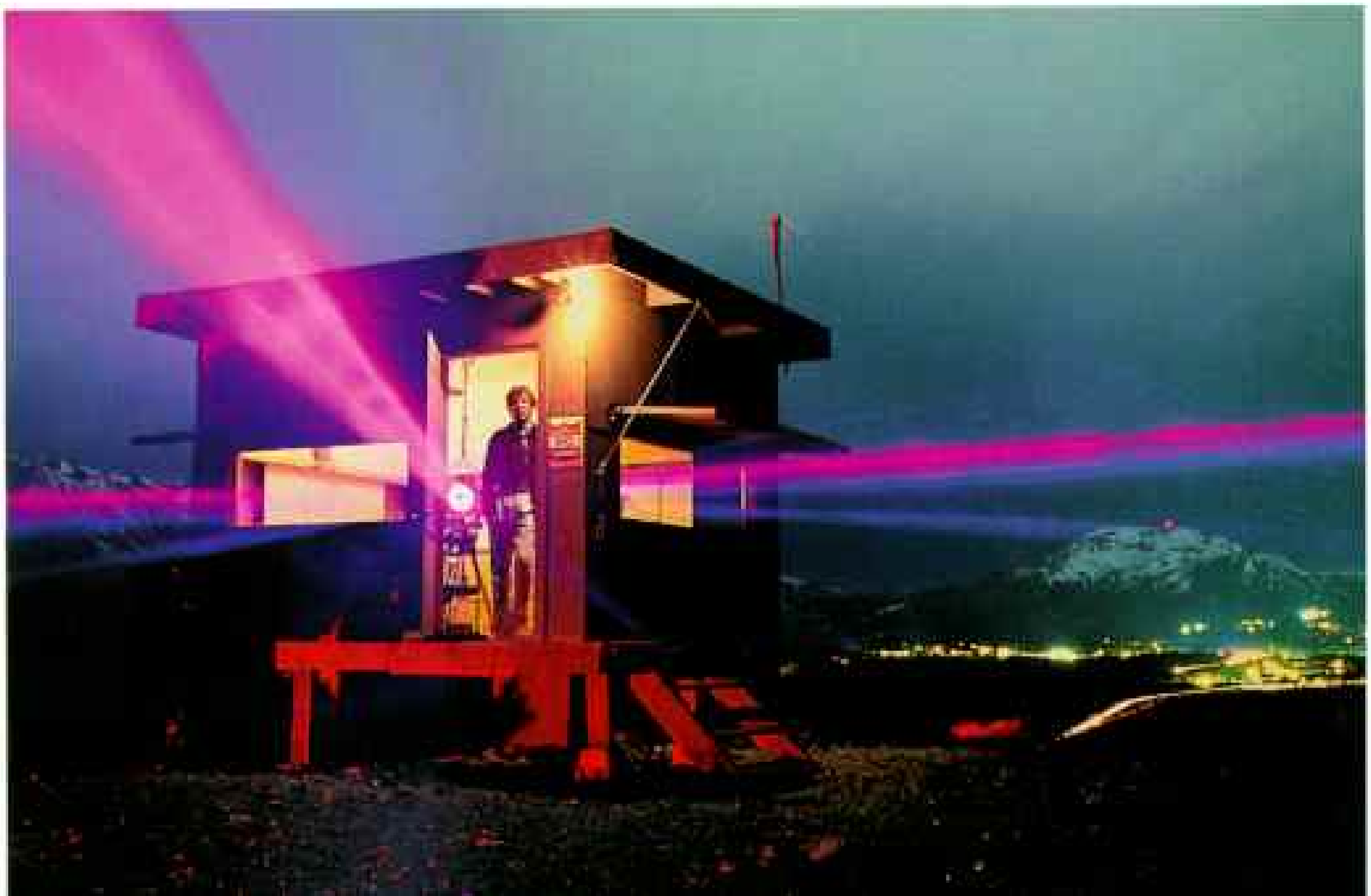
*See "St. Helens: Mountain With a Death Wish," NATIONAL GEOGRAPHIC, January 1981, and "Mount St. Helens Aftermath," December 1981, both by Rowe Findley.

Big blasts of the past

U. S. volcanoes have often erupted with enormous force, sending ash far afield. Mount Mazama exploded around 4900 B.C., forming Crater Lake. An eruption at Yellowstone 600,000 years ago was among the largest. Floods of basalt inundated the Northwest about 15 million years ago. Lesser flows and eruptions are shown in light red. The U. S. Geological Survey lists 44 sites with the potential to erupt, perhaps explosively.



Measuring almost imperceptible changes in the landscape, lasers in the caldera at Long Valley, California, help gauge its potential for eruption. Earthquakes throughout the 1980s raised concerns at the nearby Mammoth Lakes resort area, background. Magma is on the move beneath the caldera, and Long Valley's violent past warrants the continued monitoring of the volcano.



The blast that astounded the nation left Mount St. Helens with a huge gash on its north face (left). The 1980 eruption advanced prediction skills and monitoring methods. Relatively quiet today, the steaming mountain still yields data on dome formation (below).

growing out of the side of a previously collapsed one. Volcanologist Ana Lillian Martin-Del Pozzo drove me up a winding trail to a huge half caldera, three miles across.

Colima covers part of the east wall; the south side lies open like a Greek theater. The main performance came several thousand years ago when the old cone collapsed southward, sending avalanche material almost 30 miles away.

"We believe there are cycles in which lava flows from inside the crater and is covered by ash in the explosive eruptions that follow," explained Ana Lillian. "This continues, building up the cone until it can't support itself."

Later we visited debris from the avalanche—chunks of rock hundreds of feet tall, standing like mini-mountains on the flat plain.

THE EFFECTS OF VOLCANOES are not restricted to people nearby, and their dangers are not limited to the earthbound. Jim Lynch of the National Oceanic and Atmospheric Administration showed me satellite images of the dustlike smudge in the stratosphere from Pinatubo. "The lighter sulfur dioxides may continue to circle the globe for five years," he said. The results, along with lower surface temperatures and possible damage to the ozone layer: brilliant red sunrises and sunsets worldwide.

The lower and denser ash clouds from volcanoes pose a threat to jetliners because of microscopic shards of volcanic glass. Sucked into jet engines, they fuse in the heat into clumps that destroy thrust. Over the past decade dozens of planes have flown into ash clouds, which often do not show up on aircraft radar. Three narrowly avoided catastrophe.

In July 1991 volcanologists, airline representatives, and pilots met in Seattle to discuss ways of avoiding ash clouds. British Airways pilot Eric Moody gave them a firsthand account of sudden power loss over Indonesia in 1982. Told with an impish twinkle and an airman's nonchalance, his story belied the horror of a Boeing 747 sinking seaward at night with 263 passengers and crew aboard.

"We were at 37,000 feet when dust came billowing into the cabin and I smelled sulfur. Engine four began to run down, and I shut it off. Then we lost the others, one by one. For the next 13 minutes we were the proud possessors of the world's largest glider."

The plane had flown into an ash cloud from Galunggung on Java; the occasional eruptions were well-known to local pilots but not to others. Moody and crew prepared to ditch at sea, all the while trying to restart the engines. Finally they emerged from the ash cloud.

"Around 13,000 feet number four restarted, then the others," he said. In the cooled engines, the glass coatings apparently shattered and thrust returned. The plane landed at Jakarta with instruments impaired and the front windows opaque from abrasive ash, Moody leaning to peer out a side window with

Mushrooming like a nuclear cloud, hot ash rises in an updraft over a pyroclastic flow at Redoubt Volcano in Alaska, threatening aviation. In December 1989, a 747 flying 200 miles to the north lost power when glassy ash from the volcano melted onto the

BILL ELDRED

jet's turbines. Though that airliner landed safely at Anchorage, dozens of similar incidents around the world highlight the need for an improved warning system. Radar doesn't see fine ash, but satellites do: Getting information quickly to the pilots is the problem.

his toe barely touching a pedal for guidance.

Satellite cameras can track ash plumes, but the information is often slow in reaching airline flight-information systems. The Seattle conference concluded with a call for quicker worldwide alerts.

"GIVEN THE INFREQUENCY with which most volcanoes erupt, people who live around them can't just sit there worrying all the time," said Chris Newhall, recalling his work at Pinatubo. "Unfortunately, they want you to tell them just 24 hours before they should leave. So far, we just can't do that."

But scientists keep trying to sharpen the time factor. I found new techniques at work, including seismic tomography. This procedure, using X-ray principles, gives a picture of solid and soft areas 20 miles into the earth, helping unravel the puzzles of magma location.

And I found geologists continuing to sniff the gases of volcanoes, to take their temperatures, check their pulses, measure their flexing muscles, all for more knowledge and to safeguard against surprise explosions.

In Ecuador, geologist Patricia Mothes of the Geophysical Institute of Quito drove me 45 miles to Cotopaxi. Most volcanoes have a princely look about them; Cotopaxi is a Charlemagne of a mountain with a huge robe of snow around shoulders nearly 19,400 feet high. That snow could become a killer if an eruption heated the mountain unexpectedly.

"We know of three occasions since 1534 when eruptions melted snow and sent lahars as far as 200 miles," said Patty.

Her job is to help anticipate any new activity. On the lower slope of the currently quiet volcano, she set up a surveyor's theodolite and focused it on a palm-size reflector higher on the mountain. Locked on, she activated a small laser beam that leaped to the reflector and back, measuring the distance: 4,680 meters and 798 millimeters, nearly three miles. The distance varied less than an inch from measurements taken several months earlier. A series of such measurements indicated no dangerous swelling of Cotopaxi's cone.

No serious shaking either, reported her husband, Minard "Pete" Hall, a professor at the National Polytechnical School in Quito. In a laboratory at the school, Pete and his Ecuadorian colleagues watch the nervous needles on seismic drums, receiving radio signals from a dozen or so seismic detectors implanted on and around Cotopaxi.

To avert possible disaster, the couple has helped simulate emergencies with local civil defense groups. "We locked officials from six provinces in six different rooms and—by radio—described to them a scenario of lahars racing toward their towns. They had to initiate warnings and evacuate their people."

And the simulated result? Pete smiled grimly. "We lost a lot of people. We'll get better."

Sheer numbers lead many municipalities to forgo practicing evacuation. Two million people live in and around Yogyakarta, Java, only 20 miles from the volcano Merapi.

An otherwise well-shaped peak, Merapi bears warts on its western face—lava domes. In 1969 a dome that measured six million cubic meters collapsed in a huge but expected pyroclastic flow. It missed the city and caused few deaths. But today's dome accumulations are twice the size of the one in '69.

Scientists at the Merapi Volcano Observatory in Yogyakarta are monitoring the gases seeping out, hoping to predict the next eruption. "H_2O—water—is the main gas in magma, with smaller amounts of hydrogen chloride, sulfur dioxide, and carbon dioxide," said geochemist Mohammad Badrudin. "As magma rises, the proportion of water vapor decreases, and other gases increase—signals of possible explosion."

In the foothills I was nudged awake after midnight by a limber-limbed technician named Yustinus Sulistiyo for a hike up Merapi to sample its gases. A full moon brightened our 5,000-foot climb, tough enough without daytime heat. We reached the top at sunrise, then entered a steaming crater to check its temperature and snatch a bit of its sulfurous breath. Into a crack showing red just inches below, Yustinus inserted a thermometer that registered 1492°F—hot, but not volcanically feverish. Gases were then capped inside a bottle for later analysis.

Back on the peak I looked down perhaps a hundred feet to the lava dome, smoldering like an ominous fuse. Sharing the view were other climbers, drawn by the challenge of Merapi and the lure of volcanic power. To a Swiss woman curious about the steaming lump, I explained dome collapse and pyroclastic flows. "Really?" she exclaimed, a flash of concern crossing her face. "Should we be here?"

It was safe enough when we stood there in the summer of '91, but months later tourists would be warned off as Merapi oozed new lava that sent small PFs down its sides. A few daredevils scaled the mountain, I was told, to stare potential calamity in the eye.

WHERE SHOULD WE NOT BE? With volcanoes, we seem to play a sort of mental Russian roulette; why fly away, we think, when the killing danger may be years away? Why not climb Merapi where a lava dome has squatted for years without a serious collapse? Why not live at Campi Flegrei, a crowded residential area adjoining Naples, Italy, where the ground huffs and puffs like a beast breathing?

Campi Flegrei sits across the Bay of Naples from Mount Vesuvius, the destroyer of Pompeii and Herculaneum. The African and Eurasian tectonic plates still grind together below.

Prediction methods will undoubtedly improve, says Franco Barberi of the University of Pisa, one of Italy's leading authorities on volcanoes. "But for now, it is very difficult to make a decision about evacuating millions from an area—perhaps for nothing.

"We have all these factors to look for—seismicity, deformation, gas changes—but volcanoes show individuality. We saw precursors to eruption at Campi Flegrei a few years ago; now it is quiet. We think the gases leaked out gradually."

Vesuvius itself remains a threat. Pliny the Younger described the great eruption in A.D. 79 that killed his uncle, Pliny the Elder. He wrote of panicked crowds fleeing as their carts were tossed about by earthquakes and remembered seeing "a horrible black cloud . . . writhing snakelike and revealing sudden flashes larger than lightning." Then came the rain of ashes and "the darkness of a sealed room without lights. To be heard were only the shrill cries of women, the wailing of children, the shouting of men."

"Records show that from 1631 through 1944 Vesuvius never went more than seven years without an eruption," said Professor Barberi. "Now nearly 50 years have passed, and long periods of repose are usually followed by high explosivity."

How bad could it be, now that millions of people are living uncomfortably close to Vesuvius? With colleagues at the University of Pisa, Barberi created a computer model based on data from previous eruptions. Should the

Scalding exhalations from volcanic fumaroles created an ice cave near Iceland's Torfa Glacier. Volcanic eruptions beneath glaciers often melt the ice, causing floods, while the island's geothermal power industry capitalizes on volcanic fire turning water into steam.

volcano repeat its A.D. 79 eruption, ashfall, pyroclastic flows, and mud slides would likely destroy 500,000 homes. Casualties, if no warning is given or preparations made: 200,000 dead.

DON'T FEEL TOO SMUG if you live in Scott City, Kansas, or Mendig, Germany. Both areas were touched by eruptions larger than Vesuvius or Pinatubo. The blast at Mendig, northwest of Frankfurt, occurred 11,000 years ago, leaving a giant hole in the ground and scattering ash from Sweden to northern Italy. The hole is now a pleasant lake, the Laacher See, plied by the rowboats of picnicking Germans. A bucolic scene—until engineer Klaus Schmidt walked me to the southeastern shore to show me where the water bubbled with carbon dioxide and other gases from the magma beneath.

Near the lake, I descended into caves where miners in the Middle Ages carved lava for millstones. Thick, slow-moving basalts cooled in pillars, and the workers cleared away the softer material surrounding them, then sliced the pillars into wheel-shaped sections. Lava is still mined here, for construction material.

"Had you told the paleo-Rhinelanders that an eruption was coming, they would have said you were crazy, that none had happened for a long time," said volcanologist Hans-Ulrich Schmincke. "But the Laacher See sits atop the Rhenish Shield, a piece of old earth crust still being uplifted. One cannot say when or if a volcano will erupt again, but it remains an active volcanic area."

Our own Yellowstone Basin, where subsurface magma still heats up Old Faithful geyser, periodically has served up eruptions, the last 600,000 years ago. These dropped ash as far away as Mississippi. If clouds from Tambora caused "the year without a summer," what would another Yellowstone, ten times larger, do to food production? As Yellowstone erupts every 600,000 years or so, we're about due. Then again, it might not happen for millennia.

If not Yellowstone soon, where might the next major eruption be? I asked Chris Newhall, the Pinatubo veteran.

"I wish we knew. Possibly Iwo Jima."

From Tokyo I hitched a ride on a U. S. Air Force plane bound for Iwo, largest of the three aptly named Volcano Islands, some 600 miles to the south. Three hours later I looked down on Suribachi, a 530-foot cinder cone that hardly seemed worthy of the prefix "mount." It was hard to believe that the five-by-two-mile patch of land connected to it was the site of one of the bloodiest battles in World War II, where some 25,000 soldiers—Japanese and American—died.

Today Iwo is inhabited by 150 Japanese airmen and 25 U. S. Coast Guardsmen who operate a loran navigation station.

The island itself is only a resurgent dome in the center of an old caldera six miles across. Jagged offshore rocks mark its limits. That volcano blew out more than 2,500 years ago. Now the island seems on the way to another blast. Magma refilling the chamber beneath it has elevated most of the island some 25 feet since 1945. It is now rising about a foot a year.

"From radiocarbon dating of corals that died when they were raised above sea level," Chris Newhall had told me, "we know that the refilling has gone on for at least 400 years. It's the most restless caldera anywhere."

For further proof of active magma one need only enter the caves the Japanese Army excavated on Iwo as shelters against American naval bombardment. With U. S. Army Maj. Rick MacDougall, who had also boarded the plane for a quick look at history, I bellied into one and found it stifling hot and smelling of sulfur. Old bandages, medicines, and vials of morphine, neatly arranged, remained on a carved-out ledge. From a corner stared a dried and cracked gas mask. "I think I would rather have taken my chances outside," said the major, wiping his brow.

And what of the chances outside now—in a natural blast surpassing any made by man?

Chris Newhall had said: "We think we would have some warning, but we're not exactly sure what form that warning would take. Volcanoes are different. That's why studies of Pinatubo and others are so important—they help us understand the conditions that precede really big explosions. Our only defense is knowing when they are coming and trying to get people out of the way."

Even if Iwo exploded with a force greater than that of Pinatubo—how much effect could

Bearing food and gifts, Balinese from the village of Duda pass beneath arching bamboo poles as they celebrate an annual festival. These Hindus revere the volcano Gunung Agung as the center of the universe.

Dominating the skyline, nearly 130 volcanoes shape the backbone of Indonesia. On Java, 12,000-foot-high Semeru looms over Bromo, steaming inside Tengger caldera. Indonesians have terraced the fertile slopes of their volcanoes for millennia and

have seen their fields destroyed by lahars and eruptions. During recent decades the densely populated nation has averted large numbers of casualties through rigorous monitoring and public-safety programs.

an eruption on such an isolated island have? Possibly, say the experts, a cooling effect on the whole earth.

A RETURN TO ICELAND helped me better understand those who continue to live in the shadow of a volcanic eruption. Almost two decades ago an eruption intruded on the southwestern island of Heimaey and its picturesque fishing village of Vestmannaeyjar. A protected bay lined with docks and fish-processing factories provided a livelihood for some 5,000 inhabitants. The sea-carved cliffs of old volcanoes just offshore, grass-topped and alive with seabirds, had also spawned a burgeoning population of local artists.

This tranquillity was shattered one night in January 1973 when the ground opened unexpectedly and hell boiled into heaven. The eruption built a 700-foot-high mountain where a meadow had been, rained black ash on the town and its cliffs, and sent lava creeping toward the all-important bay.

I arrived a few days afterward and watched islanders fight to save their world. They cleaned ash off roofs, doused fires lit by hot fragments, and sprayed the advancing lava with seawater to cool and slow it. Reviews on this last effort were mixed, but the lava cut only partway into the bay.

Last year, I returned to find Vestmannaeyjar humming with normality, yellow-slickered cod fishermen swabbing down their boat decks, sheep grazing in green meadows. Ash lifted from streets and lawns had been exported for making building blocks. Students had shoveled grit from the cliffs. Even the cindery lava was tinged green by moss.

Svavar Steingrimsson, plumber and fisherman, led me up the volcano's cone. A spare, athletic man, he excels at gathering tasty guillemot eggs by swinging from a rope across the island's dizzying cliffs. Good cheer lights his suntanned face.

"I was never happy living away from the island," he told me, remembering months spent elsewhere after most of the islanders were evacuated during the eruption. "I couldn't wait to come back."

But his home sits atop the volatile Mid-Atlantic Ridge, I reminded him. And just ten years before the eruption on his island, an underwater volcano blew, creating the island of Surtsey 12 miles away. Did he ever worry about its happening again?

I was instantly sorry I had asked. His face sobered and he stared into the distance, perhaps at the bay and the cliffs above it, all shaped by volcanoes. Had I opened a crack in a venerable contentment?

Only for a moment. He turned to me with a grin. "But if I worried about it, I could not live here."

All of us, living on this volcanic planet, might say the same. □

Skylight into the underworld: An observer in Hawaii Volcanoes National Park peers into a lava tube, an enclosed channel of molten rock. Offshore, a diver braves hot water and billowing black sand as lava erupts below the surface. Such flows continually add new land in the planet's timeless process of renewal.

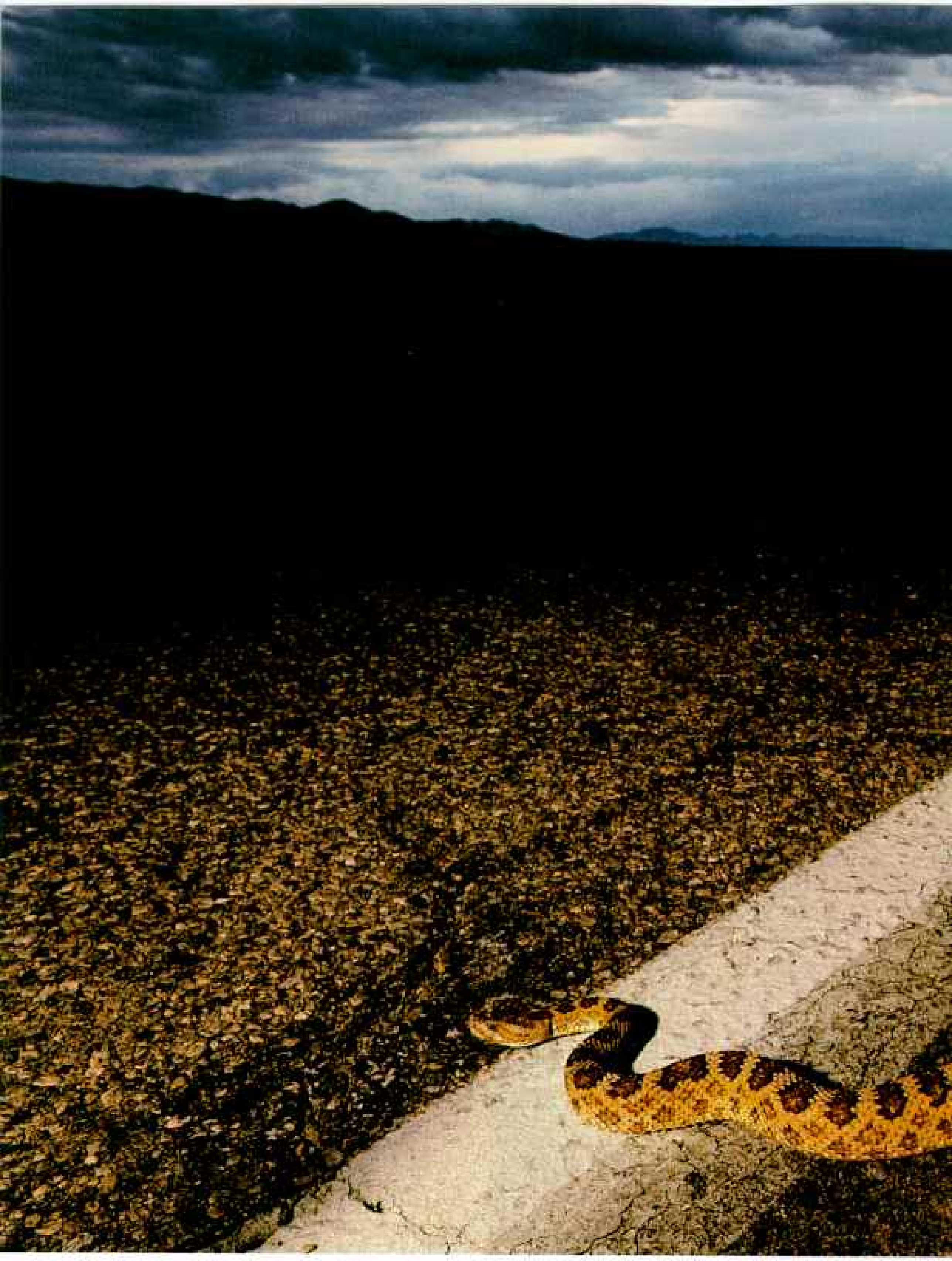
The Hard Ride

# of Route 93

By MICHAEL PARFIT
Photographs by CHRIS JOHNS

"I DRIVE HIGHWAY 93," the bumper sticker reads. "Pray for me." It was printed in the seventies, and, like the road, it's frayed. You see it on old cars, but you see more old cars on this road than on the broad, sterile interstates that float across the country hardly touching the land. This is Highway 93, a tough two-lane blacktop that runs 1,860 miles from a car wash and a liquor store in Phoenix, Arizona, to the Canadian National Railway yard in Jasper, Alberta—long, narrow, dangerous, magnificent; in hard contact with America all the way. I drive 93. All the time. I live on it in Montana. I've lived on it in Idaho. I've worn out six cars on it. I fly up and down it in my old Cessna. I ride it in buses and in the odd vehicles that pass for buses around here. I've even gone down it in an ambulance, flat out on a gurney, hanging on for dear life to the

Cowboy Cheth Wallin works 14-hour days in south-central Nevada. On the long rugged road between Arizona and Alberta, folks earn their spurs the tough way.



Searching for a warm patch of pavement on a cool Nevada night, a rattler puts its life on the line. Plenty of animals—such as coyotes, eagles, antelope, wild horses, and skunk—thrive in the isolation along Highway 93,

but why do people stake their claim out here? "If you want to shoot a rabbit or a squirrel eating apples off your tree," explains a naturalized Nevadan, "you don't have to worry about the bullet flying into your neighbor."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"Gamblers drive 93 back to Phoenix in the morning after all night at the casinos: 'Drunk, tired, broke, and mad.'"

hand of an emergency medical technician who turned out to be the woman who rents me movies. I guess she prayed for me, and it worked.

Once in a while you look around at something you've grown used to and you notice that everywhere else things have been changing, and suddenly the familiar thing is the last of its kind. In a country now linked by interstates, that's Highway 93: the last hard road.

On 93 you can still experience the buffet of large vehicles breaking the speed limit going the other way, be blinded by headlights bearing down on you, and know when trapped behind a combine that the next passing lane is 40 miles ahead. A rest stop is a gravel turnout with a picnic table, a pit toilet, and a garbage can with bullet holes in it. You don't have to pay to use Highway 93; the only toll is on your shock absorbers and your mind. Life on Highway 93 is close to the bone.

In wind and rain in Phoenix I begin my pilgrimage. I drive a 1977 Ford F-150 four-wheel-drive with a toolbox in the back, a CB up front, an intermittent taillight that gets me in trouble with the police, and a good-hearted 351 V-8 that runs on regular. I carry a case of oil; the main seal leaks. Like most people who take solitude on the road, I also bring a cargo of loss and hope: Death has been in the family lately. I'm close to the bone myself, out on this road to see old friends, to make new ones, and to do some mending. Pray for me.

IT BEGINS: Farmer's Liquor. Weiss Guys Car Wash. Cinder-block motels, a machine shop, a liquor store turned into a boxing gym. Interstate 17 floats overhead on smooth concrete slabs. I'm below in the grit. A coyote howls on a billboard, advertising booze.

The modern retirement cities of Sun City

A blizzard of lights outside the Union Plaza Hotel swirls before oncoming traffic along Fremont Avenue, part of an old stretch of 93 in Las Vegas. The new 93 bolts through the city like a pious pioneer avoiding temptation.

At ease in limo luxury, Sgt. Steve Busch and his bride, Peggy, cruise down 93 in Las Vegas. Nevada's hassle-free marriages (no blood tests, just cash and an I.D.) and the glitz of Vegas (Joan Collins was married here!) help make the city a wedding wonderama.

and Sun City West hide behind walls from this outlaw road. The town of Surprise doesn't. Surprise is a 93 kind of place: It's hot and dusty, with small houses and chain link fences bent where the kids jump over.

Just beyond Surprise, I pass a line of skulls on a dirt turnout. It's a guy selling boiled longhorn skulls out of his Oldsmobile. "Funny about a road," a woman in Wikieup told me. "There's a lot of ranchers on 93. And there's a lot of. . . ." She searched for the word. "A lot of—*questionable* people on this road."

Yeah, I know. I love it.

MICHAEL PARFIT, a free-lance writer, is the author of *South Light* and *Chasing the Glory*, both published by Macmillan, Inc. Parfit lives on Highway 93 in Montana. Photographer CHRIS JOHNS lives in Woodville, Virginia. His most recent story in the magazine was "Africa's Great Rift," in the May 1990 issue.

There are a lot of ranchers on 93—and miners, farmers, loggers, truck drivers. Wickenburg, 52 miles out of Phoenix, celebrates them all: a Cowboy Poets Gathering, an autumn Bluegrass Festival, Gold Rush Days in February. From up and down 93 and all over the West people come to sing and rhyme about working hard and loving lonely.

Now, at a Wickenburg dude ranch, I see a copy of a ditty I saw up in Idaho not long after my wife, Debbie, and I moved to Highway 93 in 1971, full of love for each other and for the big open land. Debbie's gone, but I still like the song:

Sweet clean air from
east to west
And room to go and
come
I loved my fellow man
the best
When he was scat-
tered some.

One night in Wickenburg, at the Bluegrass Festival, I hung around an impromptu jam session in a little arena formed by three parked motor homes. Astroturf was thrown on the dust. Lanterns hissed. There were two fiddles, two mandolins, a banjo, one mournful steel guitar called a Dobro, and three guitars.

The Dobro player, Millie Vannoy, had two Shih Tzu dogs. The male wore a red cowboy bandanna, the female a stuffed heart on each ear. They barked.

"Let's sing one the dogs don't know," said itinerant guitarist Art Kershaw, who once lived in Kalispell. Millie was tentative on the Dobro: She didn't like making mistakes where all these experts could hear.

A banjo picker named Les gave advice I got to thinking about as I rolled up the road at two that morning: "Hey, Millie," he said, "you gotta hit them bad notes hard."

HIGHWAY 93 WAS ONCE promoted as running all the way to Central America, but that was an exaggeration. It never even made it to Mexico, and lately it's been losing ground to bureaucracy. Signs still label it Arizona 93 from Phoenix to Wickenburg, but the state's abandoning the number. The federal designation begins just north of Wickenburg. I stop there on gravel that glitters with glass and talk to truckers on the CB. Where are you headed, and what do you have on?

"Come out of L.A.," one says. "Goin' to Texas. Windows."

"Outa Tucson. Vegas. Pipe."

"Going to Georgia. I got bodies."

I swear that's what it sounds like. Bodies? In a semi? Say again?

"Potties. Universal toilets."

Most are laconic, but one guy roars past in a big refrigerator truck and rolls out an American road rosary.

"Salem, Oregon, outa Dallas. Ninety-three, Ninety-five, Eighty, Three ninety-five, A-three, Three ninety-five, Two ninety-nine, One thirty-nine, Thirty-nine, Ninety-seven, Fifty-eight, to Five. Cabbages."

"So what's the worst part of it?"

"The worst part? Right up through here."

Yup. Pray for us all. Before I reach Wikieup, the road gets mean. A good two-lane is 34 feet wide; enough shoulder outside the white fog lines to duck from someone else's drift. Here the road's 24 feet narrow. Gamblers drive 93 back to Phoenix in the morning after all night at the casinos: "Drunk, tired, broke, and mad," a wrecker told me.

About 30 miles south of Wikieup I get stuck behind a motor home with Alberta plates—another snowbird in search of sun.

On a curve to the right I glimpse the highway past him: completely empty. Here's a straightaway at last. I drift left, a foot across the dotted yellow line, and look.

Help! There's a semi right on top of me. The buffeting air slams me. A wall of iron pipes booms past and is gone. I shiver, hot.

The Hard Ride of Route 93

Driving desolate stretches of 93—like the one near Nevada's Mormon Mountains—tests stamina and common sense. "People know when they're getting tired," says Sgt. Jeff Mundwiller of the Nevada State Highway Patrol.

"If they'd just stop, pull off the road, and get a couple hours' sleep they'd be OK, but they keep pushing." To Alamo . . . Ely . . . Wells. . . . "A major cause of accidents," says Mundwiller, "is people falling asleep behind the wheel."

"In some places there might not be many cars on 93, but I would never call this highway lonely."

"THIS WILL BE THE BEST milk shake you have ever had on the planet, bar none." Whew. I'm ready. I've crept into the village of Wikieup to visit Paul Moss, proprietor of the Chili Factory. Paul has a ponytail, small red sunglasses, and a background teaching young doctors business management at the University of Utah Medical Center. We may look like hicks out here on 93 in our Levi's and old trucks, but don't count on it.

"They call this Blood Alley," Paul says genially over the whir of the machine. He gestures broadly and slowly, all poise and presence, like an actor delivering Lincoln. Lyn, his wife, comes in, and—I can't believe it—it turns out she's from the Bitterroot Valley, a thousand miles up 93, less than a hundred miles from my home.

"Her family's been on 93 for a hundred years," Paul says.

My truck chugs a quart of oil and rolls on. North of Kingman there's a hand-painted sign put up by someone angry about his loss to this road. "KILLER HIGHWAY," it reads, red on yellow. "CAUTION."

I stop at an antique store that has a Confederate flag in a window, and Craig Cherry gives me veiled warnings about everything. A Doberman is chained in the yard.

"There's some sly dogs out there," he says. He isn't talking about the Doberman. "At least they think they are," he says. He gestures to a long slope west of the highway, which is covered by a haphazard city of trailers and homemade homes, as if there'd been a flash flood of houses from Kingman. I ask who lives in the boulders above his store. "We keep to ourselves in the desert," he says slyly, flipping a short stick over and over in his hand.

I drive up there and meet Jim King. King is

Working girls welcome a cowboy to the Big 4, a legal bar and bordello in Ely, Nevada—largest town within a 100-mile radius. Owner Mel Clifton belongs to the Chamber of Commerce and last year helped sponsor the Little League.

what an Arizona rancher might call a nester: a man and wife on small acreage, on a thin living, with a backhoe, a couple of trucks, several outbuildings. Lot of nesters along 93.

King has no well. He hauls water for his double-wide trailer from the city of Kingman in a 280-gallon tank in the back of his pickup. Costs him $1.40 per fill-up. He even grows onions, Brussels sprouts, broccoli, and cabbage with the hauled water, planted in the bed of an old army truck. The truck bed's on stilts, so he can sit in the shade under his garden.

I COME TO HOOVER DAM in the dark. From here, wires and pipes lead away. Western cities haul power as well as water. Highway 93 goes right across the top of the dam, and the traffic slows to 15 miles an hour to cross it, caught by the narrow roadway between walls of rock, acres of concrete, miles of shining water, and a web of high-voltage wire that glistens in the night. I park and stand beside the water, watching the parade of cars and trucks as they glide past under amber lights, a strangely patient movement for a highway, as if the world had run down.

Or maybe this is a shrine in which even 18-wheelers must walk softly. Solemn bronze angels stand watch by the visitors center, and on each post of the guardrail by the dam tonight stands an empty pop can, Coke, Pepsi, 7 UP—each can reflects the slow-moving lights. Someone questionable, with a curious and appropriate devotion, has offered aluminum candles to the steel god.

From the air, at night, Highway 93 north of the dam is a boulevard of light—malls, convenience stores, fast-food joints, and gas stations—all the way to Las Vegas. It's a long spear of glitter shoved into the bonfire. I follow it straight through the blazing city and then out again, heading for Lincoln County, the one part of the highway where I always seem to get in trouble. I don't know if I remember the trouble more or the people who helped.

In 1974 Debbie and I landed here in an ancient plane and a brake failed. We got help from Bill and Bob McCrosky's Texaco station, towing service, and bar a mile from the airfield. A few years later I landed there, low on fuel, not knowing that the airport fuel pumps were empty. Dan Devlin, who worked at McCrosky's, gave me a ride to Pioche to pick up five gallons of high-octane car fuel. Then, just last winter, I flew up out of the warm South, intending to camp, but the temperature was only 10 above. There was Clyde Mecham at the airport with an old truck, worried that I might freeze. He drove me to McCrosky's, where the bartender, Cordelia "Cordy" Benezet, gave me a ride to a motel in Caliente in her old station wagon.

"The people here are friendly," she said. When I agreed with feeling, she modified it.

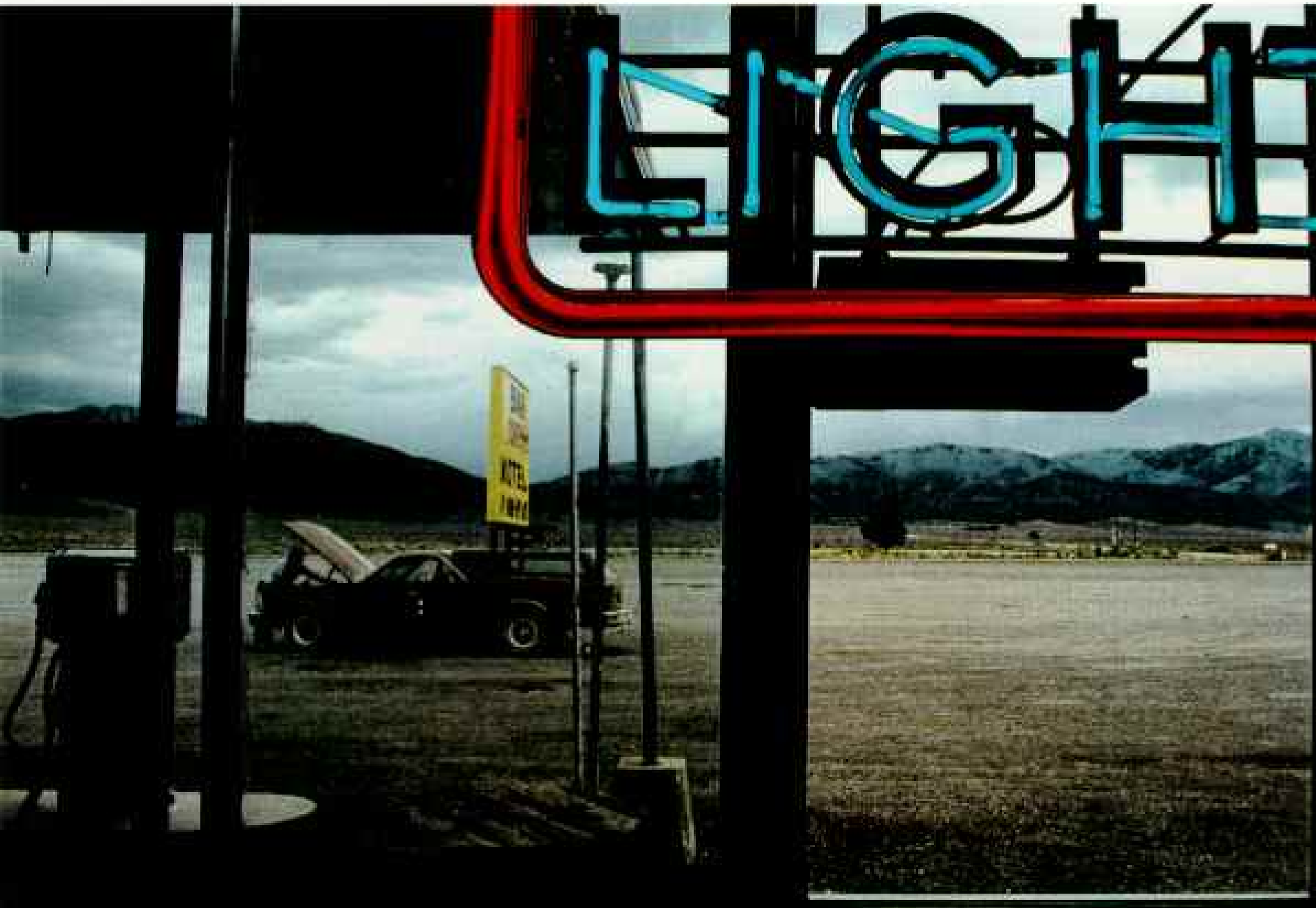
"I don't mean *outgoing* friendly," she said. "I mean they're generous with themselves."

Now when I get to Panaca, it's day again and there's somebody else in trouble. It's Reyes Martinez, who has been driving 93 all the way down from Twin Falls, Idaho, with his family, towing a broken Chevy pickup on a U-Haul trailer behind a big old yellow Dodge. Two hours back up the highway, where there's nobody, a trailer tire blew and ruined the wheel. Martinez managed to jam the Dodge's spare on the trailer and got to McCrosky's. Bill McCrosky finds him an old wheel and tire out back and puts it on. There's no charge.

"Got to give 'em credit," Bill says as they pull away. "Most people would have made us come get 'em. They figured out how to get it here. Saved us the trip."

ANOTHER DAY, another quart of oil. I'm off, past Pioche out into the vast spaces of the geologic province called Basin and Range: long valleys that drain only into themselves, bounded by austere mountains, populated by cows and coyotes. In the heart of this is Geyser Ranch, where I stopped late last year.

In the ranch house Kathy Baumeister was



Diving for the dipstick, Georgette Jessen checks her oil at Nevada's Schellbourne Station, on the former Pony Express trail. Although the nearest town, McGill, is 27 miles away, Georgette thinks about moving to Wyoming or Montana because "there's getting to be a lot of people here."

making good, thick boiled coffee. She reminded me of a cowboy poem heard in Wickenburg:

She does what is needed
And won't look for praise.
Knowin' it comes as seldom
As her eight-hour workdays.

Her husband, Luke, the ranch foreman, was talking to Sean Keele, who had brought a flatbed load of hay down 93 from Twin Falls. Turned out Sean was related to my friends Lynn and Ruby Keele, who lived up in Idaho near Debbie and me. They ran one of the smallest post offices in America, where they cacheted envelopes with a woodcut of a grouse. Lynn and Ruby are dead now too.

Luke showed Sean a piece of wrought silver. "Cowboy without silver," he said, "might as well work in Texas."

Another quart of oil, another hundred miles. Ely stands high and windy at a junction of valleys and highways, 93, 6, and Route 50—nicknamed "the loneliest highway in America." I drive past the junction thinking: In some places there might not be many cars on 93, but I would never call this highway lonely.

The road runs fast, but I stop and let slowness catch up with my life at the gas station, motel, bar, and café at Schellbourne Station, 40 miles out in the desert north of Ely.

Lyman Rosenlund, who owns Schellbourne Station, wears stained overalls, red Budweiser suspenders, a blue shirt, and a questionable hat. His talk is slow and quiet.

When I drop in for coffee, Lyman's reading the *Wall Street Journal*. At the bar George Murray, a trucker on his way down 93 out of Montana with a load of potatoes bound for Los Angeles, eats ham and eggs cooked by Charlcia "Charlie" Rosenlund, Lyman's wife.

"Isolation breeds a state of mind. 'There's a strong feeling of self-reliance. If this were the Baltics, we'd be declaring our independence.'"

Lyman points to a story in the *Journal* and says: "After another 30 years they'll prove this planet was not made for civilization."

"Great breakfast," says George.

Lyman and Charlie came here in 1953. Outdoor toilets, no well, no electricity. The power didn't get here until 1974.

"All we had was whiskey, shot glasses, and four kinds of cigarettes," he says. "Those miners was in here every night. It was so easy to make money." His eyes are blue and quizzical. Behind him a waterfall splashes down a little rock wall. Rubber frogs play on the stones, eyed by rubber snakes.

We sit. George eats. Lyman reads. I sip. Outside a coyote crosses the road to go sing on a ridge—tough, adaptable, opportunistic, wild, free, clannish. Not unlike Lyman and all my other friends on this open road.

"Those days," he says at last, "if you couldn't get a job, you could cut cedar posts or Christmas trees, or sort ore. You could do lots of things. Today it's even difficult to acquire dynamite. Hell, we used to put it under the bed to keep it warm. Mom and I knew the United States of America at its best."

MY BREATHER'S OVER. Blacktop rolls out. The speedometer keeps climbing. "Speed limit out here," Luke Baumeister once said, "is Peg the Needle."

A memory flashes in the rearview mirror of my mind. Only a few weeks before, I had been riding 93 with the Nevada State Highway Patrol, handing out tickets to guys like me.

"God bless America!" Sgt. Jeff Mundwiller had said, reading the meter. "Eighty-four miles an hour. Give me a *break!*" He reached up and flipped on the lights. After he got back from writing the ticket, Jeff had looked at his

Herding sheep (or is that sagebrush?), George Bishop rides the Nevada range. A few months later these sheep really did disappear: They were sold following a dispute with the Bureau of Land Management over grazing rights.

chart of fines: "That'll cost him 171 bucks."

I drive 93—at 55.

This whole road's a small town. I drive 147 miles north, and it's like going across the street. I find myself standing with a friend of Lyman's—rancher Steve Boies—near the junction of Salmon Falls Creek and an irrigation ditch built by horses and men about 1910. We talk—of course—about water.

"This is the lifeline of this ranch," Boies says. "Crane!" he adds, pointing at a sandhill crane rising from a field. "Water's what makes it all possible."

We get back in his pickup truck and drive a dirt road through sagebrush.

"Deer!" Boies says. A dozen mule deer bound up a hill.

Boies manages the ranch with his wife, his mother, and three employees; it's a different operation than it was before his father died in 1976. Then there were more hands, a bunkhouse, and a cook. Boies only misses part of that. "Nothing's worse'n having a damn ornery cook around," he says. "Never knew a cook wasn't ornery."

The Boies family owns 14,000 acres and has a permit from the federal government to graze 113,000 acres more—mostly rolling sagebrush hills and grassland managed by the Bureau of Land Management. Their private land includes a number of isolated 40-acre chunks around the springs that Boies's grandfather bought back in the days when owning water gave you use of the land.

But under pressure from environmental groups, the BLM is changing its policies. (Some groups have raised the cry "Cattle Free in '93," meaning the year, not the highway.) Back down at Schellbourne Station, Lyman, who used to run sheep, saw his allowable herd size go from around 900 ewes to 498 in two years before he sold the sheep.

Here on Boies's ranch, the agency has proposed rules that would let Boies graze certain portions of the BLM land near streams only one summer out of four.

"The days of 'control the water, control the land' are over," Boies says. "If there's a threat to life as it is along this highway, it's government policies." We bounce on down the road. Boies shouts: "Eagle!"

THE ROAD DRAWS ME ON, away from beautiful deep sunlight of afternoon in the high desert out into low windy clouds and nightfall north of Twin Falls. I rise and fall as the road crosses hills of lava, the lights of small towns showing occasionally in the distance. It feels exactly like sailing ten miles offshore. In fact, a lot of large yachts use this part of Highway 93: riding the swells of rock on their flatbed trucks to avoid overpasses on the interstate.

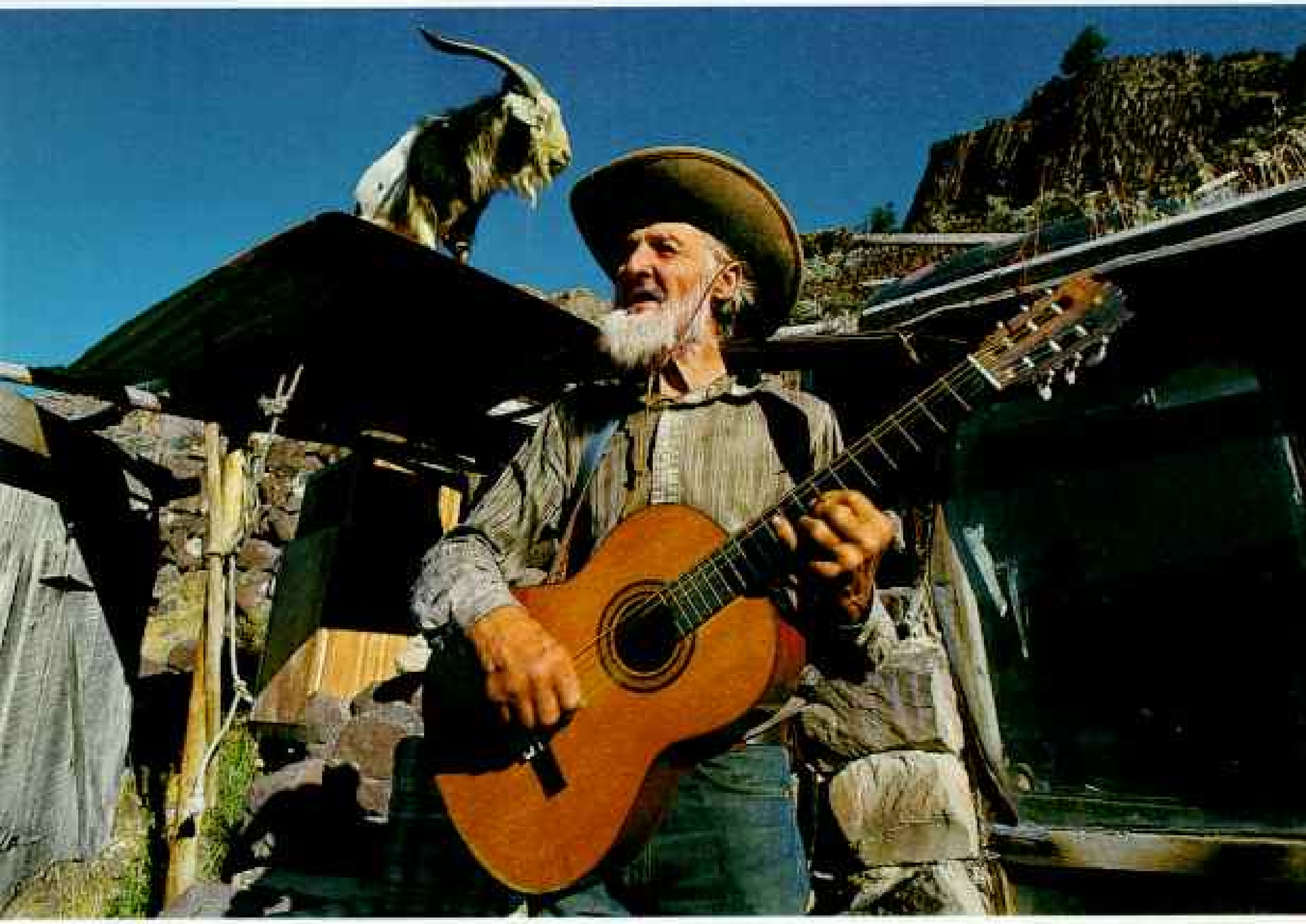
Once I came through here, past Craters of the Moon National Monument, in a snowstorm at 2 a.m., hurrying home to Debbie, and drove 93 for 20 minutes without headlights because I could see better through the snow. The whole 20 minutes I met no other car, but I saw two mule deer and a coyote.

I turn left at Arco and head for the magnificent mountains of the Big Lost River Valley and the village of Mackay. For me it's dangerous territory, close to the bone. Debbie and I moved to Mackay in 1971, when she was 21 and I was 24, and we left in 1976, but from where I stand today it looks like the best time of our lives. As I drive deep into this utterly familiar landscape, I have a strange detachment. A young man lived here who had my name and looked like me and really loved his wife, but I can't quite remember him.

What I remember now is driving back to Montana through here in June of '91 in a motor home I'd rented because Debbie was too sick to ride in a car. I was going back to Montana after taking her to her sister's house in California to make her last stand against the cancer.

I drive slowly, trying to catch the storm of memory that roars past somewhere overhead. It is elusive. I park the truck by a bad bridge over the creek and walk slowly home.

It is an old log homesteader's cabin out in the sagebrush, with cottonwoods around it.



"Dugout Dick" Zimmerman lives in one of his hand-dug caves and rents out nine others south of Salmon, Idaho. Sharing the hillside with his goat, Billy, the 76-year-old Indiana native came here in 1948 to get away from it all. "But they're finding me," he says with a laugh.

We had happened upon Highway 93 by chance while wandering around the United States and had found the house by chance while wandering around this valley. I had no iden then how unusual both house and highway were, and how unlikely it would have been to find such a wild and beautiful place to live anywhere but on this anachronistic road.

Much of each winter, snowdrifts would block our dirt road, and we would have to walk a mile to the house. It seems now that it was always 40 below and the wind was always blowing. But she hung in with me, cooked our meals, heard out my heartache, and walked with me in the bitter wind. Across the open sagebrush slope we could hear home long before we got there: The wind blew in the bare cottonwoods and made the sound of the sea.

The door is not locked. It never was. The house was abandoned when we moved into it and is abandoned now. Some people lived in it for a while after we left, but they changed nothing. It is as if we left last week. Here's the pitcher pump that replaced trips to the spring; it's dry. The bay window I cut in the logs—chainsaw architecture—has lost a pane. And here's my ingenious door, with a latch hidden by a nail; it still works. On log posts and ceiling, my varnish shines.

But I didn't hang in with Debbie, and our marriage came apart in Montana in 1989. Man, I hit those bad notes hard. Then, in July 1991 at her sister's home, with our two kids in the next room and her brother, her sister, and me by her bed, 20 years and 11 days after we were married, she died.

I touch a log. Suddenly I find myself desperate to fix the house up again the way it was. Prime the pump! Put flowers in a jar! Then I think: Why? As if I could capture those days

One football game remains for Idaho's Challis High School Vikings, who've had a disappointing season: seven games without a victory. Heading down 93 to battle Arco's Butte Pirates, seniors Lawrence Lisonbee and

co-captains Chris Rowland and Kyle Castle prepare with quiet determination —but they lose again, 14 to 7. "It just didn't fall together," says Chris. Nonetheless, football has taught him a lesson: "You have to learn to keep a temper."

with varnish. The varnish is still there, but the days aren't.

The storm of memory roars above me. I cannot touch it. Then I walk away from the house, and out of my mouth come unplanned words: "Debbie, where did you go?" The storm hits like lightning and I'm on my knees in the sagebrush.

I DRIVE 93. Fast. In this nation of cars, road noise and heartbeat thunder together, like a Chevrolet commercial. Mackay's gone. Challis passes. The canyon of the Salmon River rises on either side like the gates of a refuge, dry golden walls of rock and grass in late sunshine.

At last in need of a voice—the more questionable the better—I stop along the river to visit "Dugout Dick" in one of the 16 caves he has built of stones, adobe, old lumber, car parts, and tires in a talus hillside. He plays me his guitar and talks about ghosts.

"Bonnie comes to visit me," he says, all scraggly gray beard and sincere eyes. "She was my common-law wife. She got beat to death by a drunk in a spud cellar in '63."

Dugout Dick is 76. His real name is Richard Zimmerman. He's lived here in a cave since 1948. To pay his bills, he rents spare caves for $15 to $50 a month, milks goats, and sells tourists religious poetry.

"I been out of the body several times," he says—no wild gestures, no rolling eyes. "Another time I floated to another planet." In some places this kind of man would be put away out of sight of the normal world, but on 93 we still love him. I give him a ride to his mailbox and drive to Salmon.

Oil change and lube: $21. Salmon, Idaho, is one of the most remote and isolated towns on 93: 2,941 people 142 miles south of Missoula. A mill town, a tourist town: People fly from here into the vast wilderness areas to the west. But isolation is relative: People in remote places up and down 93 are like soldiers in a hospital—there's always somebody worse off. I remember driving with Steve Boies—who is also a long way from anywhere—and he pointed behind us at a four-wheel-drive wagon turning west.

"You think *we're* isolated," he said. "They live 30 miles back there off the oil. We're uptown compared to lots of ranches."

Isolation breeds a state of mind. "It's conservative here," said Dick Hauff, a retired U. S. Forest Service supervisor. "There's a strong feeling of self-reliance. If this were the Baltics, we'd be declaring our independence."

I had met Dick one day a few weeks before, when I rode the bus from Missoula to Salmon to Arco and back. I use the term bus loosely. From Missoula south I traveled in a 1980 Dodge van with 186,000 miles on it and a bungee cord holding the hood down. It towed a 16-foot horse trailer of freight, which happened to be hundreds of small wooden boxes for a cheese factory in Salmon. From Salmon the bus was an extended-cab one-ton Ford pickup driven by a young man with hair down his back who wore a Harley-Davidson T-shirt.

Turned out that the Harley driver, Lee Murray, was the least questionable of our small group, except for a polite woman riding south from Challis. A 14-year-old boy who got on in Mackay inadvertently explained why parents up and down 93 like to say: "Great place to raise kids." He wore a dark cowboy hat and a couple of earrings in his left ear. He was going home to Las Vegas.

"I hate it here," the kid said. "The teachers know you too good. You can't do *nothin'*."

"Someday," Lee said later, "I'm gonna drive the mail." It got dark going back to Salmon, and Lee listened to a talk show on KFI in Los Angeles. We passed occasional house lights where he drops off Avon supplies to ranch wives every month. The eyes of deer shone in the fields. Callers to KFI argued about trade relations with Japan. One car rose out of the night and flashed past. The road went dark again. KFI in the Sky reported bad traffic on the 91 Freeway in L.A. "Amazing the things that happen," Lee said.

I follow Lewis and Clark's route out of

This land is whose land? The vexing question pits environmentalists against mill owners like Montana's Peter Larson, who fears that further government limits on timber sales will cost lumberjacks their jobs. "The Lord put these resources here for us to use," says Larson.

Salmon and cross Lost Trail Pass on 20-mile-an-hour switchbacks.

"You can drive the pass many, many times too slow," said Mary Riley, who owns the Bitterroot Stage bus line with her husband, Jack. "But only once too fast." I drive slowly down into Montana, and the character of the land changes. The sagebrush is gone, the grasslands diminish, cowboy boots on the bar rail give way to logger boots. The rock ridges of the Bitterroot Range rise from cloaks of pine, Douglas fir, and tamarack. The cloaks are threadbare in patches, and I pass hundreds of acres of forest cut down and decked in rows in each town.

In the spring of 1988 I flew over a convoy of loaded logging trucks driving Highway 93 from Eureka, a logging town where Canadians come to gamble, all the way south to Darby to protest government policies as well as environmental activism that loggers believed were keeping them out of the woods. Much farther back, in 1979, Debbie and I bought land north of Missoula and came down to Stevensville to one of many log-home builders along this part of the highway, who are now shipping even to Japan, to design and order our last home. So even my house has driven 93.

MISSOULA IS BUSY in the night, kids cruising the strip of shops and fast-food joints near an intersection on 93 known as Malfunction Junction. I dash through and head north.

Lot of traffic on this road: It's the main highway from Missoula to Glacier National Park. The state highway department has plans to widen it—to a full four lanes in many parts—but there are fights over that up and down the

Buffeted by a freak windstorm, George Stritzel's roadside variety stand survived to keep serving up its eclectic mix of merchandise in Ravalli, Montana. Blow by and you'll find fresh fruit, candy bars, old

hats, tools, real estate listings, kitchen utensils, postcards, velvet paintings, and a customized Harley-Davidson motorcycle. "To put it delicately," says a neighbor, George's place "is crammed to the full with stuff."

road. Just out of Missoula environmentalists are worried that a larger road will be a barrier for animals, because the forests that close in on 93 at a pass provide the only east-west crossing corridor for wild animals for almost a hundred miles in either direction. Even wolves have crossed there, and a mountain lion using the corridor killed a child there in 1989.

In Arlee, where the woman lived who held my hand that night in the ambulance when what might have been a heart attack or appendicitis turned out to be only a kidney stone, the debate is simple. People here argue whether the road should go through town—which would result in sidewalks, gutters, and street lights for the first time—or bypass it, which would be quieter but might sink some of the few small businesses that hang on in Arlee now, living close to the bone.

NORTH OF MISSOULA I pass a place that ought to bear a cross made of iron. No one here will ever forget the great Valentine's Day train wreck of 1990, when a freight pulled by three locomotives tried to take a 25-mile-an-hour curve at 72 and threw some of its 37 cars and mountains of loose lumber out onto Highway 93. Amazingly, no one was killed. The two engineers, who were later fired, claimed to have been in a "reduced state of awareness."

The CB crackles. One of the many truckers hauling wood chips to the pulp mill in Missoula is flirting with a woman on a radio at home. "I drive truck," he says, "but I ain't no truck driver." In the solitude and mist of early morning I follow 93 past the wooded coves, the quiet villages, and the astonishingly calm waters of Flathead Lake.

"It looks like the lake gradually turned white and reached up to touch the sky," my daughter, Erica, who is now 15, wrote in her journal when we covered the same ground just before Christmas last year. A little later she wrote: "We are in Canada!"

In Canada Highway 93 is a provincial road: British Columbia 93 and, later, Alberta 93. Past Cranbrook the Canadian Rockies grow huge on the northern horizon, vast but weightless in snow and alpenglow.

And with the mountains comes another transition, as pronounced as the thickening of the forest north of Salmon but entirely human. It happens between Canal Flats, where everyone works at the mill, and Invermere, where people work at resorts. There a highway dominated by those who use the land for a living becomes a conveyance for those who play on it. The transition zone is turbulent.

"Canal Flats is just a dirty little logging town," said a manager at a resort when my kids and I stopped there a few days before Christmas. "Very rough. Ethnic people. The police don't want to go down there." She preferred Invermere: "Lot of quaint things there: glassblowers, artists—crafty people. Don't even consider Canal Flats part of the valley. All their money goes into their vehicles."

I like Canal Flats. There's lots going on there tonight. The curlers are having a Lumberman's Bonspiel over at the ice rink, sweeping and sliding, and there's a dance at the community center. I choose the dance.

By ten the center is packed: Fifty or more young couples jitterbug and two-step to Roseanne Cash and drink vodka, Bacardi, or beer at two dollars a paper cup. Outside, a kind of round-robin fistfight goes on all night, as much a ritual as the dance; boys changing partners while girls watch.

Jocelyn Sagar, who's taking tickets and selling hot dogs, has the last word about this area.

"Invermere is a tourist town," she says. "Canal Flats is a people's town."

The village of Lake Louise, the gem in the heart of the Rockies, looks like the ultimate tourist town. The first time I called the famous Chateau Lake Louise, the public relations woman said, sounding snooty: "We don't think of ourselves as being on Highway 93."

Yeah, I wanted to say: You don't belong here either. All your money goes into old wine.

But the snootiness was a facade. These people are just as questionable as the rest of us

Change arrives at a glacial pace near Canada's Columbia Icefield, where 93 weaves between Banff and Jasper National Parks. Says a nearby resident, "What you'd see here 200 years ago you're gonna see today"—a point not lost on visiting hikers, rock-climbers, and horseback riders.

on this road. Maybe it's because many of the 650 employees of the hotel are 20 years old, work for minimum wage, and love the mountains with a lunatic love that drives them out into the high country on skis in January. Maybe it's because isolation strikes here too. Or maybe it's because the hotel's general manager, David Bayne, once drove the length of Highway 93 from here to Phoenix with four friends sitting in lawn chairs in the back of a doughnut-delivery panel truck, towing a boat.

He did it right. Not only did he drive the road in one shot, but somewhere near Panaca, Nevada—where else?—he got in trouble. A tire blew and the five men discovered they had forgotten their lug wrench. But another of Lincoln County's inexhaustible supply of generous souls, a man named Grover, showed up in a pickup with a shop jack and every tool in the world, and got them back on the road.

My kids and I spent Christmas at Lake Louise, far from the memories of home. People had come from all over the world to the hotel, but it was still just another small town on Highway 93. Christmas Eve, as the lights in the rooms were going out, Erica, my son, David, and I went to the lake and skated up and down holding hands, thinking lightly and without pain about friend and mother, Debbie. Skating, we sang every carol we knew, to the mountains, the moon, the sleeping hotel. As Christmas morning came, we were still singing.

I drive 93. It is the last leg, up through the astonishing mountains and the ice. The road finishes in a crescendo of beauty: lakes, forests, rock, glaciers. Besides 93 it's called the Icefields Parkway; to the people who live here, it's the Banff-Jasper road, or the B-J. As I round a curve, a coyote hops over the guardrail out of my way, adapted to the world as it

"I'm tired. I'm happy. Trains are rollin', picking up where my highway leaves off. As in life, one thing ends, but everything goes on."

is—unadorned, beautiful, close to the bone.

I drive 93. But 93 ends. I cross the wide, braided stream of the Athabasca River and come to Jasper, Alberta, population 4,500. A long way from Phoenix. But this is again a working person's town: The Canadian National Railway employs about 400 people here, hauling coal, grain, sulfur, potash, and lumber east and west through the Rockies.

I drive through the railroad yard with Steve Wort, yard operations coordinator. He's driven all of 93; we share memories of Hoover Dam. "Strange place." Mule deer and fat elk graze between the 16 sets of rails, eating leakage from the grain hoppers. "Everything we have that has wheels is rollin'," Steve says. "And it's all rollin' through here."

I'm tired. I'm happy. Trains are rollin', picking up where my highway leaves off. As in life, one thing ends, but everything goes on.

A grain train pulls in, and an elk moves out of the way with a breathy shrug. A dark-haired young woman who can't wait another five minutes jumps from the forward engine as it's still moving. A red backpack's slung on her shoulder and her long hair's blowing, and she heads for the office to sign out and go somewhere important. Maybe it's a man, or a man and a child, or a precious solitude, or a blues band at the Astoria bar. Doesn't matter: Her longing catches mine.

I watch her go, wishing for something I can't have. She strides away across the tracks, sure as that coyote that jumped the rail: unknown woman, familiar woman; another part of this long chain of strung together, strung out, opportunistic, adaptable, hard-working, tough, lonely, questionable, cranky, open, big-hearted friends of mine who live close to the bone on this hard road.

I live on 93. Envy me. □

"Levi's the kind of horse who'd take you through anything," says Jodee Dixon, a former guide in Alberta's Tonquin Valley. Her trail advice isn't half bad for the highway: "Hold on to the horn and have faith in your horse."

GATEKEEPERS OF

Nepal's Sherpa people prosper amid dizzying change as climbers

By JIM CARRIER
Photographs by ROBB KENDRICK
CONTACT PRESS IMAGES

THE FULL KHUMBU MOON lit the ice like frozen lightning as the shadows of the Sherpas slipped over my tent. I listened, half awake, to their gentle sounds: the jingle of crampons, the creak of backpacks, the resonant hum of men chanting mantras. Juniper smoke, incense from their offering fire, seeped inside the tent, and I unzipped the flap to the predawn chill. They gathered nearby to adjust their loads and drink hot milk tea. Then they were gone, winding through the jagged blocks of ice at the base of Mount Everest, trailed by a fading "Ommmmmm."

On the flanks of the great mountain that borders the land where they have lived for centuries, the Sherpas were at work. But this expedition was unique: For the first time an all-Sherpa team was climbing the world's highest mountain. These men formed the 1991 Sherpa Everest Expedition, and they carried the pride of their people.

"This is *our* expedition," said team member Sonam Dendu, who had reached the summit of Mount Everest twice before. "It is for all the Sherpas."

An ethnic enclave of 35,000 Buddhists living mainly in the Hindu Kingdom of Nepal, the Sherpas are well-known as high-altitude porters for mountain expeditions and guides for tourist treks. But that image is both recent and superficial. Until Westerners created a job market in the early 1900s, Sherpas never scaled mountains. They passed among them with respect, acknowledging distant peaks as the homes of gods. Outsiders, despite decades of hiring Sherpa expertise and labor, seldom have fully understood the Sherpa heritage.

Since the Kingdom of Nepal opened its

THE HIMALAYA

and trekkers descend upon their mountain home.

HOISTING THEIR WEIGHT IN FIREWOOD, SHERPA BOYS DELIVER THEIR LOADS TO TREKKING LODGES IN THE HIMALAYAN HIGHLANDS.

Ice spires line a rugged trail as the first all-Sherpa expedition forges toward Everest, highest of mountains. Sherpas have assisted foreign expeditions scaling perilous Himalayan

peaks since the early 1900s. The world took notice in 1953 when Sherpa Tenzing Norgay and New Zealander Edmund Hillary won the race to be first on Everest's summit.

borders in 1949, Sherpa culture has been tested. The economy has been restructured by mountaineering and commercial trekking. Forests have been denuded for visitors' campfires, Gore-Tex parkas have replaced *chubas*, traditional robes, and Snickers bars have become as common as yak butter.

Although the Sherpas' lives improved materially, some feared for their culture and in the mid-1980s began an effort to regain their ethnic bearings, reviving traditional ceremonies and building cultural centers. And a 32-year-old guide named Lopsang Sherpa, who was once a servant, began dreaming of an all-Sherpa Everest climb to pay homage to legendary Sherpa mountaineers. "We want to take pride as a people apart," he said.

American Peter Athans, who had scaled Everest in 1990 with Lopsang's assistance, helped raise money for the expedition, and I was invited to write about the Sherpa people through the window of this historic climb. I would rendezvous with the team at the Everest Base Camp, and as they tackled the mountain I would undertake a parallel journey: I would visit their homes, meet their relatives, hike along their village trails. As they reached for the heights of the earth, I would explore the heart of their culture.

WHEN I FIRST VISITED Khumbu, the Sherpa region closest to Mount Everest, in March 1991, I was dispirited by the commercialization. At the closest airport, at Lukla, I was greeted by a sign reading "Sherpa Coffee Shop" and by vendors selling imitation Tibetan jewelry, actually made in Kathmandu. A line of people awaited work; during the spring season thousands of trekkers and two dozen expeditions arrive here needing guides and porters.

Sherap Jangbu, my guide and interpreter for the next three months, had hired a second Sherpa and two *zopkios* (male cow-yak crossbreeds) to carry our duffels to Base Camp. As we made the two-day hike to Namche Bazar, usually called Namche, the unofficial

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The Sherpas' own ascent

Prayer flags wave Buddhist blessings to the expedition team (left), gathered at Base Camp. Later in the Khumbu Icefall, a climber measures every step across a hundred-foot-deep crevasse (above); one slip could send him into the icy abyss. Muffled by his oxygen mask, Ang Temba (below, at right) radios from the top of Everest.

PETER STEARNS, ADVENTUREIMAGE (ABOVE AND TOP)

capital of Khumbu, we passed the Apple Pie restaurant and the Cheap Lodge. Sherap himself, through the help of a wealthy trekker he befriended, owns the large Panorama Lodge in Namche, where I stayed between excursions into the countryside.

Amid the rock-and-ice jumble of Base Camp, at 17,600 feet, Lopsang introduced me to the rest of the Sherpa team: Sonam Dendu, 30, a stonemason; Tenzing Tashi, 35, the son of a married monk; farmer Ang Rinzing, 33; Nima Tashi, 31, who, like Sonam, had already climbed Everest twice; Ang Temba, 25, the only high school graduate; Lhakpa Gyalu, 39, father of six and a farmer; and Gyalzen Sherpa, the oldest at 49, who was working his 13th Everest expedition. A support team, including Peter Athans and other foreigners, would aid the push.

The Sherpa team had been picking its way through shifting crevasses to set a safe route of ropes and ladders through the treacherous Khumbu Icefall, returning to Base Camp each night. They regarded danger philosophically. "Climbers have many reincarnations," said Tenzing Tashi with a laugh.

On April 1 the Sherpa Everest Expedition began its ascent, leaving Base Camp to establish the second of two camps in the Western Cwm. The Sherpas burned incense as an offering and headed for the peak they call Chomolungma—"goddess mother of the world."

SHERPAS FIRST REACHED this part of the Himalaya in the 16th century, migrating south from a land in eastern Tibet called Kham ("Sherpa" means "eastern people" in Tibetan), settling

Wrapped against the chill, buyers and sellers negotiate narrow paths above Namche Bazar (left). The Saturday market is the largest in the Khumbu region, attracting throngs of vendors from surrounding areas. Most sellers, like a man peddling dried corn (above), are of other Nepalese ethnic groups. Many Sherpas have found a better deal—running lodges for trekkers and climbers.

in an oblong region of canyons drained by the Dudh Kosi.

In the harsh, high Khumbu area they raised yaks and traded; in the lower Solu region to the south they terraced hillsides for buckwheat, corn, and rice. The Sherpas' language and customs held them closer to Tibet than to Nepal, and they knew no authority but their own.

But geography placed Sherpas between the mountains and those who wanted to climb them. After Great Britain colonized India in the 1800s, many Sherpas migrated to find work at a military post in Darjeeling, just across Nepal's eastern border. In the 1920s the British hired these strong, reliable Sherpas as porters for pioneering Everest explorations. Early expeditions had to bypass Nepal and approach the mountain from Tibet, but

Gatekeepers of the Himalaya

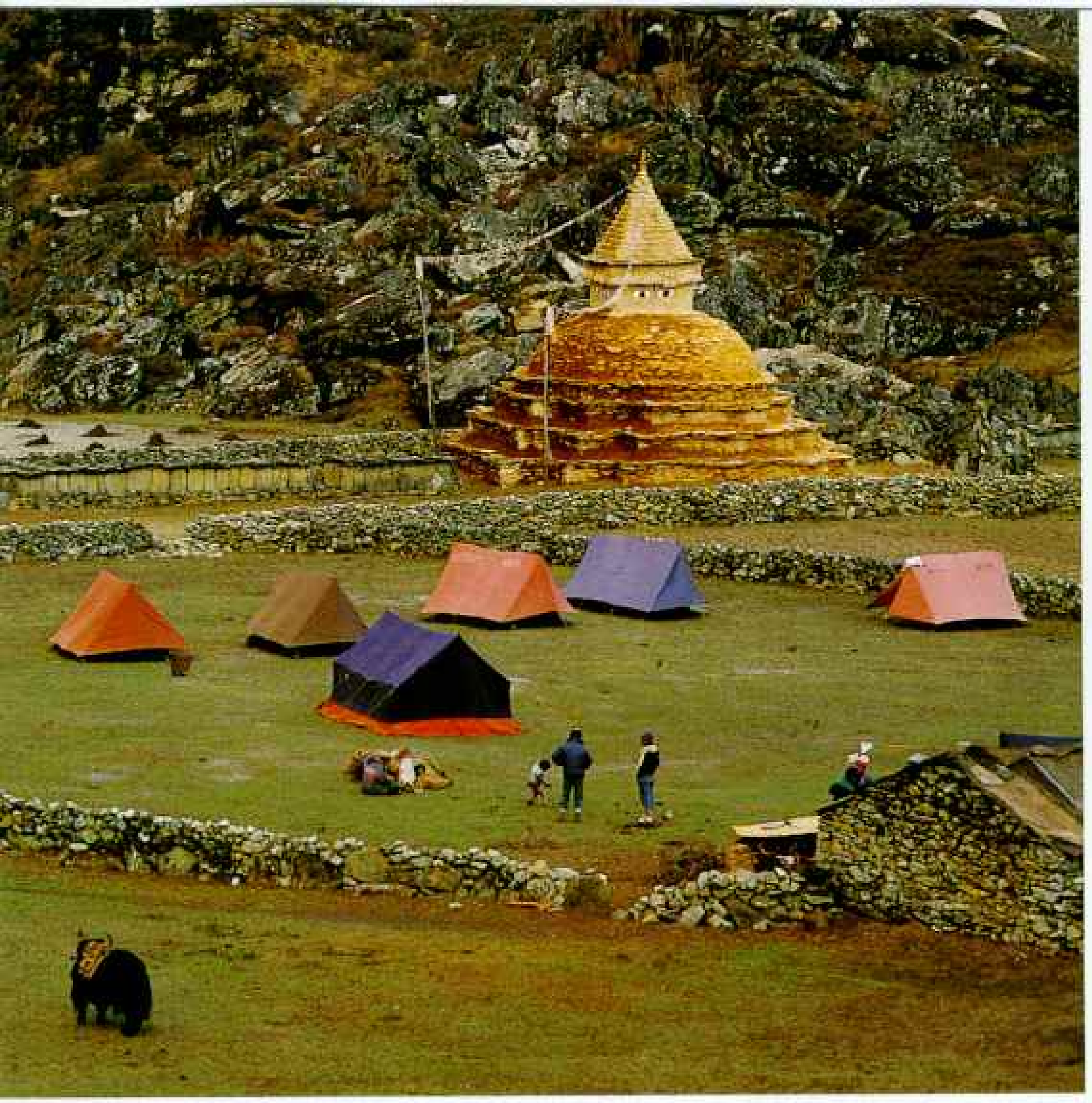
after 1949 climbers were able to trek right through Khumbu to reach Everest.

In 1953 New Zealander Edmund Hillary and Tenzing Norgay, a Sherpa raised in Khumbu, became the first to reach the 29,028-foot summit. Some Sherpas accused Tenzing of killing the golden goose; they thought the feat would end mountaineering in the Himalaya—and their livelihood. It did the opposite. By 1976 all but eight of Nepal's 25,000-foot-plus peaks had been topped. The tourist-trekking business had blossomed, and Sherpa life was changed forever.

Today more than half of all Sherpas live off tourism and mountaineering. Cooks, guides, and camp staff are among the best paid people in Nepal, earning as much as $1,200 a year in a country where the average annual income is less than $175.

Sherpas themselves rarely carry loads on tourist treks; they hire three-dollar-a-day porters from among the Rai, Tamang, and other local Nepalese ethnic groups who aspire to be "sherpas," which has become a job title for a mid-level camp assistant. The Sherpas who climb on hazardous high-altitude expeditions

One shy, one show-off: Young Sherpa girls master the art of bubble gum (below), a treat brought by foreign trekkers. Camping in private fields (right) for five rupees (about 15 U. S. cents) a day, trekkers leave problems as well as profits. Their trash litters camps and trails.



are the elite. They can get from $1,600 to $2,000 for three months' work.

For most Sherpas high-altitude climbing is a job, but they are not immune to the spirit of a challenge. Seventy-three Sherpa men have reached the summit of Everest; one Sherpa, Ang Rita, has topped Everest seven times.

Moreover, Sherpas feel they have done the most difficult work while the acclaim has gone to foreigners. "I would guess more than 60 percent of foreign climbers are *led* to the summit," said Ang Phurba, who owns a trekking company based in Kathmandu.

IN KHUMBU, a world of sheer cliffs and plunging gorges, there are no paved roads, no motor vehicles, no telephones, no electricity except in three villages. Goods arrive on the backs of porters or yaks. Yet news travels at remarkable speed along the trails. Sherpas hail one another with, "Where are you coming from?" They love to stop at tea shops and gossip. When Sherap left his toothbrush at home, two brushes appeared out of passing knapsacks; word had reached his wife, Lhakpa Doma, through the Sherpa trail telegraph.

At the Panorama Lodge, Sherap's family moved comfortably between traditional and trendy. Each morning Lhakpa poured fresh water into seven bowls, an offering to Buddha, and lay prostrate before the family's private altar. In the evening she sometimes dashed out to watch Indian movies when the electricity was turned on in the village.

In the dining room, tourists ordered pizza and French fries. In the kitchen the family ate *dal bhat* (lentils and rice) and curry made

Monks conjure ferocious gods while performing a ritual dance that sets evil-thwarting boundaries around the village of Junbesi during the five-day Dumje festival. Opening the

ceremonies, they use peacock quills to sprinkle the ground with sacred water. The festival probably dates back more than 450 years to when the Sherpas lived in Tibet.

with meat pulled from a goat carcass hanging over the stove and washed it down with the ubiquitous homemade beer called *chang*.

On Saturdays the family shopped at the weekly bazaar in Namche, where Sherpa women haggled with Tamang grain porters and Tibetan traders weighing yak fat on hand-held scales. The bazaar also sold sweets that have brought tooth decay, but the family now brushes regularly, and a Canadian-trained Sherpa woman has opened a dental clinic. Sherap knows his morning cough is from too many cigarettes, and Lhakpa trims the amount of buttery Tibetan tea they drink because of hypertension diagnosed by Western doctors.

IN THE KHUMBU ICEFALL a wall of ice collapsed in the late afternoon heat on April 4 as three of the Sherpa climbers were descending aluminum ladders. Lhakpa Gyalu plunged 40 feet into a morass of ice. As team members scrambled to find him, word of the accident sped to Lhakpa's home village of Phortse. His father, Mingma Tsering, wept at the news. "They've taken my other son too!"

By the time I met the 70-year-old Mingma two days later, word had arrived that Lhakpa was safely off the mountain, with only a broken ankle. Mingma was a sinewy man with a cordial and expressive face, whose life was a catalog of the triumphs and tragedies of Sherpa mountaineering. He had climbed and trekked for 55 years. He had earned a Tiger Medal from the British, given to the best climbing Sherpas, and a thick stack of letters of recommendation, now torn and yellowed. "A very tough Sherpa who would accept any work cheerfully," reads one letter. Yet he has no pension for a lifetime in the mountains.

Ten years earlier Mingma's younger son, Pasang Nima, had died on a climb. "He was with a team caught in a storm," Mingma told me as he poured dough for potato pancakes onto a flat, heated rock for our supper.

"They waited four days on the Lhotse Face. They were traversing when an avalanche swept him 3,000 feet down. He lived two days more after they recovered him. I talked by radio to the *sirdar*, the chief Sherpa, who asked, 'What do you want to do with the body?' " Mingma paused as if remaking the awful decision. " 'My son is dead,' I said to him. 'I don't want someone else to die carrying him down.' " Pasang Nima was lowered into a crevasse.

"He was a bright boy. We were very proud of him. His mother is still in mourning." In the soft firelight I needed no interpreter to read the lines of grief on his face.

Of the 115 climbers who have died on Everest, 43 have been Sherpas. Near the end of the Khumbu Glacier is a series of Buddhist rock shrines called *chumngs*, which stand like tombstones against a passionless skyline. Each holds a tablet with a Sherpa's name and the climb he died for.

By April 14 the Sherpa expedition had

No tree is too tall for Lhakpa Tseri (above). Boys cut dead branches and sometimes live ones—an illegal act in Khumbu. Once cut for fuel and building, trees here are now scarce and protected. Law permits the six main beams for this two-story house in Namche (right) to come from Khumbu; the rest of the wood comes from lower regions.

established camps as high as 26,000 feet on Everest's South Col, a barren ridge where hundred-mile-an-hour gusts buffeted the climbers. As they struggled with tents, equipment, and oxygen tanks, Sherap and I climbed through hillsides of rhododendron to visit an important symbol of Sherpa faith, Tengboche (Thyangboche) Monastery.

The monastery is perched on a ridge among old-growth evergreens. Below it, the broad meadow was filled with tents and trekkers, yaks and visiting monks. Woodsmoke and incense mixed with the aroma of freshly shaved pine as carpenters fashioned new interior beams for the monastery, which was being rebuilt after a fire.

In the private quarters of the *rimpoche*, the head lama (page 86), I laid before him a white cotton *kata*, or ceremonial scarf, with a donation of 300 rupees (ten dollars) folded inside. He slipped the money out before placing the scarf around my neck to bestow the blessing he offers dozens of times each year for trekkers and climbers.

Behind the monastery sits a stone cultural center established to preserve a bit of Sherpa history: religious artifacts, jewelry, and traditional dress. "Much has been lost since expeditions and trekking came," he told me. "I am trying to show children that this was our culture."

Yet the rimpoche is a clear-eyed, practical man. "Before, the gods didn't like climbing," he told me, "but everything has changed. Like the King of Nepal, for instance. He used to be a big man . . . and now he's not." The lama smiled ever so slightly at the memory of the once absolute monarchy, and he clapped slender hands for an aide to bring sweetened coffee.

Sherpa grace, selflessness, and generosity under pressure come from Tibetan Buddhism. Sherpas believe that life is an endless cycle and that a holy life guarantees reincarnation as a human, rather than as a snake or dog. Sherpas earn religious merit by their gentle thoughts, by practicing nonviolence, doing good deeds, spinning prayer wheels, and offering gifts to lamas. Religion is a daily, if not hourly, practice.

Well-to-do Sherpa families once sent their second-born sons to monasteries, but today few young Sherpas are willing to embrace the ascetic life; Tengboche has only two dozen young men in training. One of them is Nawang Tenzing, the 23-year-old son of Gyalzen Sherpa, the oldest man on the Sherpa team. "There are not so many new monks," he told me with a handsome smile. "Some fall in love with girls. Others can't take the responsibility."

Two-thirds of the trainees will eventually quit, predicted Pasang Thundu, the rimpoche's brother, who runs a lodge across the meadow from the monastery. Pasang knows. He was a monk at Tengboche for 16 years, but left for "chang and a good woman."

ON APRIL 20 the Sherpa team made its first attempt at the summit from the South Col, donning oxygen masks at an elevation of 26,300 feet. Within an hour, Lopsang Sherpa, Tenzing Tashi, Ang Temba, and Sonam Dendu were pushed back by blasting wind and drifting snow.

Ang Temba, whose schooling may have made him a skeptic, had told me at Base Camp, "The lamas say there is a god on the mountain. But unless I can see one, I won't believe it. People say there is a yeti too." The legendary yeti, or Abominable Snowman, is a bearlike bogeyman of both Tibetan and Sherpa tradition.

In the spring Sherpa villages bless their crops and purge bad spirits, using rituals that reenact the conquest of evil when Buddhism was introduced into Tibet more than a thousand years ago. To see the celebrations, Sherap and I flew by turboprop to a village in the Solu region, 25 miles south of Namche.

Within minutes we had left the bleak and snowy high country for a gentler landscape. When we landed at Phaplu, the air was balmy, with rain-filled clouds. In Junbesi, nearly a day's walk to the north, we joined villagers at an ancient monastery for a five-day drama-dance called Dumje.

That night children and their parents watched spellbound from a weathered balcony as villagers posing as drunken men chased "bawdy women" around the courtyard. Next came monks costumed as gods. Wearing fierce masks and flowing robes of red, yellow, and black, they leaped and twirled, circling yak-butter lamps to the groan of long copper horns and the rhythm of cymbals and drums.

Down a pathway, not far away, a discotheque blasted rock and roll for teenagers who had wandered away from the rituals.

A tearful toddler is comforted at the Phaplu hospital, where scores of patients are treated daily by Mingma Gyelzen, the first Sherpa physician. The 15-bed facility—as well as 26 Sherpa schools—was donated in part by Sir Edmund Hillary.

Next morning I climbed the hill behind the monastery to visit Ang Dorje Lama, the 66-year-old farmer and politician who had paid for this year's Dumje. "After my death my son must take his turn sponsoring the Dumje," he said. "If he doesn't, he'll be selling out his religion."

But his 37-year-old son, J. P. Lama, runs a trekking business based in Kathmandu and rarely visits the village. "I will do the Dumje," J. P. told me later, "but what the real meaning of it is, I don't know."

His dilemma is common among young Sherpas caught up in making a living and learning the ways of mortgages and contracts. Of Dorje's five children, only one lives in the village; two attend colleges in California and two live in Kathmandu.

Buddhists make up less than 10 percent of the Nepalese population, and assimilation into the Hindu majority threatens Sherpa culture even more than Western wealth. Most government officials are Hindu and tend to regard Sherpas as backward hill people.

In a remote area of Solu south of Phaplu I stood early one morning on a ridge overlooking the waves of farm-patched hills. Suddenly I heard bells—everywhere—clanging out the Westminster chimes, the traditional time signal. Every farmhouse in earshot was tuned to the broadcast from Radio Nepal, with its daily diet of Nepali language and music, just signing on from Kathmandu.

ONLY 3,000 SHERPAS live in Khumbu, but most of their top climbers come from that region. Ang Rinzing, one of only two team members from Solu, spends more than half the year away from his home near the village of Tapting. "I

am climbing for Solu pride too," he told me at Base Camp.

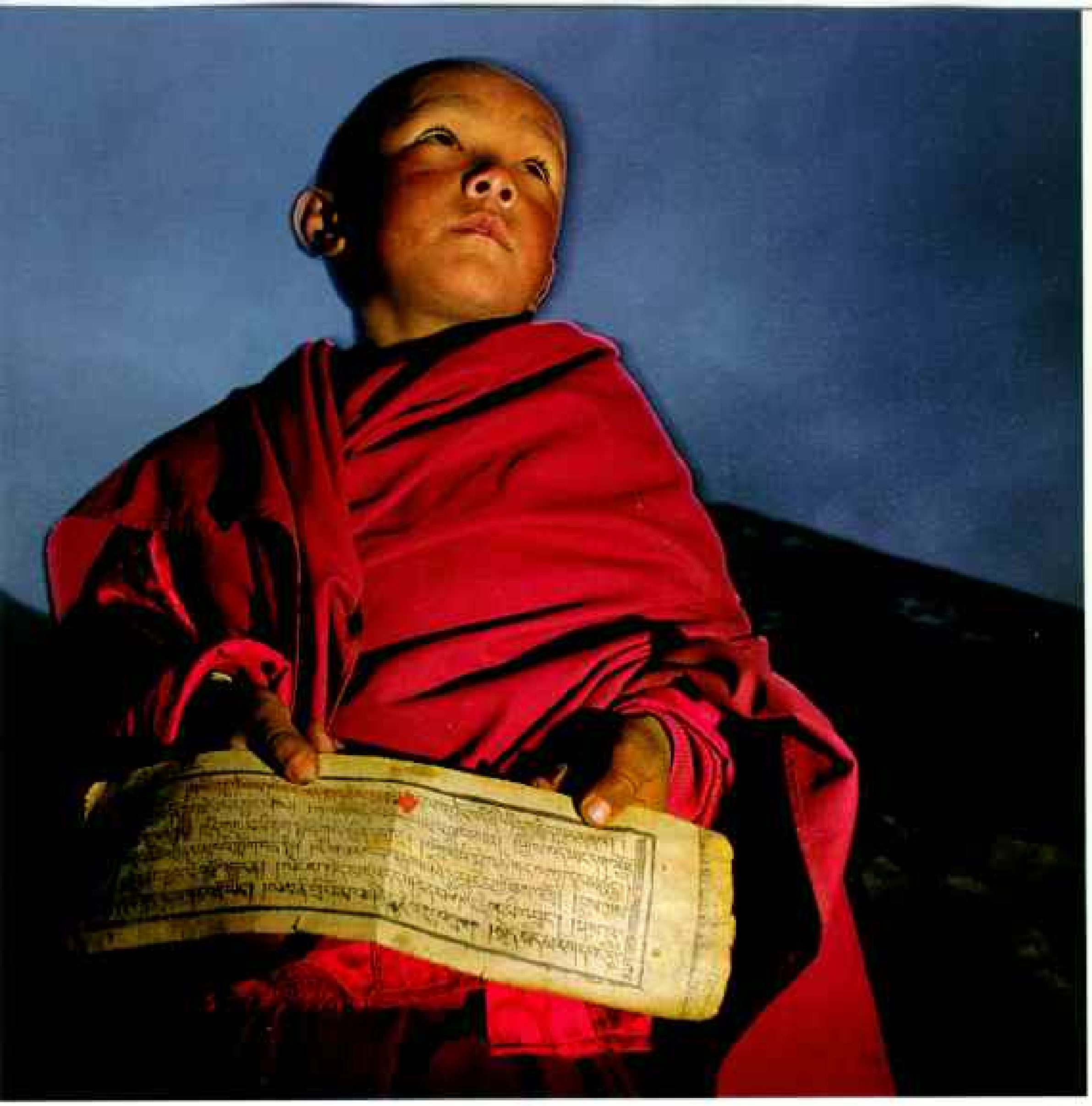
When Sherap and I arrived at his house, his 22-year-old wife, Ang Chopka, seated us in the places of honor near the fire and fixed Tibetan tea, a pungent mixture of tea, butter, and salt. She was in constant motion. She boiled potatoes and warmed a pot of chang, urging it gently on her guests with the words, "*Shay, shay*—Please, please," filling the cup three times as is customary.

Soon the house was filled. Chamji Sherpa, mother of climber Nima Gyalzen, on the support team, and two neighbor women arrived. I asked them how the women coped when left behind for months at a time.

"If someone dies in the village, there is no one to carry the body," Chamji told me, "but now that the planting is done, we just sit around and sunbathe." She giggled.

Chamji offered us some *rakshi*, a distilled liquor she had made from rice. "The son goes off to the mountain and we drink," she added with a touch of melancholy. Shortly the rakshi took root. Chamji surveyed the male visitors, stood and swayed: "We could have a dance."

"If we teach our children pride in Sherpa culture, perhaps we can save what is important," says the head lama of the Tengboche Monastery (below). Monks mold Tsering Dorje (right), believed to be the reincarnation of a lama who died a decade ago.



In the trekking business, extramarital affairs are not uncommon for Sherpa men; Sherpa women are not so free. Said Chamji's daughter-in-law, Pemkili, "If a married Sherpani strays, her man would not stay. Never. The neighbors would call her a prostitute."

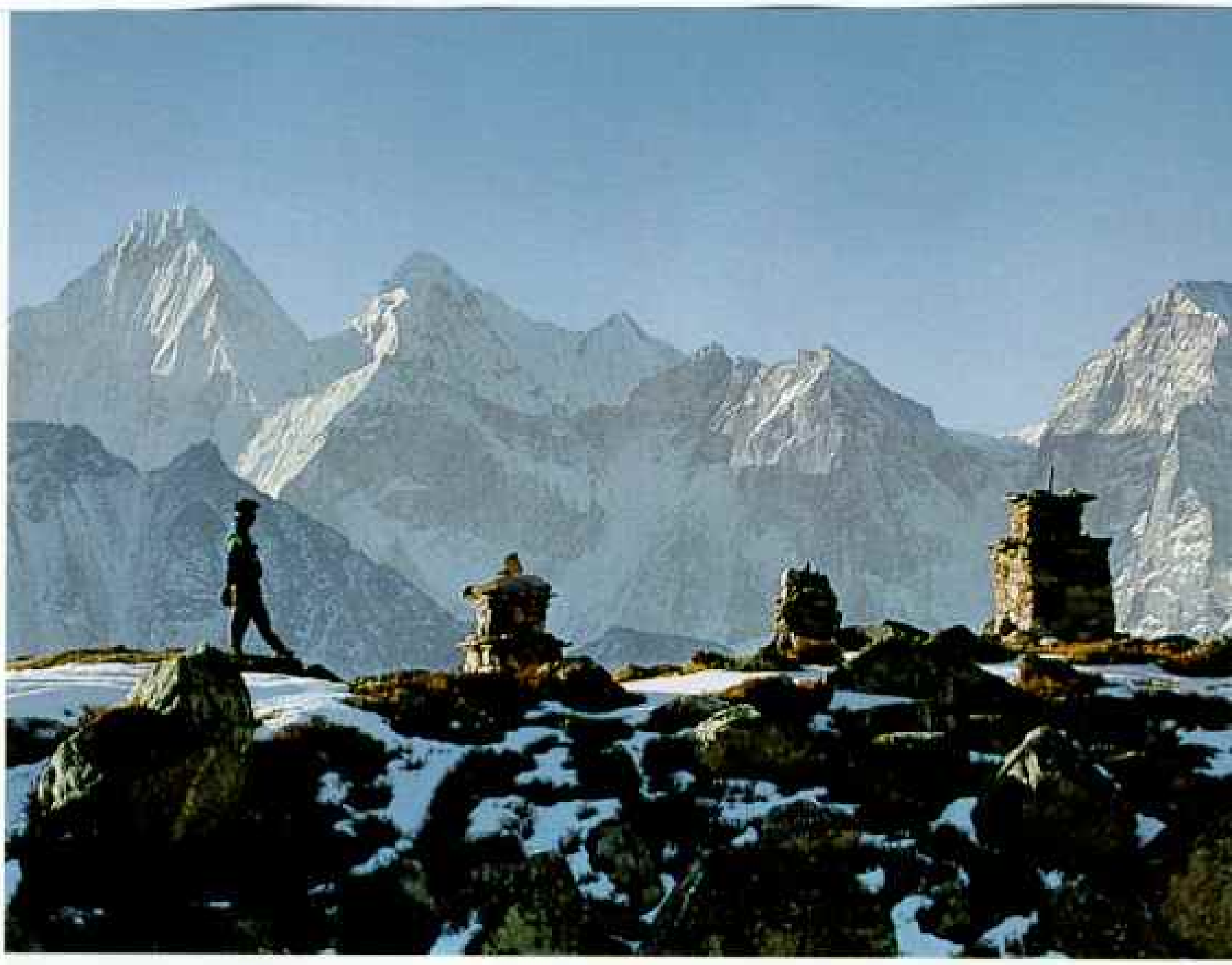
Pemkili, who has no formal education, said she wants a boy for her next child: "They can go wherever they like, and they make better money. And they're much smarter."

WHEN EDMUND HILLARY and Tenzing Norgay climbed Everest, there were no public schools for Sherpas. After being petitioned by parents in Khumjung, a village north of Namche, Hillary built the first Sherpa school there in 1961. Its first eight students went on to spectacular success: college abroad, business ownership, political influence. In the years since, Hillary has helped build and equip 25 other schools. Hillary's Himalayan Trust, a nonprofit institution, has provided scholarships to promising students, allowing them to attend college in Kathmandu.

An educated layer has been added to Sherpa society. Two Sherpas ran for the Solu-Khumbu District seat in the Nepalese Parliament but lost. Four Sherpas fly for Royal Nepal Airlines. Three are physicians.

Much help has come from the international community. The Himalayan Trust has planted thousands of trees in Khumbu and helped establish Sagarmatha National Park in 1976, in an effort to preserve the region.

In April 1991 I spoke with Sir Edmund Hillary, then 71, at the 30th anniversary



of the Khumjung school, where dozens of schoolchildren lined up to drape katas around their hero's neck. "It was absolutely vital that the local people obtain schooling so that an influx of tourists not overwhelm them," he told me. "That they not just become peons but instead can take advantage of the economic possibilities."

Hillary's vision was prophetic. Sherpas now own 21 of a hundred trekking companies in Kathmandu. Paradoxically, trekking is so lucrative that many Sherpa boys drop out of school to work at it after getting rudimentary academic skills.

Education can shorten the steps needed to rise from kitchen helper to *sirdar*. Modern Sherpa guides must know how to negotiate with foreigners, keep trekking budgets, and read contracts and manuals.

Ang Temba, the youngest on the Sherpa team, got a job as an assistant sherpa right out of high school. His uneducated father never got beyond cook. Gyalzen Sherpa, the oldest team member, realizes his future is limited. "Even if I got on top," he told me, "it wouldn't make that much difference, because I am not educated."

On May 1, Gyalzen left Base Camp for a two-day break to plant buckwheat at his home, and he reported more frustration from the mountain. Another attempt at the summit had been repulsed by 60-mile-an-hour winds. The team's strength and time were running out. They would have one more chance.

ALL OF KHUMBU AND SOLU waited. As the spring climbing season wound down, many village men returned home from other expeditions. Kitchens in Khumbu grew lively. The chang flowed. From the lodge, Sherap and I set out daily to visit families and chat over tea.

On May 8 we climbed an 18,000-foot mountain near the summer hamlet of Gokyo and looked out on the majestic peaks on the Tibetan border. The air was calm everywhere except on Everest, where a fierce, steady plume of snow ripped off a ridge.

Sherap left a prayer flag for good luck. "It looks like a bad day for Everest," he said, "tough going."

But that afternoon a runner reached Namche with the crucial message: The Sherpa team had left the South Col at 2:30 a.m. for their final push. At nine that morning Sonam Dendu and Ang Temba had radioed

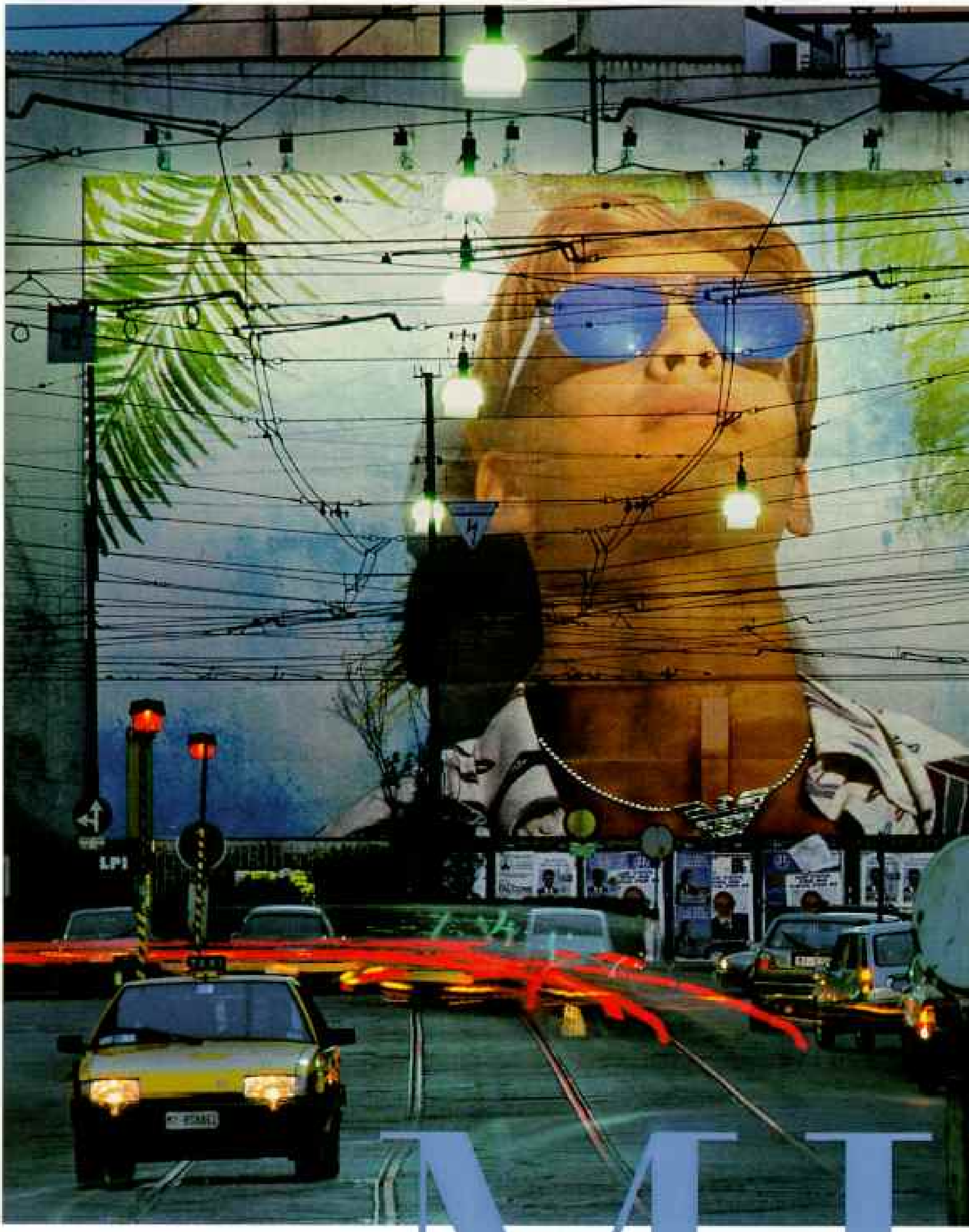
Shadowed by Himalayan heights, shrines honor 43 Sherpas killed on Mount Everest. Once a high-altitude porter, Ang Tsering (below) knows loss; frostbite claimed seven fingers during a 1986 expedition. He now rents out pack animals for expeditions and trekking groups.

back: "We're on top!" They had soon been joined on the summit by two members of the support team, Apa Sherpa and the American, Peter Athans.

The news traveled quickly, and sighs of relief resounded throughout Solu and Khumbu.

Nine days later the team gathered in Khumjung, where I joined them and the entire community in celebration. As night fell, we linked arms and danced, singing Sherpa songs, spilling onto the moonlit pathways of the village. The monsoon clouds were rolling in, drawing a curtain on the peaks of the gods. In the morning the climbers would return to their homes—to their roots and traditions.

As I stood among them, I thought about the efforts by both Sherpas and outsiders to "save" their culture. Sherpas have been resilient, managing to blend wisely with the modern world, partly because they have been needed and respected for their skills, rather than exploited. Much of traditional Sherpa life is intact, and many Sherpas, thoroughly cosmopolitan, are choosing to keep it that way. Pragmatism pays the bills, but spiritual harmony still guides them—on and off the mountains. □



MIT

By JOHN McCARRY
Photographs by GEORGE STEINMETZ

Image is all in frenetic, get-ahead Milan. A magnet to money, design, and manufacturing, the northern Italian metropolis plays down its smog, drug, and political problems while it dreams of becoming a leading city in the new unified Europe. A billboard in the trendy Brera district projects a larger-than-life image of the Armani fashion house.

Where Italy gets down to business

LEAN

A priest's roll call summons girls for their first Communion at the church of San Simpliciano. Only a few people in the city attend church regularly, but Milanese money supports one of the larger Roman Catholic archdioceses in Europe.

ALTHOUGH I WAS BORN IN ROME and spent most of my boyhood there, it was not until I was 27 that I went north to Milan. On my first day in the city I was stranded beneath an awning, waiting for a thunderstorm to end. Peering through sheets of rain, I searched for hints of the Italy I knew as a boy—a baroque church front, or a palazzo the color of ocher, or a piazza with a Bernini fountain at its center. Instead I saw only gnarled traffic creeping down the Corso Garibaldi, an avenue of ponderous stone buildings and ruinously expensive boutiques.

A woman with the emaciated build of a runway model paused beside me to pull the collar of an elegant black raincoat around her long neck. I nodded and smiled. She smiled back, and said, *"È bella Milano, no?"*

Well, no. Beautiful is not the first word that springs to mind when describing Milan—especially not to a Roman's mind. Milan is known around the world as the capital of high fashion and slick design, the mecca of elegance and taste. Yet the actual physical aspect of the city is oddly unaesthetic, a configuration of computer-card facades vaguely perceptible through an alchemic haze of smog and hype. In fact, all of one's conventional images of Italy—idle piazza crowds and shadowy lanes, abundant sun and endless meals—have little to do with this foggy capital of Lombardy, a region of Italy that drops from Alpine lakes into the fertile Po Valley.

Over the past three decades Italy experienced an astounding economic boom. In 1986 the country's gross national product surpassed that of Britain, making it the fifth largest economy in the world, after the U. S., Japan, Germany, and France. To a large extent Milan was the locomotive of this success. Milan alone accounts for 10 percent of Italy's GNP, has a 38 percent higher per capita income than the rest of Italy, and pays 25 percent of the nation's taxes.

Milanese like to say, *"Milano lavora e Roma mangia*—Milan works and Rome eats." Milan feels itself to be, both in physical and in spiritual terms, closer to Zurich than to Rome, more European than Italian. Many Milanese believe this affinity for Europe may further strengthen Italy's political and economic ties with the European Community, the 12 nations now working toward a unified Europe. By the end of this month the community plans to organize Europe into a single economic market by dismantling national barriers to the free movement of people, goods, and services.

But the next phase of integration, which seeks a common foreign policy and a common currency, will not be without its obstacles. Before Italy can join a prospective monetary union, it must drastically cut its trillion-dollar national debt. More insurmountable may be what many in Milan perceive as their city's enslavement to Rome.

I had thought that their closer union with the European Community would be something the Milanese would be celebrating with glasses of Spumante—at last, the opportunity to cut the Italian peninsula adrift and leap with both feet onto the continent of Europe.

But few Milanese think integration can liberate them from the bureaucratic inertia of Rome. As one young woman told me while we stood squeezed into a subway car at rush hour, "Spain has all of these sexy young politicians and now Spain—Spain of all places!—is where everything interesting is happening. We have the same bunch of geriatric politicians we've had for years. And they don't give a damn

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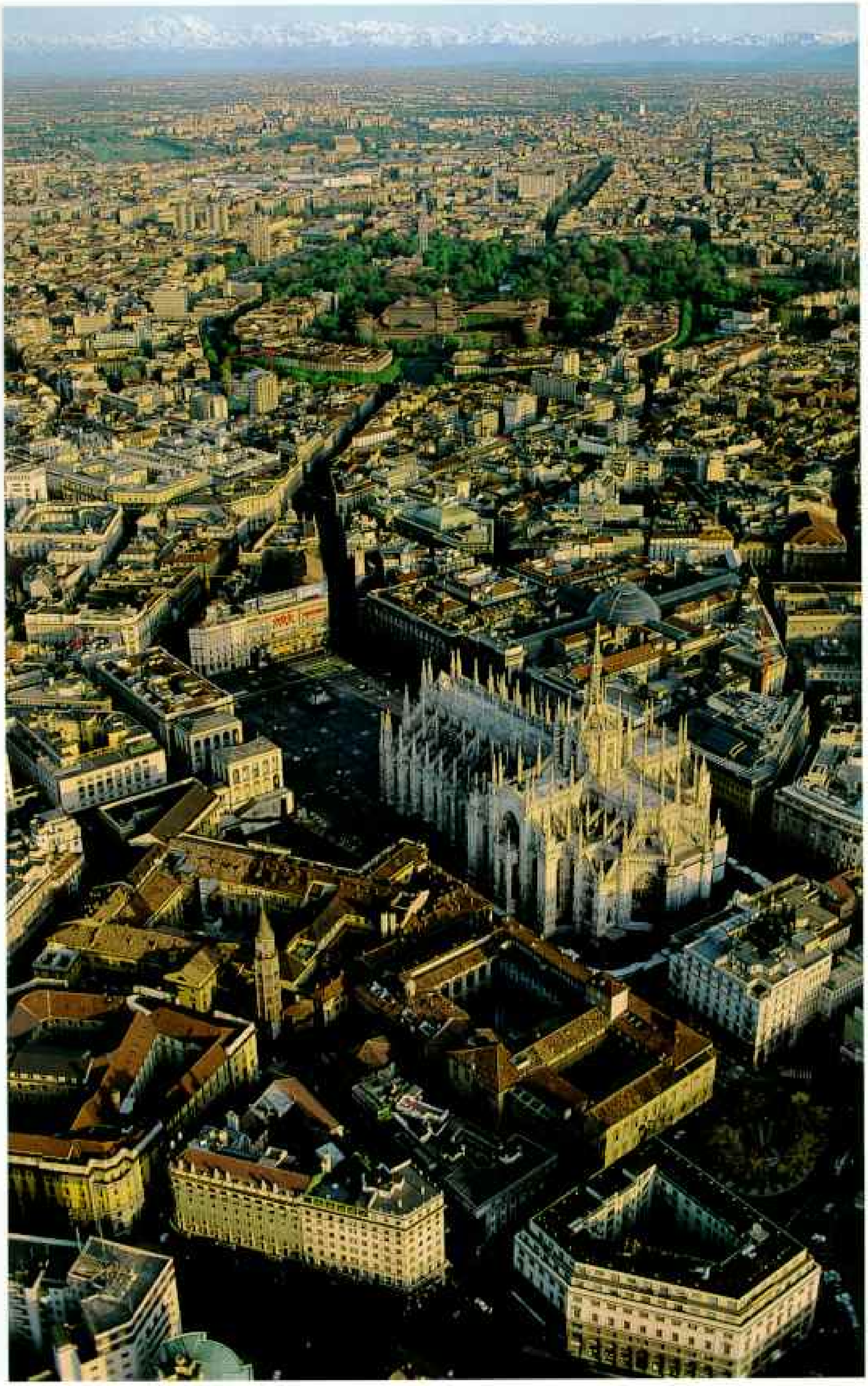
Free-lance writer JOHN MCCARRY divides his time between Washington, D. C., and the Middle East. This is his first article for the magazine. GEORGE STEINMETZ turned to photography after earning a degree in geophysics from Stanford University. His photographs last appeared in "Alcohol, the Legal Drug" in the February 1992 issue.

On a rare day as clear as sparkling wine, the marble duomo, a Gothic masterpiece, commands a view from the city center to the Alps, 50 miles away. In the 1400s Sforza dukes ruled from the castle, now reconstructed, in the background.




A. S.
FERRYHE NORD MILANO

Campaigning in Piazza del Duomo, native son and former Prime Minister Bettino Craxi urges votes for the Socialist Party. In April elections he was returned to parliament, but local Socialists lost their majority for the first time since the 1950s. The Lombard League party, seeking more autonomy from Rome, gained ground.

A crossroads since antiquity, Milan has been ruled by Spain, France, and Austria, giving it an affinity with the north. Post-World War II prosperity drew southern Italians. Maria Lanotte (facing page, at right) arrived in 1972, followed by her father, Pasquale, at left, and other family members. Southerners now form a large portion of Milan's 1.5 million people.

about anything except holding on to power."

I visited Milan at a moment of great change. I found a city contemplating its role in the European union, while struggling to cope with a decline of the economy—profits of some firms have begun to shrink, and the country's 5.5 percent inflation rate now exceeds the European Community average. I discovered a city transforming itself from the country's industrial base into the center of its service sector. At the same time Milan is confronting pollution, AIDS, drug addiction, and immigration.

THE STORY OF MILAN is, above all other things, the story of its middle class. Its modern success began after the Second World War, when the Milanese set about rebuilding a city devastated by Allied bombing. The Pirelli rubber company, Falck ironworks, Montedison chemicals, and Alfa Romeo all flourished after the war.

But while such big enterprises are Milan's best known, it is really the smaller establishments that have driven the boom. Unlike those in most industrialized nations, in Italy about four-fifths of private companies are small businesses, the vast majority family owned.

The result is a bourgeoisie that combines the traditional with the progressive. Rita Borgo, head of the press office for the Milan stock exchange, which handles 93 percent of Italy's transactions, gave me an example. "Today we have 230 companies listed on the stock exchange, but there are at least a thousand important, well-established companies that remain unlisted," she lamented. "These are for the most part medium and small businesses. They do not list themselves because they don't trust the exchange. They feel that they'll lose their privacy."

This concern with discreet, family-run businesses is nothing new in northern Italy. Modern banking was invented there by the bourgeoisie in the Middle Ages, when a few powerful families began lending money to foreign nations. They gave gold to England and granted loans to Spain. The same values practiced by those families—respect for savings, a spirit of enterprise, a love for order, and belief in the work ethic—remain deeply ingrained in today's Milanese.

Spending money is about the only hedonistic activity the Milanese allow themselves. Yet even this indulgence is tempered with characteristic prudence: Despite the staggering cost of living, the Milanese middle class manages to save about a fifth of its income.

Milanese such as Gianni Versace seem much more interested in making money than in spending it. Versace, a fashion designer who had sales of 680 million dollars last year, took time to see me a few days before the presentation of his spring collection. When I arrived at his headquarters on the Via Gesù, he was occupied with a woman from a British publication, an extravagant-looking person with a great deal of costume jewelry, who was leaving vermilion lipstick on his cheeks and shrilly pronouncing his name Gee-ANN-ee. "You're beautiful, Gianni, just beautiful!" she called as she made him pose for her photographer.

Versace, a smallish man in a pair of old and

unfashionable jeans, turned to me and smiled with admirable patience. He looked tired, and I told him so. "One always looks tired in Milan," he responded. "This is a city to work in; it's not a city to have fun in."

The Milanese look elsewhere for fun, saving it up for the weekend, when they vacate the city en masse. Attempting to defend Milan from the unkind criticism of people from places like Rome, the barman of a modest establishment rhapsodized about his city's special geographic position. Expertly assembling a *panino*—a sandwich especially popular in Milan because it takes less than five minutes to prepare and consume—he told me, "Jump in your car, and in just a few hours you're in the mountains or at the sea."

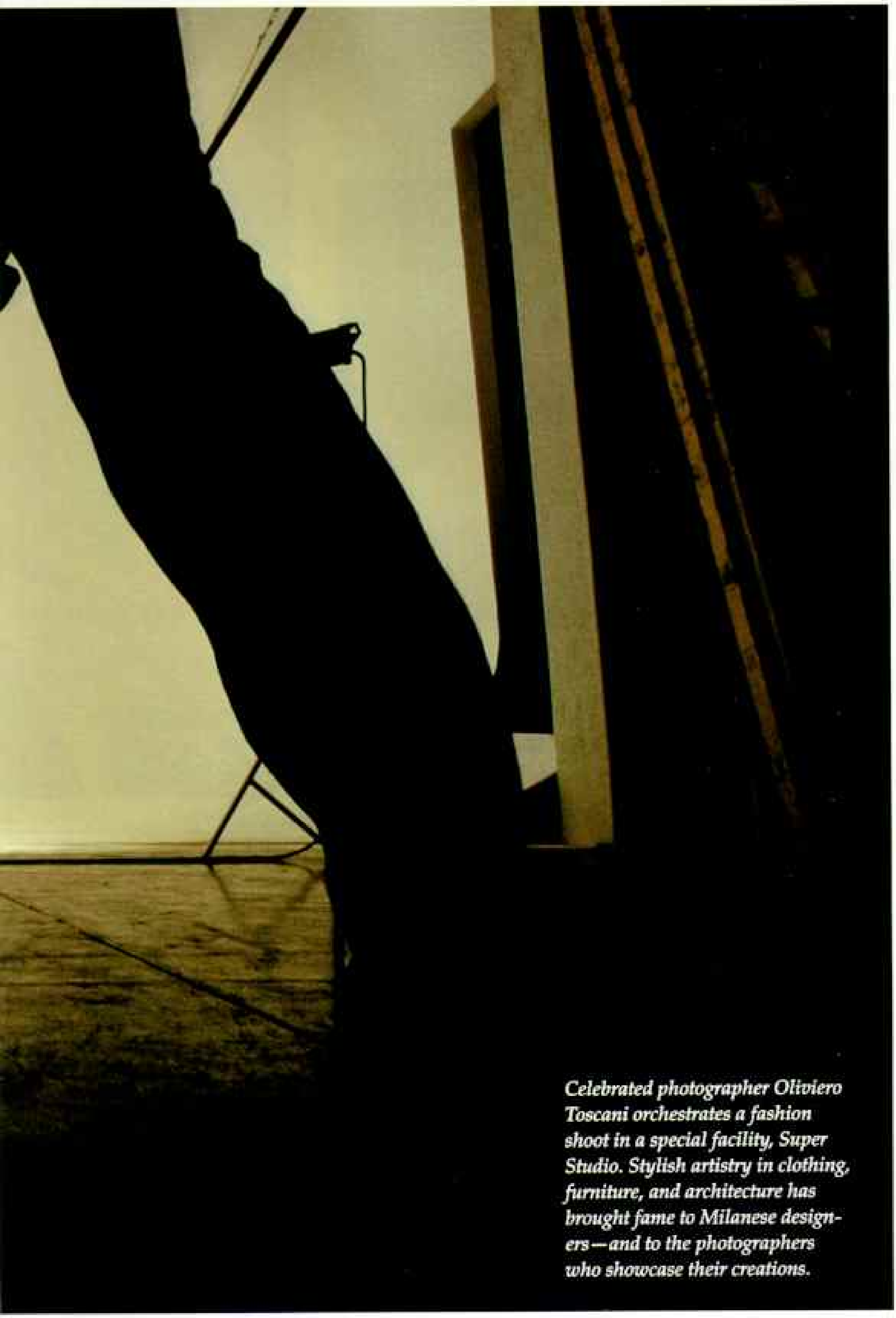
The implication of this remark, of course, is that you can hop in your car and, within minutes, be anywhere but in Milan. But because of Milan's narrow, crowded streets, and because it has a high ratio of cars to citizens, the Milanese are forced to sit bumper to bumper in their Lancias and Fiats for a couple of hours before the city gives way to the country.

I did meet up with one iconoclast, who perversely stayed in town every weekend just, as he put it, for "the indescribable joy of finding a parking space." During the week this seemingly prosaic task is said to drive a few high-strung Milanese clinically batty—on a typical workday there are an average of 400,000 parked cars covering one and a half square miles, or 33 percent of available public space.

Almost twice as many cars circulate in this city of 1.5 million, each traveling an average of 19 miles a day, a complaining procession whose clouds of exhaust make Milan one of the most polluted cities in the world.

But air pollution is not Milan's only environmental problem. In 1991, 159 of the 533 public wells had to be shut down because they were contaminated with industrial waste. Milan produces 2,000 tons of trash a day, but the city's two incinerators can handle only 900 tons of it; the surplus is dumped in landfills. "What we lack is planning," said Sonia Cantoni, an urban planner with the publicly administered Lombardia Risorse. "Landfills are not the fruit of planning," she told me sadly. "They are a desperate emergency policy."

LA BELLA FIGURA, a fine sense of image, is perhaps Milan's most important commodity. The city's tireless preoccupation with what looks good communicates itself not only in clothes, convertibles, and coffee tables but also in gestures, expressions, and words. It is a whole philosophy of life: How to make all things and all actions look beautiful. It is present in all corners of the city: On the Via Monte Napoleone,



Celebrated photographer Oliviero Toscani orchestrates a fashion shoot in a special facility, Super Studio. Stylish artistry in clothing, furniture, and architecture has brought fame to Milanese designers—and to the photographers who showcase their creations.

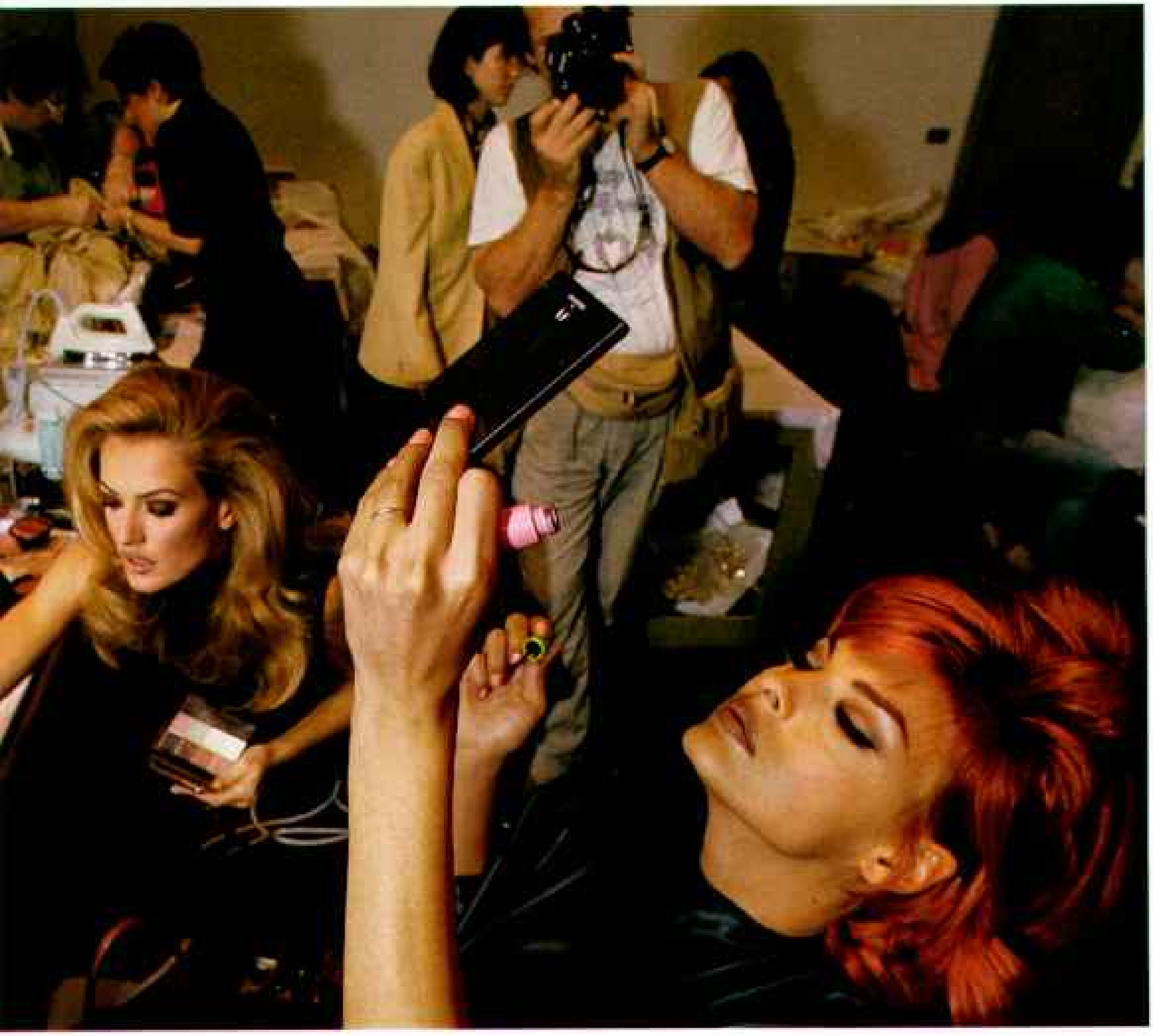
Getting down to details, designer Giorgio Armani arranges the lineup of models for the unveiling of his spring collection. In Milan's multibillion-dollar fashion industry, top models Linda Evangelista, far right, and Karen Mulder earn $10,000 a day showing off Gianni Versace's latest.

where an impeccably groomed mannequin, head cocked at a cinematic angle, strides through a sea of Japanese shoppers as she watches her reflection in the artfully composed store windows; on the Corso Garibaldi, where hair-designer-for-the-rich Aldo Coppola serves champagne to a crowd of 2,000 plus to celebrate the opening of his newest salon; on the Piazza del Duomo, where a young executive saunters through a cloud of pigeons, fashionable olive suit coat draped over his shoulders as he speaks into a cellular phone.

It is no surprise that Milan, in its love affair with money, managed to turn this philosophy into big business. Milan today, a world leader of design, won its reputation in part by its inimitable talent for turning ordinary objects like steering wheels, ice buckets, and chairs into works of art. And although Milan joined the international fashion scene less than two decades ago, it is the biggest exporter of high-fashion clothing in the world; Paris, by comparison, is only sixth.

THE MILANESE STYLE—subtle, understated, discreet—is more than skin-deep. It goes beyond the contours of an Alfa Romeo convertible or the lines of an Armani suit.

One can see this in the everyday behavior of the people of Milan. Without exception, I found them to be quiet, low-key, unimaginably polite. Even at the bar around the corner, where every morning I stopped for a cup of cappuccino, it was necessary to say goodbye to the barman at least five different ways—*"Ciao! Ci vediamo! A domani! Buona giornata! Arrivederci!"*—before stepping back



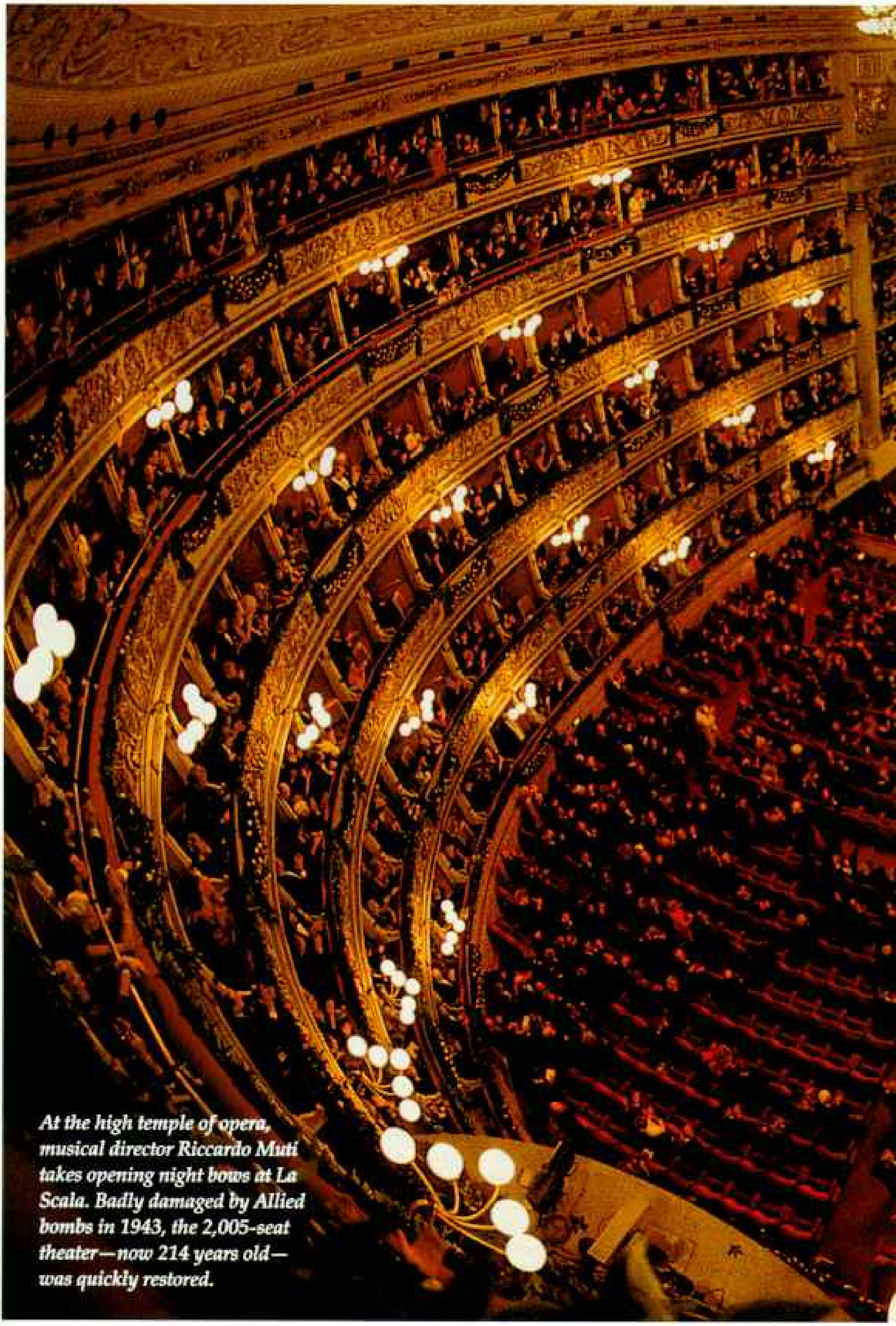
onto the sidewalk with a clear conscience.

The Milanese are also incurably modest. I asked many of them if, considering their city's substantial economic weight, they thought Milan could become the capital of a unified Europe. Invariably, they laughed, shook their heads, and said things like "Milan? The capital of Europe? Are you out of your mind?" But then they would usually add that Milan will certainly become one of the important centers of the new Europe, alongside London, Paris, and Berlin.

I heard this response from Cesare Mazzonis, then the artistic director at Il Teatro alla Scala, the majestic opera house where such legendary operas as Puccini's *Madama Butterfly* opened. In his office above the stage, I asked Mazzonis if he was confident that La Scala would remain the premier opera house of Europe. Mazzonis, a gentlemanly figure, who speaks English in flawless Oxonian tones, allowed a modest laugh to escape and said, "La Scala is only one of the premier opera houses of Europe. After all, you have London, you have Paris, you have Vienna."

Then he quietly added, "But it will certainly remain one of the most important theaters."

Earlier this year Rome outraged the Milanese operatic community when it demanded that state-run La Scala give back Mazzonis' last six years of salary because the maestro did not hold a requisite Italian degree in music—a requirement, many were quick to point out, that even Verdi would not have been able to meet. In the end, La Scala did not have to return the money, and Mazzonis, who had already found a job at the Teatro Comunale di Firenze, moved on.



At the high temple of opera, musical director Riccardo Muti takes opening night bows at La Scala. Badly damaged by Allied bombs in 1943, the 2,005-seat theater—now 214 years old—was quickly restored.

Immigrants, once welcome in a city needing laborers, face a vicious backlash from Milanese feeling overwhelmed by a flood of newcomers since 1980. Beaten by a policeman for sleeping in a railway station, this Tunisian did not seek medical aid, fearing deportation. Bulgarian squatters (right) found their camp and belongings bulldozed in a dawn police raid.

MILAN, with its newfound success, has within the past decade become a choice destination for those seeking opportunity. During lunch at a fast-food restaurant, I struck up a conversation with a group of post-adolescents dressed in business suits. I learned that they were all working at the same marketing firm. There were seven in all, and five of them had come to Milan from the south. When asked why they came north, one of them simply said, "Because the money's good."

As with young people in Japan, this newest generation of Milanese has wriggled out of a kind of hair shirt of self-doubt. Unlike their elders, they are used to the idea of Italy—one of Europe's poorest countries at the end of World War II—as now being one of the world's elite economies.

During the 1980s about a million immigrants came to Italy, and naturally many headed for the prosperous north. There is no official estimate for the number of foreigners living in Milan itself, but Lombardy, with a population of almost nine million, counted 152,000 immigrants in 1991; roughly half the newcomers were from developing countries. No one knows just how many illegal immigrants there are in the region.

Talking about the recent influx, Maurizio de Angelis, a 25-year-old employee of a construction company (who used his savings to vacation in California), said, "Of course they want to live here. They see us the way we used to see the Americans."

One day I rode the subway out to Molino Dorino, a settlement in the Gallaratese area of the city where about 500 North Africans and

several Gypsy families were squatting in a makeshift village of trailers.

I walked into the settlement, which is really just a parking lot in front of the subway station. Beside a line of portable toilets some shirtless men were bathing in a row of open-air sinks. Down an alley, men sat in the doorways of campers, smoking cigarettes and staring blankly; rats fed on the garbage strewn in the muddy earth. I turned into another alley, and I heard Arabic music from inside a camper. Then I saw a man, dressed in ill-fitting trousers with a safety pin for a button, striding toward me. He stood squarely in front of me.

"What do you want?" he asked in thickly accented Italian.

"I want to have a look around," I replied.

"There's nothing to look at here."

Others appeared, all of them young, male, and North African. They stood behind the first man. There were at least a dozen others who stepped around the man in charge, gathering about me. One of them, a teenager with no teeth, grabbed my notebook from my hand.

"What is this?" he asked in French.

"Notes. I'm a journalist."

The man in charge snatched the notebook, flipped through the pages. Then, using a lot of strength, he ripped out all the pages with writing. He nodded, and two others grabbed my arms. They pulled me down the alley, toward an opening in a chain link fence.

From behind me I could hear the man's rough, angry voice: "You want to look? Look at how we live! Like animals! You bastards think we should live like animals! And when it rains, the rubbish and the rats swim straight into our campers! Bastard Italians!"

The two men shoved me through the fence, into the road. Then they waited, trying to look as menacing as possible, so that I wouldn't try to turn around and come back. Just beyond the station I saw a looming billboard showing a state-of-the-art videocassette player. Written below it in simple yet tasteful script: "*Dedicato a chi non ce l'ha*—Dedicated to those who don't have one."

MASSES OF PEOPLE from southern Italy began coming to Milan in search of jobs immediately after the war. I spoke to a young man whose parents brought him from Sicily when he was three because they had new jobs on the assembly line at Alfa Romeo. He is now a second-year student at Bocconi, one of Italy's top business schools, in Milan. "Milan is a boomtown because of people like my parents, who left everything to come and work for this city's prosperity," he told me.

But some Milanese have grown tired of outsiders like the business student and his parents. And one political group, called the Lombard League, has taken advantage of this discontent and capitalized on the north's traditional dislike of the south. During last April's national elections, the Lombard League staged a campaign in which voters railed against immigrants from both abroad and the south.

In the passionate months before the election, an angry crowd blocked city bulldozers at the site of a proposed shelter for North Africans. In another incident, residents chased away Gypsies the city had allowed to settle in a closed factory while league members brandished signs reading, "We don't want Gypsy thieves among us even for one day."

The party won nearly 9 percent of the vote nationwide and more than 20 percent in Lombardy. In Milan the league's showing was especially strong—much stronger, in fact, than that of the Socialist Party, which had monopolized power since the 1950s. Critics claim that ballots cast in the league's favor were mere "votes of protest"—a cry of dissatisfaction.

When I suggested this to Umberto Bossi, the raucous leader of the Lombard League, he rolled his eyes. Crushing a cigarette into an ashtray and immediately lighting another, he said, "Any party that is in opposition to the ruling party is a protest party. But we also have a proposal—federalism." As a panacea, mostly for what the league perceives as the adulteration of Milan by less affluent southern countrymen, Bossi proposes to divide the country into three separate republics: North, Central, and South.

The same kind of scorn that New Yorkers feel for Washington, Milanese feel for Rome. And many imply that immigrant workers from the south have brought inefficiency into Milan, like a foreign virus. They complain about

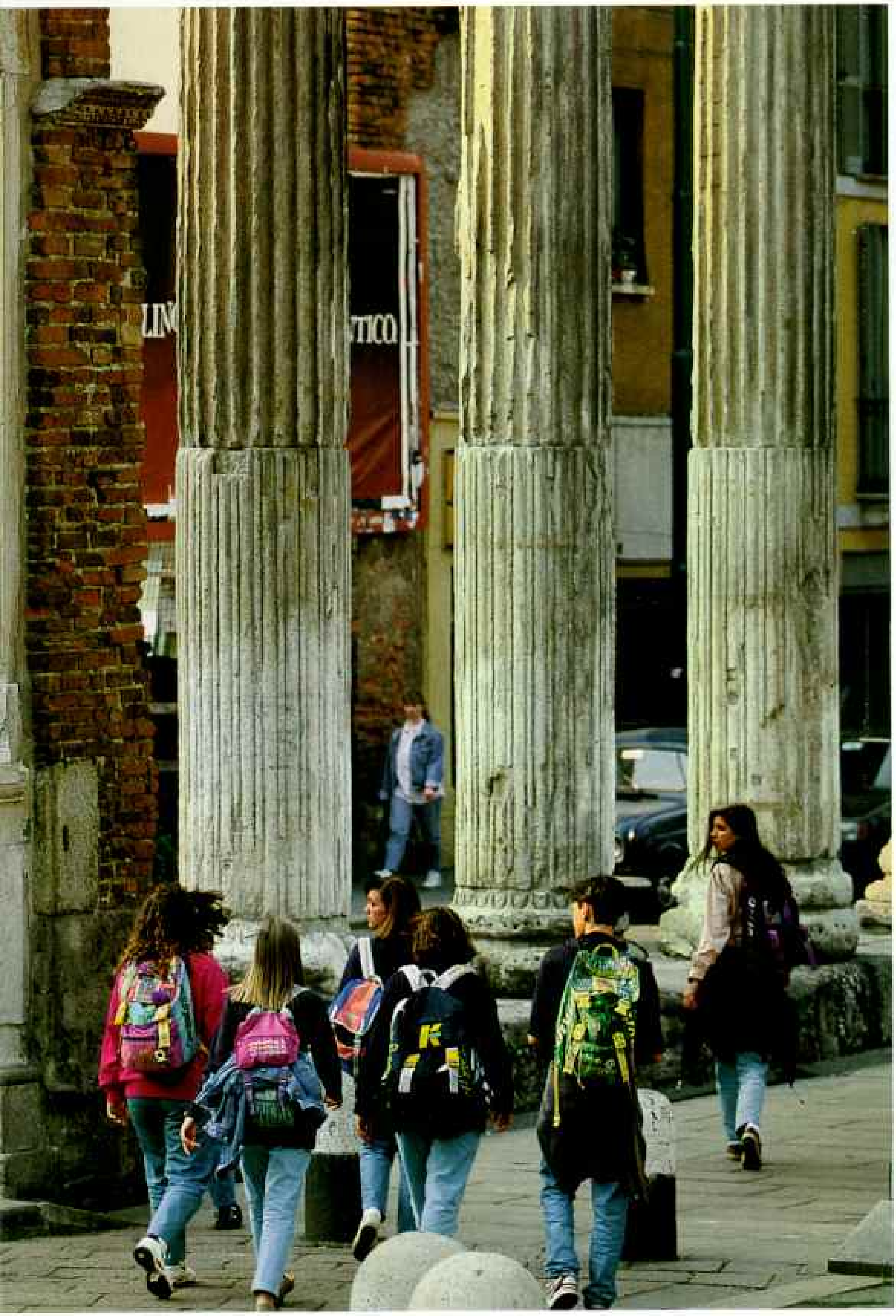
Heroin addicts shoot up in a new subway tunnel at the main railway station. They share needles, a practice that spreads HIV and helps make Milan Italy's AIDS capital.

"un'infiltrazione mafiosa"—an infiltration by the Mafia, referring more to laziness and corruption than to cement shoes and broken kneecaps.

The extent of the corruption became shockingly clear last winter when the Socialist head of a venerable Milan charity was caught accepting a $5,000 bribe for a contract for cleaning a nursing home. The incident touched off one of the biggest scandals in recent Italian history. By August more than 70 prominent politicians and businessmen had been arrested for taking similar payoffs, or *tangenti*. The investigations, which involved almost every major municipal public works project of the last decade, revealed that contractors routinely paid public officials huge kickbacks—money often deposited in Swiss bank accounts and used to fund political parties.

The tangenti scandal has shaken Milan's image of itself. Giorgio Armani, for one, yearns for a more genteel, provincial Milan that he claims no longer exists. The designer, whose worldwide fashion empire helped bring Milan into the international spotlight, received me in his airy studio on the Via Borgonuovo.

Signs of the times in the Ticinese neighborhood convey the layered character of Milan. Icon of commercialism—a billboard for a bra as "soft as skin"—makes a modern statement, as do jeans-clad teenagers sauntering past a crucifix and ancient Roman columns.



Still under wraps, full-size models herald the next class of Alfa Romeos. Milan's prestigious auto company, dating from 1910, was purchased by giant automaker Fiat in 1986. Under the gaze of Renaissance princesses, architect Cesare Casati treasures his office in Palazzo Borromeo, home of a 16th-century cardinal.

Fit and tanned with neatly groomed white hair, Armani shook his head, clucked his tongue, and told me, "The Milan that we all used to know, Milan with its gentle atmosphere and subtle flavors, has become utterly irretrievable. The human face of this city has vanished. Everything has become small, constricted, commercialized."

Armani was referring to what many Milanese have called a trend toward yuppyism. One woman described it to me as "*Madison Avenuismo.*"

The waning influence of modern Milan's original patrons—the industrial bourgeoisie—has created an atmosphere of panic for the older generation. For as the city has become more international, the inescapable problems of the postmodern world have proliferated.

Walking through the central train station, one gets a dark glimpse at the city's newly transformed underbelly. Superficially, the Fascist-era building is a benign setting for commuters on the go. Responding to the echoing calls for trains to the suburbs and prettier locations beyond, yuppies with briefcases and teenagers with backpacks swarm through the vaulted halls. Yet just beyond the massive, wedding-cake structure lies what one station guard called "Hotel Hell"—the disused railway cars that serve as transient homes for the city's down-and-out.

Wandering along the maze of steel rails that lead from the Stazione Centrale, I find a neglected railway car. An old placard on the side indicates its destination as Florence, but this car is going nowhere.

Climbing inside, I see a pair of huddled figures in the long, unlit passageway. They seem

indifferent to my presence; they are more preoccupied with passing a hypodermic needle between them. One is a boy, the other a girl, and both are under 20; they are dressed like many other young people in the streets of Milan, in jeans cinched with cowboy belts and bright paisley T-shirts. I try to start a conversation with them, but they just regard me with half-closed eyes.

A few moments later I hear a clatter of high heels and, looking up, see a tall, dark-skinned girl wearing a red miniskirt. "*Ciao, bello!*" she says in a surprisingly husky voice. The girl, who is actually a boy, glances at the couple, who are reclining, limbs limp, between us. "There's no point trying to talk to them," he says, kicking away a used needle with the toe of a pointy pump. "Not for the next 24 hours, at least."

I ask the boy in the miniskirt if he lives here. He nods. "Like it?" he asks.

"Do you?" I reply.

He shrugs, adjusts his bra.

"It's all right. There's another working girl here too, so I have company. And the smack heads don't bother you much. But now we've got all these Albanians moving in, and they're ruining the place. You always have to keep an eye on your stuff with them around."

He takes a compact out of his purse and touches up his lipstick. I ask where he's from, and snapping the compact shut, he says, "Peru." He then tells me that he's been in Milan for six months, working at night in front of the Stazione Garibaldi. I ask him if he takes precautions against AIDS. "Oh sure," he says.

With more than 2,000 AIDS cases—one-sixth of all those reported in Italy—Milan has

the unfortunate distinction of being the country's AIDS capital. About 70 percent of those who have tested positive for HIV in the city contracted it through intravenous drug use.

In Milan, where cocaine never caught on and crack is almost unheard of, heroin remains the drug of choice. What is the typical profile of a Milanese heroin addict—poor? rich? young? old? jobless? gainfully employed?

"We get everybody in here," said Riccardo Gatti, director of Servizi Tossicodipendenza, a public drug-rehabilitation center. "It's impossible to give you a profile of the typical addict." Dr. Gatti, a large, sweet-tempered man with a picture of himself in front of the Statue of Liberty on the wall of his simple office, said, "Ten, twenty years ago, Italians would return from trips to places like Amsterdam and remark in scandalized voices about the rampant abuse of drugs there. 'Something like that could never happen in Italy,' they would say. 'Our family structure is far too strong.' But now look at us. The problem is perhaps worse here than it is there."

SUNDAY AFTERNOON and the subways are packed. I am riding toward Monza when the train pulls into a station at Piazzale Cadorna, and the claustrophobic car suddenly empties all at once. Instead of following through to my destination, I get off and tag along behind the crowd.

I follow them up out of the station and see the Castello Sforzesco, the massive, turn-of-the-century reconstruction of the Sforza family's 15th-century palace. But instead of going into the museum that is housed there, the crowd passes right on through the castle's

*At a hot springs spa in nearby Sirmione, vapors from mineral waters relieve respiratory ailments that many attribute to Milan's pervasive air pollution. The city's sick sky—*cielo malato*—is blamed on 1,150,000 vehicles. Spot-checking diesels, city police measure the darkness of the smoke and hand out stiff fines.*

labyrinthine courtyards to the Parco Sempione.

The park is as crowded as the subway. On the lawns that stretch before the Parisian-looking Arco della Pace, sweaty soccer players wage vociferous games. A few half-dressed sunbathers dreamily look on, and a Bangladeshi couple play catch with their kids.

Emerging from a lane, I hear the sound of drums and an electric guitar. Following the music through the trees, I come upon a trio of young Milanese dressed in African-American fashions. The lead singer, a beefy teenager wearing an oversize leather cap and an enormous clock around his neck, struts around, breathlessly rapping in Milanese dialect.

I spot an elderly couple dressed in aristocratic tweeds approaching along the gravel path. Polished walking sticks in their fists, they pass by with stony faces.

I end up spending the day at the park, listening to the rap singers, watching the soccer games, having a picnic lunch on the thick grass. And as I sit in the sun talking to passersby, I realize that this is the only group event I've witnessed. In a city where a piazza culture does not exist, the park is the playing field for the city's citizens on the one day they're obliged, as Catholics, to take off. Yet it occurs to me that the Sunday crowds are not so much an example of civic togetherness as an excuse for isolated groups of citizens to carry out private activities in one big public space. The lovers have staked out their territory, the athletes theirs, the drug pushers theirs, and not once during the long, lazy day did I witness any kind of interaction among them.

Despite the pleasantness of the scene, I'm reminded of what Giorgio Strehler, director of

Like fanatics in a revolution, the rowdiest of 84,000 soccer fans set off smoke bombs at San Siro stadium. The black-and-red banners honor team Milan, national champions in 1992. Other colors represent Italy and the home city.

Italy's most prestigious theater, Il Piccolo Teatro di Milano, said recently: "Italians no longer know how to be one," he complained. "We seem sick with loneliness. The only way to have a collective experience today seems to be to sit together and watch the same soccer game or the same show on TV."

YET SOME MILANESE don't see things so pessimistically. One of the city's staunchest optimists is Italy's famous entrepreneur, Silvio Berlusconi. Proprietor of three private television networks and owner of a champion soccer team, Berlusconi has almost single-handedly turned Milan into one of Europe's most important audiovisual markets. I visited his villa outside the city to ask for his forecast for the Italian economy. Wearing a zippered track suit, he greeted me in a gilded drawing room and said, "The only segment of the Italian economy that can be said to be in any kind of crisis is big business. And these big enterprises, whether public or private, have found themselves in a tight situation basically because of bad management and lack of ideas. Small- and medium-size businesses, on the other hand, are healthier than they've ever been."

Others see a bright, new role for Italy after the economic integration of the continent. Milan's historical connections and strategic geographic position could make it a pivot between

Western and Eastern Europe, as well as southern and northern Europe.

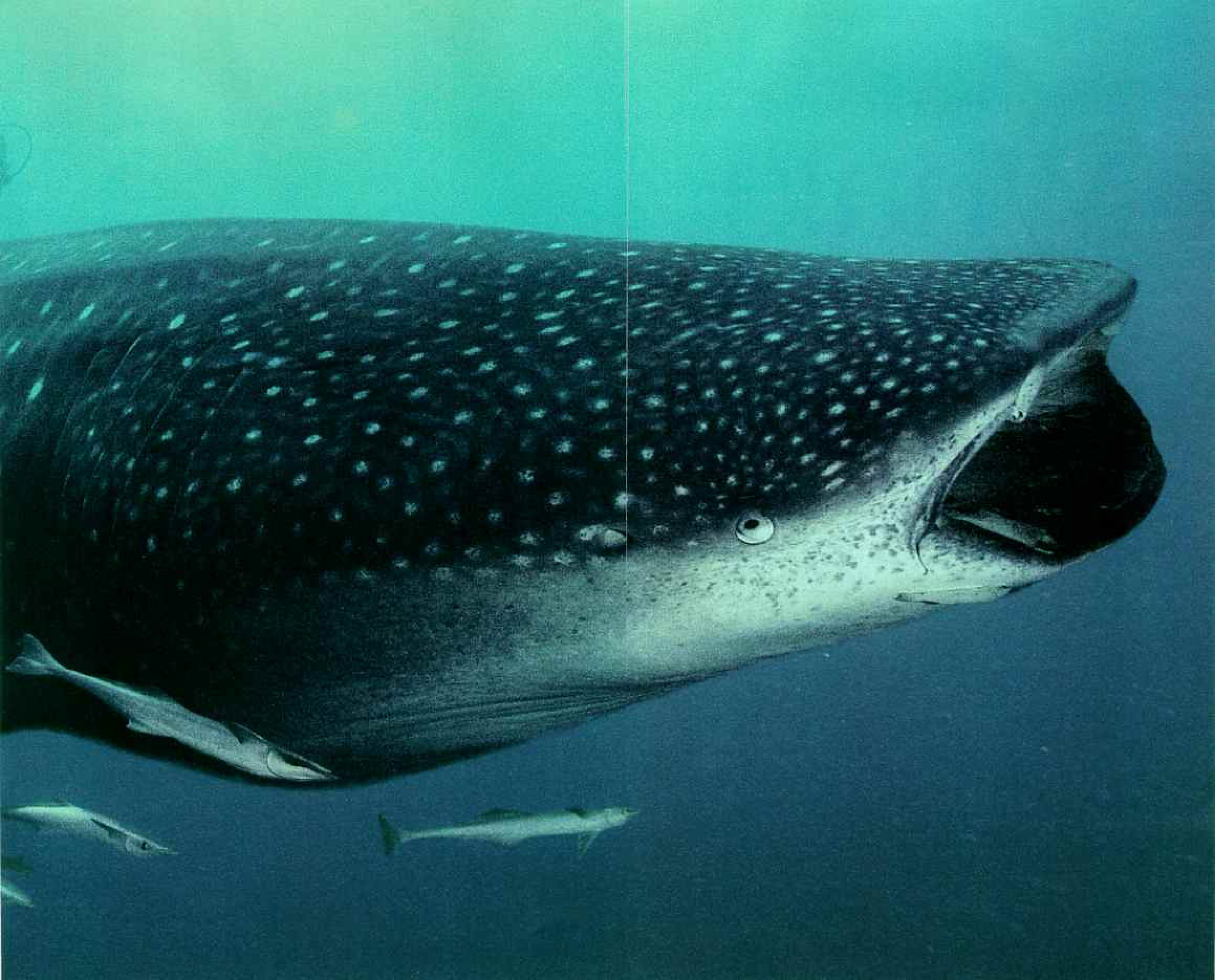
"Before the events in Eastern Europe, Italy's principal task was to join the European Community," says Piero Bassetti, president of Milan's chamber of commerce. "Its role would have been, at best, to represent the interests of the southern half of the continent. Now Italy's role has changed.

"If Italy decides to take advantage of the opportunities that are opening up in Eastern Europe, then I believe that our economy can become as dynamic as Germany's," Bassetti adds. "In fact, it will be our only guarantee that Europe does not become just one big appendage of Germany. And it is up to Milan to decide upon and to pursue this course."

Survivor from the 13th century, the Naviglio Grande canal long carried freight, including marble for the duomo. With a glance at the past and a perfunctory bow to Rome, Milan rushes on with its own sense of style.

And as Inge Feltrinelli, an influential German-born publisher, told me, "Italians are experts at creating out of chaos. They always have been. For decades I've been hearing, 'Italy cannot go on.' But it always does. There's been one hopeless government after the other, but Italy just keeps producing."

Feltrinelli paused, smiled. "Or perhaps I should say Milan keeps producing." □



Gentle Monsters of the Deep

Whale Sharks

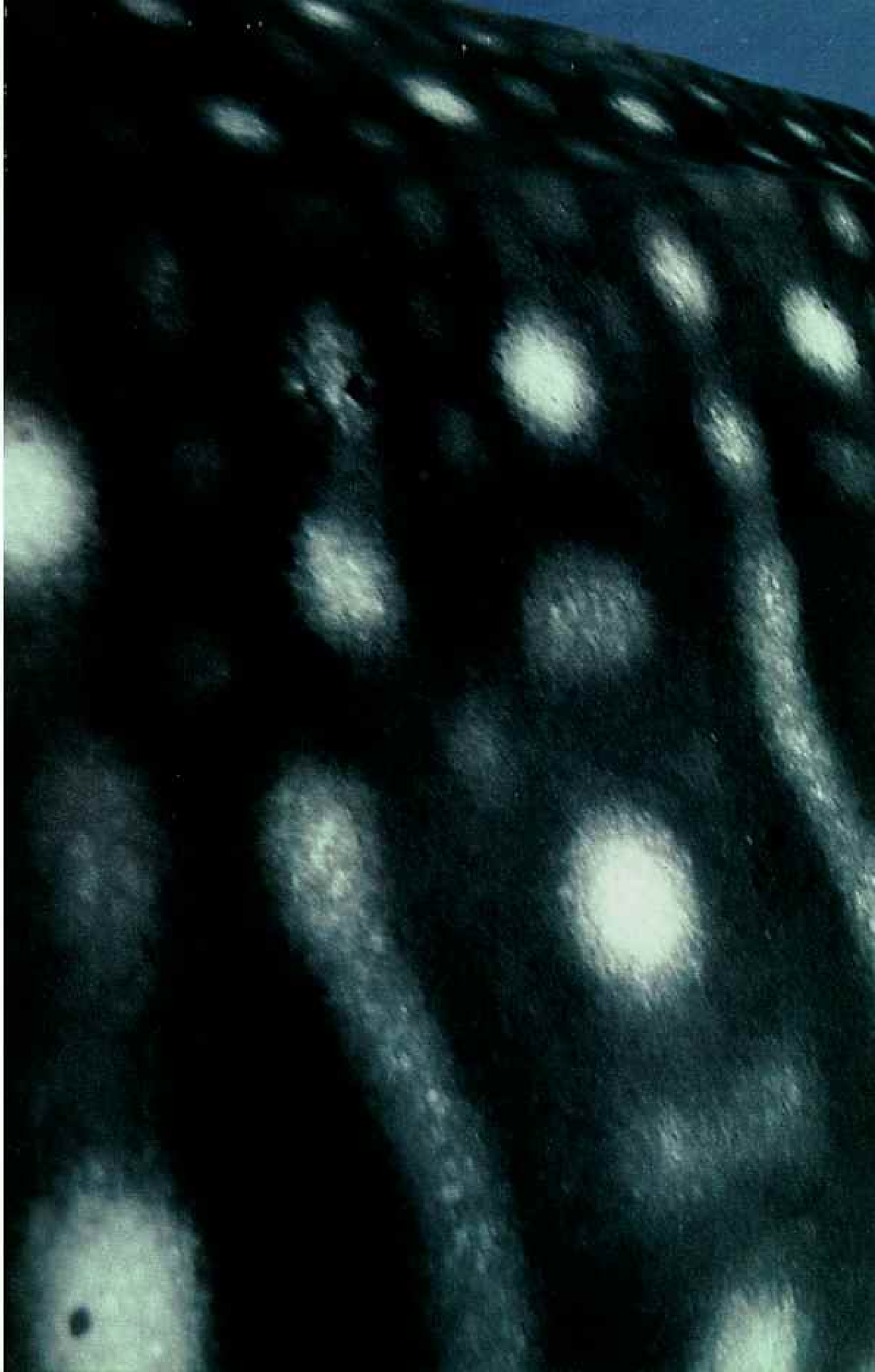
By EUGENIE CLARK
Photographs by DAVID DOUBILET

OUT OF THE DEEP BLUE GLOOM our quarry emerges, all 30 feet and ten tons of it: The giant whale shark is only a few yards away, swimming toward us. Photographer David Doubilet and his assistant, Gary Bell, swim to position themselves directly in front of the oncoming fish, so they can photograph its enormous mouth working as it feeds. (No real danger here because, incongruously, this huge shark feeds on plankton—mainly shrimplike krill—and small schooling fish.) Rodney Fox, a shark naturalist, monitors the dive time as I swim toward this member of the species *Rhincodon typus*—the largest fish in the world—to study it up close.

As we move in, the whale shark begins to alter its course slightly and go deeper, the typical evasive behavior when divers approach. Because of its great size and the featureless blue background of the open sea, the fish appears to be floating in space. Swimming as fast as I can, I *just* keep up with it, but not for long.

My hand trails down the massive body, over the thick, hard, textured skin. The shark feels almost inanimate, like a wooden submarine. To stay with it longer than I can by swimming, I propel myself up toward its dorsal fin. There I find a handhold. Under the trailing edge

Like an oceanic space ship, a 35-foot whale shark as big as a gray whale cruises off Western Australia with the author in tow (preceding pages). The brightly dappled creature is a true shark, with gills for breathing, yet it usually consumes nothing larger than anchovies.



of the fin, where it joins the body, the skin is soft and white and scaleless. On this big a specimen, the skin is folded and easy to grip.

The shark feels my touch and speeds up; I feel the water pressing hard against me. It is as though I am being towed through the water by a bus. I dare not look behind, for fear of having my face mask ripped away. David and Gary are off to one side of the shark's head now, swimming along and shooting pictures. They are being pushed by the bow wave created by the moving mass. Still, I wonder how they can keep up. Soon, they can't.

I release my grip and watch the vast, spotted creature sink slowly into the depths. I look over at David and see through his face mask that he has opened his eyes wide in a silent *Wow!* As we drift up into the light near the surface, he gives me a clenched-fist salute.

This is why we have come halfway around the world to Ningaloo Reef in the tropical Indian Ocean off Western Australia: to dive with, photograph, and learn more about the rare and spectacular whale shark. The whole dive lasted only three minutes. Of that time, perhaps one minute was spent with the shark.

No wonder little is known about this magnificent animal, so unlike other sharks and even less like air-breathing whales, mammals whose name was borrowed because of their size. Most of the time, when whale sharks are seen at all, they are found traveling at the surface in enigmatic solitude.

Few marine scientists have had more than a handful of fleeting encounters with whale sharks. Many have spent whole careers diving in tropical seas without ever finding one. No one knows how many exist, but nowhere are these fish abundant.

Before this April day at Ningaloo Reef is done, David and I will be lucky enough to meet 20 of the elusive giants. We had dived with a whale shark only once before, ten years earlier, off Baja California. It was the first either of us had seen. At least 50 feet long, it's still our biggest, and the biggest ever photographed.

OBSESSED WITH WHALE SHARKS, Eugene W. Gudger of the American Museum of Natural History in New York City spent much of his life documenting every instance where sailors and fishermen had reported ramming, impaling, or harpooning one. In the early 1930s he concluded that whale sharks originated in the seas around the Philippines and rode the currents to distant waters. In the 1980s Fay Wolfson, a zoologist at the Hubbs Sea World Research Institute in San Diego, took up where Gudger, who died in 1956, had left off. She published detailed records of the sightings, catches, and sizes of whale sharks around the world. Wolfson also became intrigued with how they are born, a mystery that still remains unsolved five years after her death.

A circumtropical fish, the whale shark may be encountered in a band around the Equator extending to roughly 30° north and 35° south. Whale sharks also travel to higher latitudes in warm currents such as the Gulf Stream or Japan's Kuroshio, and occasionally they

Broad enough to swallow two divers, the mouth of a whale shark—unlike those of most sharks—spreads across rather than under the front of its face. Nostrils, about four feet apart, look like eyes. Barely visible, rows of thousands of tiny teeth

Marine biologist EUGENIE CLARK, Professor Emerita at the University of Maryland, has written 12 articles on undersea life for NATIONAL GEOGRAPHIC. The author of three books, she is also a frequent contributor to the Society's scholarly journal, RESEARCH & EXPLORATION. Dives around the world by DAVID DOUBILET, who lives in New York City, have yielded photographs for more than 30 GEOGRAPHIC articles.

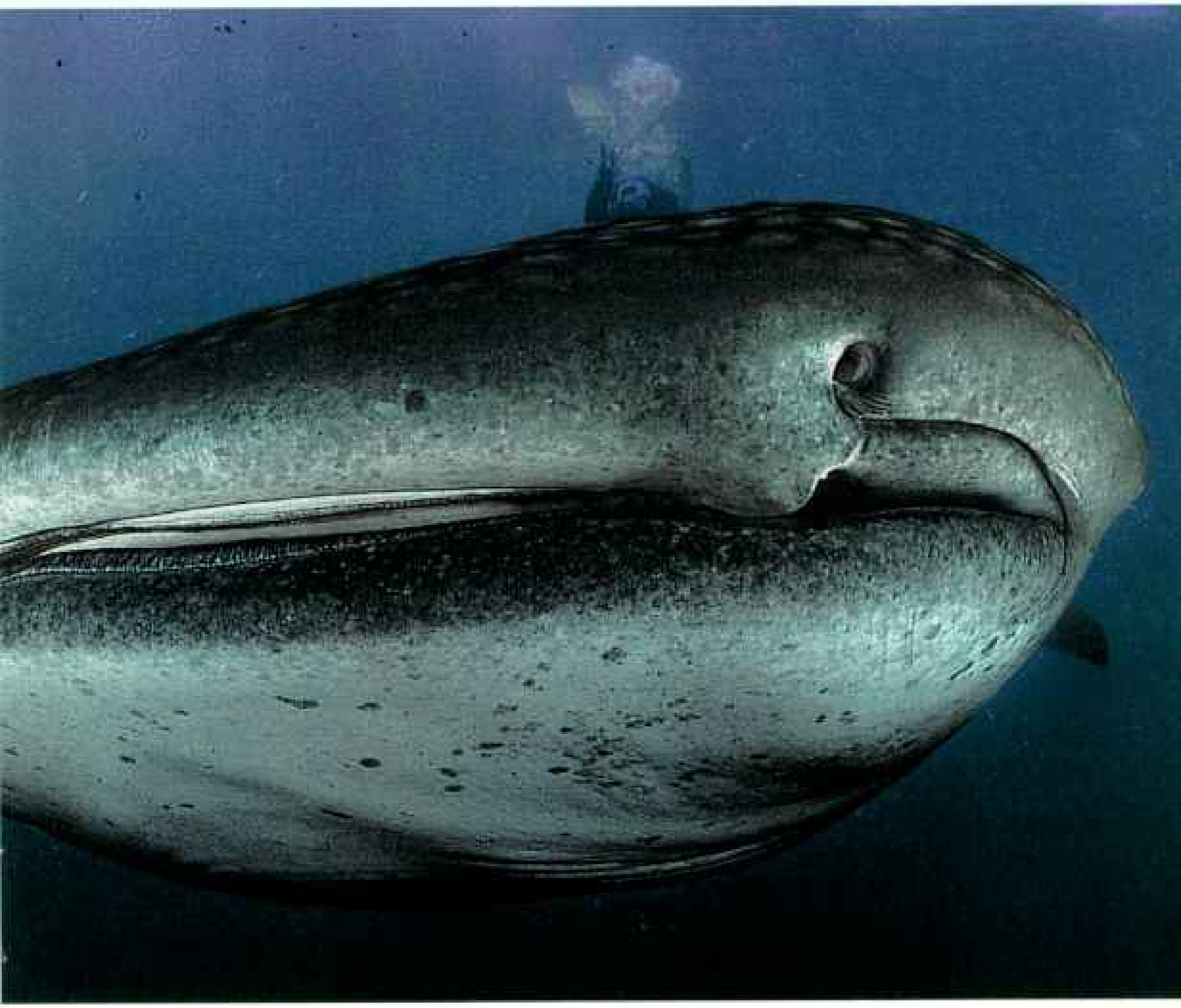
stray into temperate seas. But they seem to prefer surface-water temperatures in the 70s or low 80s where cool, nutrient-rich currents mingle with warm, plankton-laden waters. Conditions are ideal at Ningaloo Reef, where the edges of the Leeuwin current are sharply demarcated by clear blue water on one side and cloudier green water on the other. At Ningaloo the ocean is alive with food.

seem to serve no function for the shark in catching its food—small fish and shrimp engulfed by the barrelful between open jaws. Should it accidentally ingest large objects, the shark might eject them by turning its stomach out of its mouth.

The extraordinary chain of events that brought in so many of these monsters of the deep began the night of March 8, 1991—the tail end of summer in the Southern Hemisphere—when the water over the reef was turned into a rich soup by the mass spawning of corals. Millions of tiny packets of eggs and sperm popped out of coral polyps toward my face. I had never dived during a coral spawning. It was like watching a Mardi Gras in miniature where all the inhabitants were releasing pink and white helium-filled balloons.

Soon polychaete worms emerged, a writhing multitude in the beams of our lights. Some of the half-inch to five-inch worms were red; others, emerald green. Perhaps they were spawning too. The worm mass became so dense I could no longer see the reef.

When we came up from our first night dive, around eleven



o'clock, most of the coral-spawn balloons had already broken up, scattering the individual eggs across the surface and producing oily pink slicks that filled the night air with a strange aroma that was both sweet and acrid: rose petals and tincture of iodine.

It was Chris Simpson, the respected coral scientist, who in 1984 discovered the mass spawning of the Western Australian reefs. He found that the extravaganza occurs every year, usually a week or so after the March full moon. Every third year, though, when the full moon rises early in the month, some corals do not spawn until one lunar month later. This year happened to be the third in the cycle, bringing two explosive coral spawnings and the consequent sudden, huge pulses of protein in the ocean. A bumper crop of plankton and dense schools of tiny fish in the herring family soon appeared. Within a few days the very large plankton feeders arrived: minke whales, manta and mobula rays, and the intriguing fish we'd come so far to see, whale sharks.

Thanks to Geoff Taylor, a physician in Exmouth, a town near Ningaloo Reef, we knew that March and April were the best times to see whale sharks here. Geoff has been studying whale sharks in this area for 12 years, and he believes that although these sharks can be found along the 160-mile-long reef any time of year, they usually come in large numbers after the corals spawn.

AT FIRST just a few whale sharks showed up each day to feed on the food suspended in the water around the reef. Then, more and more arrived, peaking after the second coral spawning. With the help of aerial surveys, we made 285 shark sightings during the peak days from March 22 to April 22. But we knew many of these were repeat sightings, because the sharks were constantly cruising the same area in search of food.

Wearing mini scuba tanks made it much easier to drop from and climb back into the Zodiac, our dive boat, as we pursued shark after shark. The tiny tanks could be refilled quickly, but they didn't hold much air. "Remember, don't go deep!" David warned Gary Bell and me before our first whale shark dive. "We've got lots of whale sharks around. No one go below 50 feet. Check your air."

When the voice of Peter Arscott, pilot of the spotter plane, came crackling over the radio on our 55-foot fishing vessel, *Nordon*—"Whale shark ahead! Half a mile"—we all leaped into action. Captain George King threw the *Nordon*'s throttle forward. As the boat picked up speed, David, Gary, Rodney, and I struggled into our wet suits and tanks and gathered our cameras and other gear.

Soon George eased the throttle, and the Zodiac was drawn up next to the stern so we could climb aboard. Double-checking our gear, we raced over to where the shark had been seen. The Zodiac's pilot, Gary Jeisman, operated the motor while holding a walkie-talkie to his ear, taking directions from the spotter plane and the *Nordon*. "I can see him!" he shouted, confirming visual contact with the shark. We were

Surf breaks against Ningaloo Reef off Exmouth, Australia, where the autumn coral spawns prompt the largest observed gatherings of whale sharks. The habits of this rare species remain largely unknown.


EUROPE
ASIA
JAPAN
NORTH AMERICA
AFRICA
Pacific
Ocean
Atlantic
Ocean
Indian
Ocean
SOUTH AMERICA
EQUATOR
TROPIC OF CANCER
TROPIC OF CAPRICORN
Exmouth
AUSTRALIA
Ningaloo Reef
Range of whale sharks
Documented sightings, 1800 to present
Ocean current

closing rapidly on a huge dark gray dorsal fin cutting through the water some 50 yards away. "OK, get in the water," Gary said. "Come on, go, go, go! He's coming right at you." And over the side we flipped.

We were swimming with a young 20-foot whale shark. It was an exquisite animal. The clean design of its two-inch-diameter white dots—the most spectacular, yet perplexing, color pattern of any shark—was dazzling, like a set of dark-blue-and-white dominoes. Typical of most fish that swim in the well-lit zone near the surface, the whale shark is darker above than below, countershading that causes it to blend into its surroundings when viewed from any angle. Dots, stripes, and bands on a fish also tend to camouflage it from both predators and prey, advantages that seem superfluous to a creature that has virtually no natural enemies and does not need to stalk its food.

I swam alongside the shark, awed by its gracefulness. David was still looking through his viewfinder, lost in taking closeup portraits of the shark's head, when I dropped back and watched the shark slowly descend. I noted on my depth gauge that we were already below a hundred feet.

As corals begin to spawn along the Ningaloo Reef, globules harboring eggs and sperm burst by the millions from the polyps. Some produce larvae for new communities of coral. But most end up as stock in a rich soup of plankton that last year drew scores of whale sharks.

WE WERE ABLE to study the whale sharks close at hand, underwater and from the boat. Both Geoff Taylor and Rocky Strong, an American biologist who was with us, tagged a few whale sharks, but equipment problems prevented tracking them for more than a few days. Still, the tags showed that the sharks were not moving out of the area immediately after feeding. Distinctive scars enabled Geoff to identify individual fish, and, like fingerprints, the varied white spots and lines on their backs also distinguished individuals.

On average the whale sharks were about 25 feet long and weighed eight to ten tons. Most reacted to our close presence by turning away and heading deeper without any overt show of alarm, using great, slow beats of their tails. One "baby"—a 12-footer—disappeared quickly into the depths. No one yet has any idea how deep whale sharks go.

It's hard to predict how the sharks will react to people. The larger fish are more tolerant of the human touch; they even appear to enjoy it. Certainly the biggest shark we saw—a 32-footer—didn't seem bothered by the divers at all. It came along when I had just left the water and shed my diving gear. I watched from the deck of the *Nordon* as the shark basked at the surface, allowing Geoff to stroke the soft skin under its throat and David to shoot photographs of the inside of its mouth. It stayed for 30 minutes. Occasionally a shark would power-dive away, especially if anyone touched its tail.

Some of the whale sharks had distended bellies, as if they were pregnant females. But they all turned out to be young males, their stomachs gorged with food. Every time we dived with them, I tried to check their pelvic fins from underneath. Only one had fully formed sexual organs, claspers more than a foot long, and these were swollen and ragged, as if the shark had recently mated.

ALTHOUGH WHALE SHARKS are generally docile and are considered harmless, four "attacks" on fishing boats have been recorded in the Mauritius-Seychelles area. One report tells how the shark headed straight toward the boat with its mouth wide open, hit the boat astern, and turned it around. Most likely the animal was busy feeding, oblivious to the presence of the boat.

Not a single incident has been reported at Ningaloo, where increasing numbers of visitors are taking to the waters for the thrill of a shark ride. Conservationists worry about the effects of all the human contact, and there is talk of legislation to regulate diving with whale sharks and perhaps ban riding on them. Such a ban would be difficult if not impossible to enforce.

"I think it's better to educate people that the sharks will hang around a lot longer if they're not touched," says Geoff Taylor. "It's rare to see sharks feeding during the day, so any human interference is unlikely to affect them unduly. But it may condition them to avoid boats altogether and effectively destroy the whale shark tourist resource."

At night great swarms of marine worms, their bodies glowing red through the author's light, also emerge from the reef, enriching the broth. "They were disgusting," says the photographer, who reports that they somehow managed to infiltrate his wet suit.

I had never before seen whale sharks feeding, so I was delighted to be able to confirm with my own eyes what Senzo Uchida of the Okinawa Expo Aquarium discovered in 1982 when he became the first person to successfully feed a whale shark in captivity. Unlike the basking shark, *Cetorhinus maximus*—the second largest fish and also a plankton feeder—the whale shark feeds actively, purposefully. The basking shark swims through the sea, its great mouth agape, passively straining food it encounters as several thousand gallons of water per minute flow over its erectile gill rakers.

In contrast, the whale shark seeks out its food. Swimming slowly at the surface toward a dense ball of plankton or anchovies, it speeds up and opens its mouth as it nears the target. As it swims through the massed food, moving its head from side to side "like someone vacuuming in the corners," David says, it sucks in all or part of the cloud of bait. Sometimes the shark will come almost to a stop, hanging with its tail down and pumping up and down in the water as it sucks in food—a characteristic Eugene Gudger wrote about as early as 1941.

After I left to return to the United States, David and Gary had a

Under attack by diving seabirds, a living cloud of anchovies reacts like a single organism. With uncanny coordination, the school of tiny fish—a favorite meal for whale sharks—folds in upon itself, creating empty hollows under hungry beaks.

GARY BELL

remarkable experience watching whale sharks feed. Here's how David described it to me:

"Gary and I were in the water when we spotted a great brown patch of krill. Suddenly Gary hooted through his mouthpiece and pointed. Two whale sharks materialized out of the gloom, swimming rapidly about 20 feet apart. We were below them, so we couldn't see their open mouths, but we could see their bellies getting big as they went up, gulping mouthfuls of krill.

"Then they were gone, and so was most of the krill, as if two great reaping machines had passed through a field of grain."

The whale shark's unusual digestive anatomy lends itself to Jonah stories. It is easy to imagine yourself being inadvertently sucked into a whale shark's mouth, which is huge and "terminal"—located at the front of the head. (Most sharks have underslung mouths that open beneath and behind their snouts.) You wouldn't even notice the more than 3,000 teeth in each of the jaws, because they are tiny—less than a quarter of an inch long—and are covered with a skin flap, or velum. The cavernous mouth of even a small adult whale shark could easily accommodate a pair of Jonahs.

You wouldn't stay long in the mouth but would be swept or sucked along to the pharynx, or throat, where pathways for water lead out of the ten gill slits. Unlike the throat of any other shark, or for that matter of any of the other 25,000 or so species of fish, the top and sides of the whale shark's throat form a complex, giant "colander" composed of five pairs of gill plates, essentially grids of cartilage. These are covered with a dark, spongy material and have openings no larger than a tenth of an inch in diameter. The grids form a wall that would prevent the escape of an anchovy through the gill slits, let alone a human.

When the shark closes its mouth, the gill plates come down behind the tongue and press liquid through the spongy material and out the huge gill slits. You might feel the beating of a huge heart through the floor of the pharynx as the back of the throat opens and all the concentrated krill, small fish—and you—wash down through the esophagus into the immense and elastic banquet hall that is the cardiac stomach.

You could not swim back against the intake flow because every 15 or 20 seconds another load of plankton sloshes down into the stomach. Luckily you wouldn't fit through the posterior exit either. It is so small that only chyme—liquid digested goop—can pass through to the much smaller, inelastic pyloric stomach that leads to 73 turns of a narrow, spiral "staircase" inside the intestine.

But you wouldn't necessarily be trapped in the cardiac stomach. Sharks have a nonviolent way of getting rid of large objects of dubious digestibility they swallow accidentally. In a process known as gastric eversion, a shark can slowly empty its cardiac stomach by turning it inside out and pushing it through the mouth. Once the unwanted stomach contents are expelled, the stomach is pulled back into place. So, you could come gliding out on a mucus-covered carpet, slimier but perhaps wiser for the experience.

Some species of sharks—requiem or gray sharks, for instance, and the closely related hammerhead—can rid themselves of small objects out of the other end of their gut through an extraordinary process

Perfect replica of the adult it might have become, a 14.5-inch whale shark embryo was taken from an egg case found in the Gulf of Mexico in 1953. A unique discovery, it suggests that these sharks, unlike most others, hatch from egg cases outside the mother.

Members of a solitary species, whale sharks share a brief encounter before going their own ways. "I thought we'd distracted them from mating," says photographer Doubilet. But nearly all the sharks were young males, like the 12-foot "toddler" (bottom) speeding by the photographer's assistant, Gary Bell.

On an earlier dive in the Gulf of California, the author rides what she thinks is a pregnant female, swollen with possibly more than a dozen egg cases or live embryos.

Two aquatic reaping machines soar open-mouthed through a cloud of krill near the surface. In seconds the sharks' bellies became visibly distended with the food.

called intestinal eversion. At least eight species of sharks have been observed in captivity everting their intestine through the anus and then, moments later, pulling it back into place. When Senzo Uchida dissected several whale sharks caught in Okinawa, he found that they had a "ring" intestine shaped like the spiral binding on a notebook and similar to that of a manta ray. Uchida has seen a captive manta ray evert a small portion of its intestine, but so far this has not been reported for a whale shark.

THE WHALE SHARK has a great deal more to fear from humans than we from it. Fortunately for its survival, the soft flesh commands a poor price in the market. And a single whale shark is a lot to handle. The most valuable part of a shark, the oil-rich liver, is proportionally much smaller in whale sharks. Even the tiny teeth are worthless as jewelry. Whale sharks are caught commercially in few places around the world and usually in seasons when the fishing is not good for tuna, marlin, or other higher priced fish.

In the Maldives, a spray of coral islands southwest of India, whale sharks are harpooned from small fishing boats. Local divers even claim to have roped in a shark by swimming into its mouth and out through one of its gill openings, then tying off the loop so that the fish could be towed into port. Of course, the anatomy of the whale shark makes this impossible—just another of those big-fish stories.

The Taiwanese, who probably kill and eat more whale sharks than anyone else, call it *tofusa*, "tofu shark," because its meat is nearly as soft as bean curd. In Japan the whale shark is commonly called *jinbei-zame*. The *jinbei* is an old-style summer jacket with a loose weave and a classic design that resembles a whale shark's pattern: white spots regularly spaced on a navy blue background with light lines. Some Japanese fishermen also call the whale shark *ebisuzame*. *Ebisu*, their patron, is one of the seven gods of good fortune in Japanese lore and is usually depicted as holding on to a fishing rod and a sea bream.

Tokiharu Abe, Japan's most renowned fishery scientist, told me, "Sighting a whale shark can bring good fortune to a fisherman. It is a sign that the waters are rich in plankton and are attracting plankton-feeding fish and the even more valuable bigger fish in the food chain, such as tuna. Japanese fishermen don't like to kill this good-luck shark that is named for a god."

Ningaloo Reef is Western Australia's biggest marine park, and the whale sharks and most other fish there are protected. Given the surge of interest in Ningaloo, we can only hope that whale shark watchers will not discourage the shy leviathans from congregating in the park.

Now that scientists know where they can study whale sharks, perhaps we will finally learn about their migration patterns, how deep they go, where the females give birth, and whether the females lay their egg cases or hold them in utero until they hatch as free-swimming babies.

Learning more about this gentlest and greatest of fish should lead us to a better appreciation of all sharks—even those with the worst reputation. Already, as shark populations dwindle around the world from overfishing for their fins, fear and vilification are giving way to a more farsighted, active concern. □

National Geographic EXPLORER will air "The Shark Barrier" on Sunday, December 27, at 9 p.m. ET on TBS SuperStation.

Illuminated by the blue cast of midday sunlight, a whale shark descends into the depths. After feasting for several days, one by one the enigmatic beasts leave the plankton-green shallows for the clear blue currents of the Indian Ocean—highways perhaps to other feeding grounds. How deep they go, where they go, how many there are: All are mysteries surrounding the largest of all fish.

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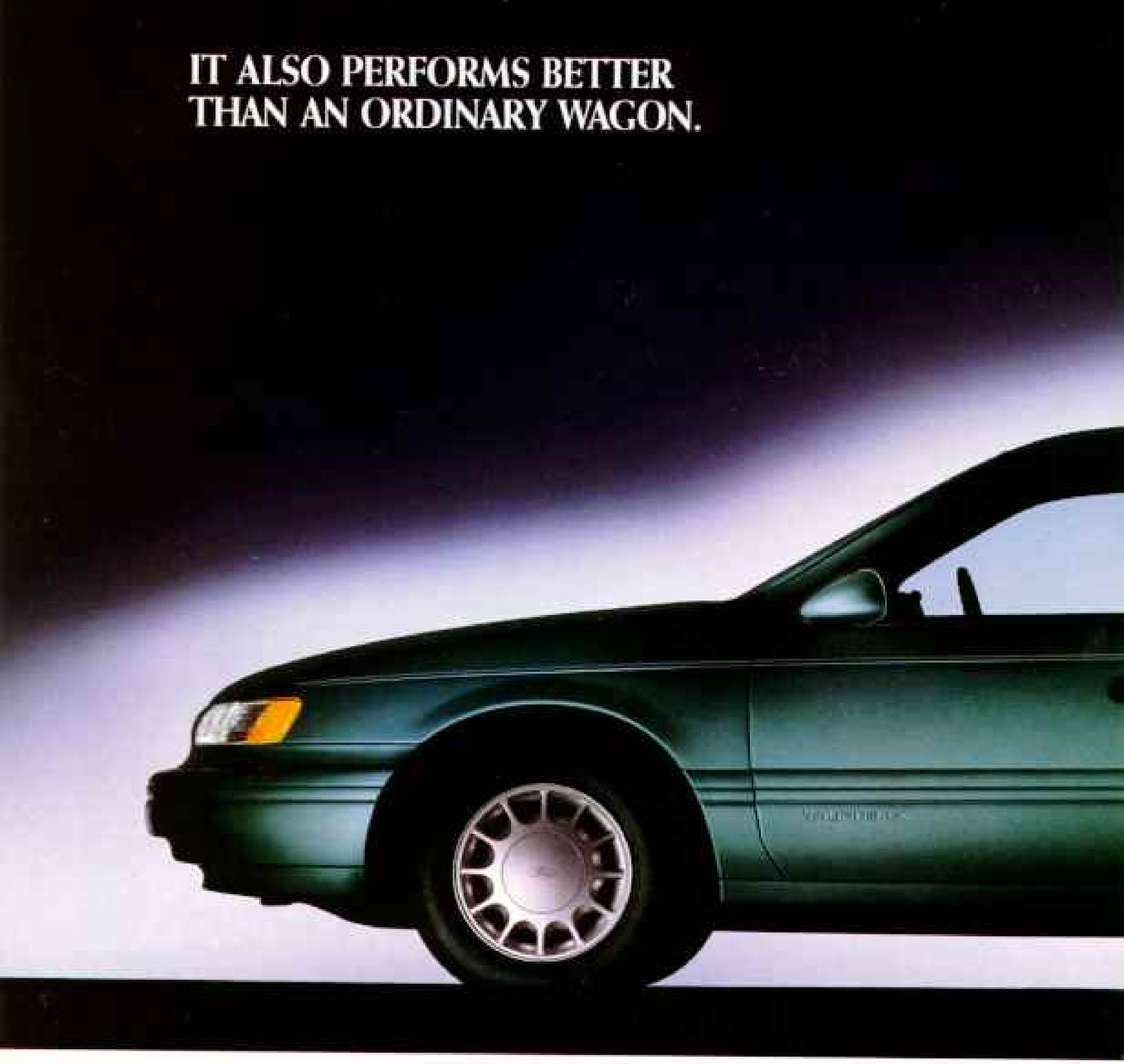

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When it comes to science, Shirley Wright has a simple method for getting her students' feet wet: she takes them to a stream.

This unique project is one of many that Shirley employs in her sixth grade class at Wilcox Elementary School in Pocatello, Idaho.

"The goal of my science program," Shirley explains, "is to teach the skills necessary for my students to become informed, responsible citizens and to encourage respect for the earth."

Her stream ecology program does exactly that.

The students identify not only the fish in the stream, but many of the living organisms that make up this diverse ecosystem. They also examine the quality of the habitat, learning how critical the health of the environment is to the diversity of animal and plant life. The discoveries made in this one day inspire weeks of classroom discussion and learning.

"The wonderful thing about this project," says Shirley, "is that it stimulates their interest in all areas of science."

That's why State Farm is honored to present Shirley with our Good Neighbor Award. We are also delighted to make a contribution of $5,000 to Wilcox Elementary School in her name.

Shirley Wright. Through her stream ecology program, she's teaching students that the definition of a good neighbor is not only how we treat others, but how we treat our environment.

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THE PRESIDENT'S REPORT ON THE

Education Foundation

STEVEN PUMPHREY

Pioneering Educators Hit the Trail

I am always amazed at how far our best teachers will go to widen their horizons: Take the 17 Wyoming educators who endured choking dust, punishing winds, and freezing nights to sharpen their geography-education skills on a wagon train.

Rolling out along a 75-mile stretch of the Oregon Trail (above), the group tried their hand at mapping and kept daily logs of soil types, vegetation, and weather. They also got a feel for this unforgiving terrain, crossed by 350,000 settlers during the mid-1800s.

The adventure was sponsored by the Wyoming Geographic Alliance, a group of educators devoted to promoting excellence in geography education. I'm happy to report that since the Society launched the concept in 1986, 49 states and Puerto Rico have created geographic alliances.

"There's a grave for every 200 yards of the Oregon Trail, and it's easy to see why," says Judy Kallal, a Cheyenne high school teacher who made the five-day trek in July. "At night the temperature was 25 degrees. We had to push wagons out of the bogs. The ride was so bumpy it was usually best just to walk.

"But 17 teachers went back to class this fall with a new enthusiasm for teaching geography."

Another group of 17 Wyoming teachers took an equally challenging four-day raft trip down the winding Snake River.

This year U. S. teachers attended 60 institutes sponsored by regional geographic alliances, the busiest summer ever. Across the country they are bringing a new, infectious spirit to their students.

Summer in the City: Prime Time for Teachers

The wide open spaces aren't the only places geography teachers can be enriched.

Right here in Washington, D. C., 67 teachers from 13 states, Puerto Rico, and Canada joined the Society's Summer Geography Institute in June. One day teams took to the streets of Georgetown (below), noting how buildings have been put to different use over the years.

"We were developing observational techniques so we could help children learn how to look at the world around them carefully," said Paula Long, who teaches at a Navajo Indian elementary school near Fruitland, New Mexico.

"I came bouncing into the classroom on the first day of school this year. When I told the students to open their new geography books, they all moaned. But I said, 'You just wait!' Three weeks later they were asking to work on their geography projects in their spare time."

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ROBERT CAPUTO

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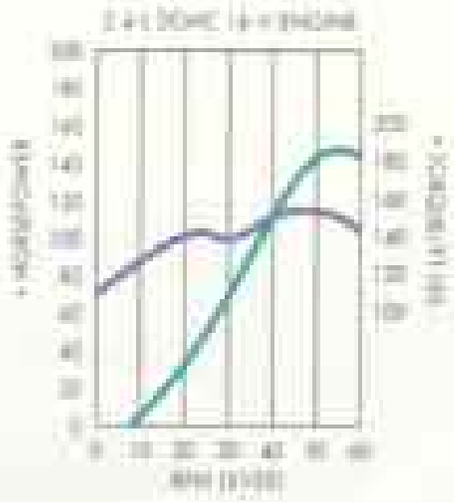

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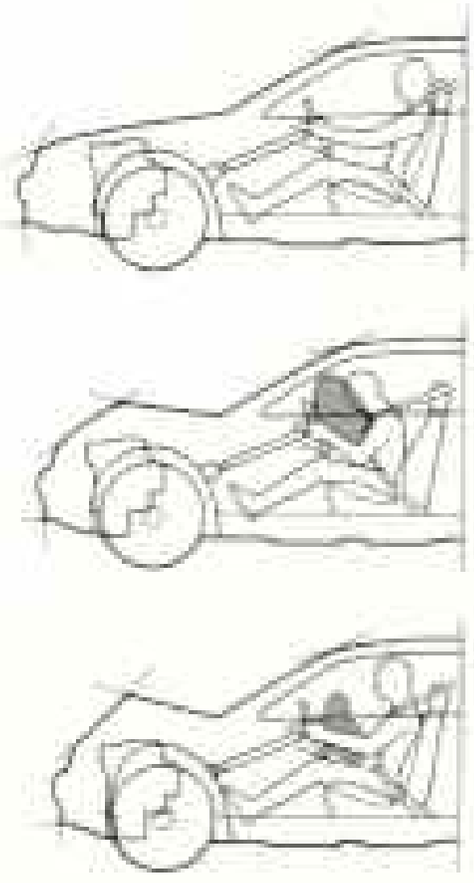

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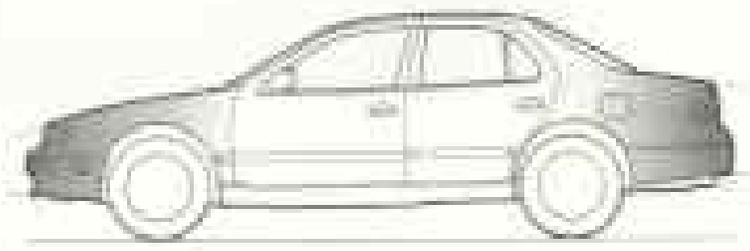
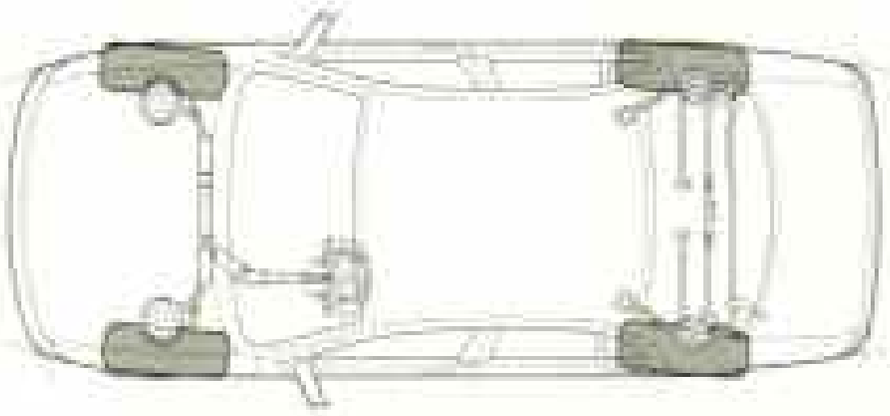


Front and rear crumple zones help manage crash energy and help reduce interior damage. In addition, steel guard beams have been placed in the door panels to help provide further protection in the event of side impact.



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Geographica

DUBY TAL AND MORI HARARARI, MASA ARCHEB MAGAZINE, TEL AVIV

Bronze Age Circles on the Golan Heights

Like a Middle Eastern Stonehenge, five concentric stone circles—the outer one a third of a mile around—rise above the Golan Heights on Israel's northeastern border, tantalizing clues to a society that flourished 5,000 years ago.

Known as Rujm el-Hiri—Arabic for "stone heap of the wild cat"—the site escaped scientific scrutiny until after Israel occupied Syria's borderland in 1967. The rubble walls, up to 8 feet high and 11½ feet wide, incorporate both small stones and massive slabs weighing tons. At least 250 workers would have labored five years to erect the complex, says Yonathan Mizrachi, an Israeli archaeologist who leads the site's excavation. It has uncovered Bronze Age arrowheads, beads, and ceramics.

The stone structure served as a ceremonial center and probably was witness to rituals linked to astronomical observations. The northeast gate, at top, lined up perfectly with the summer solstice sunrise. In a central cairn some 65 feet in diameter, Mizrachi found a looted burial chamber dug about 1,500 years after the walls went up. "We have two different stories to unravel now," he says.

Piecing the Past Together in a Historic Russian City

For centuries Novgorod, 110 miles south of St. Petersburg, served as a cradle of Russian civilization. Its wooden churches, filled with frescoes and icons vividly depicting Russian Orthodox saints, inspired art throughout Russia. Many of these churches, including the Church of the Savior in nearby Kovalevo, were destroyed during German shelling in World War II. Now 83-year-old Alexander Petrovich Grekov is nearly finished with a painstaking labor of love: reassembling the church's magnificent 14th-century frescoes.

A French-educated Russian, Grekov learned of the frescoes after returning to his homeland in 1948 from residence abroad and set about rescuing them. He spent four years crawling on hillsides dotted with mines, hunting bits of colored plaster. Then, using a lone description of the frescoes compiled before the war, he glued the small pieces—some no bigger than a fingernail—back together.

"I felt favored by God for this special task," Grekov says. The reassembled works are now displayed in a local monastery and in Novgorod's Museum of Wooden Architecture.

NIKOLAI IGNATIEV, NETWORK/MATRIX

National Geographic, December 1992

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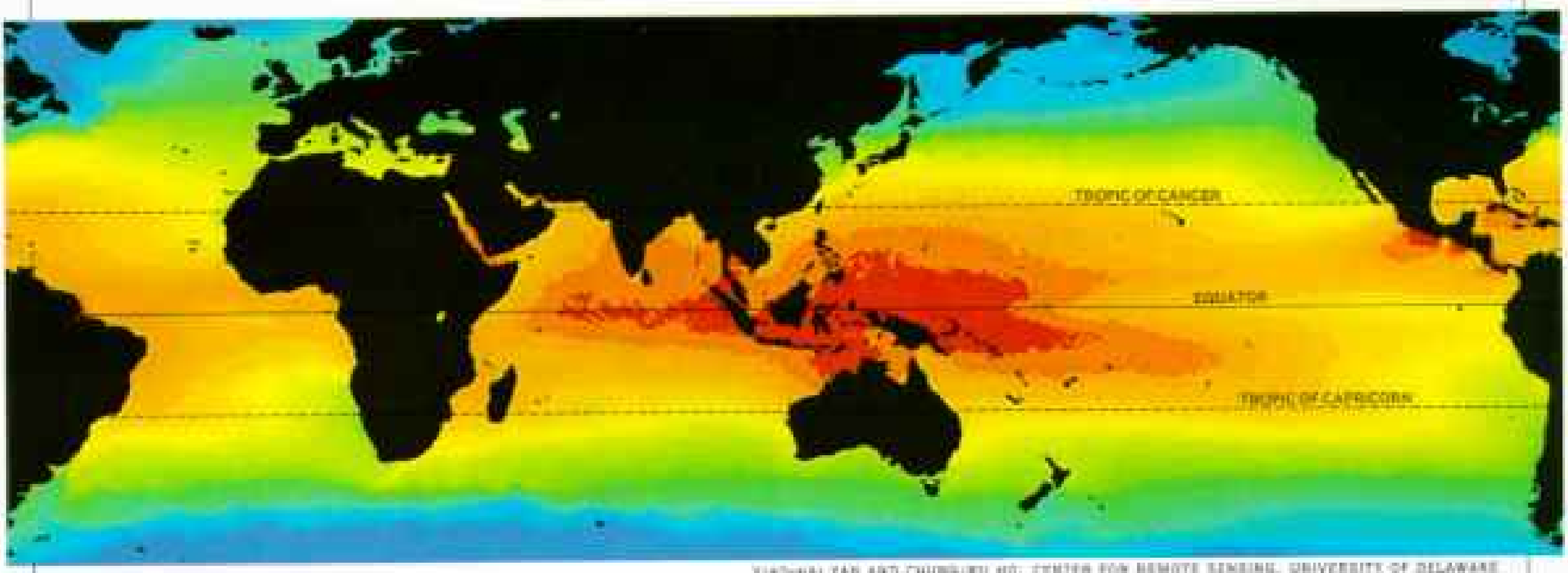

XIAO-HAI YAN AND CHUNG-RU HO, CENTER FOR REMOTE SENSING, UNIVERSITY OF DELAWARE

Is the Sea Warming in the Western Pacific?

Oceanographers call it the Western Pacific Warm Pool, a great band of ocean straddling the Equator north of Australia where surface temperatures are among the world's warmest. This computer-generated map (above) charts a ten-year average of temperatures recorded by earth-orbiting TIROS satellites since 1982. Orange indicates water of 28°C (82.4°F); red areas average 29°C (84.2°F) or more. That's two to five degrees warmer than the average elsewhere along the Equator.

The satellite data reveal that the Western Pacific Warm Pool got warmer—by half a degree Celsius—during the past decade, and much larger too, according to Xiao-Hai Yan of the Center for Remote Sensing at the University of Delaware, who led the team that produced the map. The satellite data were supported by water measurements collected by research vessels and buoys. "Half a degree is a lot," Yan notes, especially if the warming trend continues.

Much of the variability in the surface temperatures can be attributed to changes in solar flare activity, Yan says; the rest is due to El Niño weather-altering events, volcanic eruptions, and human-caused carbon dioxide emissions. Yan feels his studies can contribute to an understanding of how El Niños form and of changes in global climate.

Richard Reynolds of the National Meteorological Center, a specialist in sea-surface temperatures, agrees that the Western Pacific Warm Pool has warmed and grown since 1982. All of the world's oceans have heated up in the past decade, but this recent warming may simply be part of a normal long-term, up-and-down cycle, Reynolds says.

Sea Eagles Fly Over Ireland Again

With a poetic turn of phrase, the Irish speak of *iolar shúil na gréine*—the "eagle with sunlit eyes," after its bright yellow eyes. But the last breeding pair of white-tailed sea eagles in Ireland was recorded in 1898.

Now helped by a trial program, the bird may make a comeback. A pair was released last April on the island of Inishvickillane off the Dingle Peninsula. The young male (below, tethered prior to release) vanished within weeks. The female thrives and will soon be joined by a male from the German Raptor Research Center near Guttenburg.

The eagle, whose wings span more than six feet, once was common in Ireland and much of Europe. But hunters shot the migratory birds; poisons set against stray dogs and vermin killed others. A new Irish law banning poison baits paved the way for reintroduction, says Sean McKeown, manager of Ireland's Fota Wildlife Park. He expects the Irish venture to succeed in about 20 years. A 17-year effort in Scotland now counts ten pairs of eagles.

FRANK MILLER, THE IRISH TIMES

National Geographic, December 1992

Introducing Mercury Villager.

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Geographica

Solving the Mystery of the Noisy Butterfly

DAVID CLARK

The clickety-clickety-clack of what sounds like castanets echoes through the tropical forest of Costa Rica. Butterflies, ordinarily the essence of peace and quiet, here sound like flamenco dancers.

Scientists have long been intrigued by the clamorous *Hamadryas* butterfly but have not known how or why it made such sounds, audible up to a hundred feet away. Julián Monge-Nájera, a University of Costa Rica biologist who analyzed high-speed photographs and sound recordings with the aid of a computer, has found the answers.

Male *Hamadryas* produce the sound when their forewings collide during vigorous flight. Monge-Nájera proved this by placing sound-absorbing material harmlessly on the wings of captive males, thus quieting them.

And why all the racket? Prior to courtship, the males jostle for space on trees along female flight paths. "Males will fight for those trees," Monge-Nájera reports. "They wage fierce—and noisy—battles."

Learn by Watching—the Octopus Way

Few would expect an octopus to be this smart. But *Octopus vulgaris* has a highly developed brain—for an invertebrate. Two Italian scientists have shown that the cephalopod can learn just by observing other octopuses in action.

Graziano Fiorito and Pietro Scotto trained octopuses with food rewards to attack either a red or a white ball. Once an octopus mastered the task, a second octopus in an adjoining tank was permitted to watch it go through its eight-armed paces.

When the observers were allowed to attack the balls, those who had seen demonstrators attack red balls dived for a red ball; those who had watched chases of a white ball swam after a white ball. To the octopuses, known to be color-blind, the balls differed in brightness, not color. The observers not only had learned the task but had done so more rapidly than the trained group.

Humans and other vertebrates learn by watching their own species. But no scientist had shown before that an invertebrate could learn in a way neurologists consider preliminary to conceptual thought.

JANE BURTON, BRUCE COLEMAN LTD.

Uncovering Daily Life of Ohio's First Families

The earliest settlers in the Great Lakes region constructed shelters thousands of years ago on what is now farmland 35 miles south of Cleveland. They stuck wooden posts into the ground, perhaps lashing them together and covering them with skins and bark. They hunted game with wooden spears tipped with stone points, butchered the meat with stone scrapers and knives, and cooked it in round fire pits.

David Brose, a curator at the Cleveland Museum of Natural History, is excavating artifacts of everyday life at a site he calls Paleo Crossing. His teams have located charred remains of posts, useful for carbon dating, knives and scrapers, and thousands of flakes of flint quarried hundreds of miles away.

Most intriguing are carbon dates older than 12,000 years. If confirmed, the site would be one of the first human settlements in the Western Hemisphere.

—Boris Weintraub

National Geographic, December 1992

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WILDLIFE AS CANON SEES IT

Chilean woodstar
Genus: *Eulidia*
Species: *yarrellii*
Adult size: Length, less than 8 cm
Adult weight: Approx. 3 g
Habitat: Azapa and Lluta river valleys in Chile, and adjacent Peru
Surviving number: Unknown
Photographed by Luiz Claudio Marigo

A Chilean woodstar hovers gracefully over a flower as it extracts the rich nectar. The woodstar was once common in the fertile valleys that wind through the deserts of northern Chile. When the valleys were settled and converted to agriculture, the woodstar lost much of its habitat. Today, this rare species can be seen mostly amid urban gardens. To save endangered species, it is essential to protect their habitats and understand the vital role of each species within the earth's ecosystems. Photography, both as a scientific research tool and as a means of communication, can help promote a greater awareness and understanding of the Chilean woodstar and our entire wildlife heritage.

NATURE

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This program is funded, in part, by Canon U.S.A., Inc.

Forum

The Kurds

Having worked as a volunteer in Iraqi Kurdistan last year, I welcomed the August 1992 cover article. The fragmentation of Kurdish political identity has a cultural parallel. Until January 1991 Turkey recognized neither the language nor the ethnic group; Kurds were called mountain Turks. Iraq has attempted to arabize its Kurds through intermarriage. The impact of nonrecognition has been the emergence of different writing systems for the Kurdish language—Arabic script in Iraq, the Latin alphabet in Turkey, and Cyrillic in the former Soviet Union. The creation of a political Kurdistan to mirror its cultural boundaries may be overdue or it may be unnecessary. But it is a separate question from the recognition of a people who have been subject to genocidal persecution.

KURT E. MOLLER
Trenton, New Jersey

As a Turkish American who lived in Turkey for 15 years, I congratulate you on the fairness of the article. The Turkish government has had many problems in dealing with the Kurdish minority; explaining the Turkish side would make an interesting article.

BILL HALACOGLU
Sterling Heights, Michigan

The article doesn't mention efforts by the Turkish government to help not only its own citizens of Kurdish origin but also Iraqi Kurds. Turkey accepted 65,000 Iraqi Kurdish refugees in 1988 when they were fleeing the horrors of Halabjah and did its utmost to provide relief to the 500,000 people who massed on the border in the spring of 1991. Turkey also recently extended Operation Provide Comfort II, which provides air cover in northern Iraq, for another six months to protect Iraqi Kurds.

AYDIN SAHINBAS
Minister-Counselor, Turkish Embassy
Washington, D. C.

To understand the PKK, readers should know that victims of its violence in southeastern Turkey, where I have visited and worked, have been not only Turkish soldiers and police but also entire villages of innocent men, women, and children. This is apparently one of the missions the PKK soldiers in your photos are training for. Until the PKK takes a clear position against such actions and purges itself of elements responsible for them, the party deserves neither respect nor sympathy.

JAN HARTMAN
East Windsor, New Jersey

When the government of a multinational country is bad, trying to establish separate countries along the lines of cultural identity is a shortcut that only leads to chaos and misery. If preservation of a people's cultural identity were worth fighting for, then Germans might with justification throw out the 400,000 Kurds in their midst.

ANTONIO E. M. ATTANASIO
Lecco, Italy

For your next article on the area, I urge you to include the Assyrians, a stateless Christian community whose homeland is in Iraq.

FRANCIS E. HOYEN, JR.
Worcester, Massachusetts

Main-Danube Canal

As a former bargeman in Western Europe, I was pleased to see the article in the August issue. For 30 years we talked about this canal while discharging cargo in Würzburg and Aschaffenburg on the Main. This new waterway will bring a big change to all who make a living on the waterways connected with the Danube, directly or indirectly.

JOHN VANDER DOE
Canadian Shipwatchers Organisation
Chatham, Ontario

German criticism of the Main-Danube Canal reminds me of the U. S. furor that greeted the Tennessee-Tombigbee Waterway, regarded by many as an ecological and economic disaster. Since its completion, news of the operation of the Tenn-Tom has been scant. How's it doing: good, bad, or indifferent?

DONALD G. KLOENNE
Hicksville, New York

The Tenn-Tom opened in 1985 (see GEOGRAPHIC, March 1986). Its development authority attributes two billion dollars in new and expanded industries to the waterway, along with 10,000 jobs. However, construction destroyed many wetlands, and shipping hovers at only five million tons. Maintaining the waterway costs the federal treasury 18 million dollars a year.

For the first time, I was able to learn the historical and geographic highlights, and the pros and cons, of erecting this landscape-transforming edifice. What the author observed about apparently successful efforts to create a new but natural environment was especially instructive. It is strange that I could inform myself in an American magazine about such an important event in my own country.

FRIEDRICH KRAUSE
Singen, Germany

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The old Main-Danube Canal is responsible for a word that, according to my Nürnberg relatives, is one of the longest in the German language: Ludwigmaindonaukanaldampfschiffahrtgesellschaftenkapitänswitwenrente (pension of the widows of the societies of steamship captains of the Ludwig-Main-Danube Canal).

FREDERICK E. TRINKLEIN
Shoreham, New York

Denali

I have just returned from a trip to Alaska, which made your article and photographs all the more vivid. We didn't get to see the peak of McKinley because of low clouds. Our guide said that so many climbers on Mount McKinley have to be rescued that the National Park Service requires each guide company to have enough insurance to cover the cost of possible rescue.

SIMON DUBUC
Thompson, Manitoba

I share the author's wish that this Alaska park remain as it is, without so-called improvements. Mount Rainier National Park, which my family visits frequently, is a prime example of why Denali should continue its present practices. At Rainier on a summer weekend the traffic jams stretch for miles, filling the air with the stench of downtown Seattle. Occasionally tourists stop to gawk at the mountain or to figure out where they are going, creating hazards for other drivers. One has to hike deep into the hills to escape the noise. I wish Rainier would start a shuttle-bus system like Denali and ban personal autos. I go to the mountains to escape the crush of humanity and the trappings of civilization. People who insist on hotels and cannot bear to be parted from their autos should stay in the city.

TRACI M. DEGERMAN
Kennewick, Washington

I do not agree with Douglas Chadwick's philosophy of keeping Denali as it is. In a park of six million acres, I do not understand why facilities are so limited. At a minimum the road to Wonder Lake should become a loop, exiting through the nonwilderness part of the park. The loop should have a parking lane, unimproved campsites should be added in the wilderness area, and in nonwilderness areas improved campsites should have tourist facilities. Since the National Park Service seems to be more concerned with wilderness than service, I now have serious doubts about its ability to manage our parks in the public's best interest.

WILLIAM W. SMITH
Midland, Texas

Paraguay

I am an American born in Paraguay, where my parents were missionaries in the early 1960s. Sandra Dibble's reporting is excellent, but she did not do justice to how hot and humid the country usually is. Out of that supersaturated air could pour rain so heavy that the streets of Asunción would become huge storm sewers, funneling water to the river below. My father witnessed several cars floating away and was himself caught out in the open early in his stay and almost swept away.

BRUCE A. KINTNER
Bellevue, Kentucky

As a former resident of Paraguay I am familiar with the extremely harsh life of the majority of the people. After 37 years' absence I returned as a tourist, and after one week of touring from Encarnación to Ascunción, I concluded that only a very few, as your pictures so clearly depict, will ever benefit from any upcoming changes.

ALEXANDER TITOFF
El Paso, Texas

You did not mention the important role U. S. President Rutherford B. Hayes (1877-1881) played in resolving territorial conflicts and bringing peace to the region. His memory is honored in Paraguay in the name of the largest geographic department in the Chaco area and in the town of Villa Hayes on the Trans-Chaco Highway.

CARL SHIPLEY
Naples, Florida

I was surprised to see an erroneous description of Catholic faith and practice in the caption on page 111, which says that "two boys worship the Virgen del Rosario." Catholics *worship* God alone. We *venerate* the Blessed Virgin and other saints, praying to them for their intercession.

FATHER PETER M. J. STRAVINSKAS
Editor, The Catholic Answer
Newark, New Jersey

Chinese Emperor's Tomb

You state that "wheat, corn, and millet" were found in the second century B.C. tomb of Jing Di. Corn *(Zea mays)* is native to the Americas and did not reach China until some time in the 16th century A.D. It is true that the word is often used to refer to the primary grain crop of an area, and thus in this context would presumably refer to rice *(Oryza sativa)*, but such a usage is very misleading. It could be taken as providing evidence for long-discredited theories about an Asian origin for *Zea mays*.

WADE RAY WOFFORD
Niland, California

Our inclusion of "corn" was based on an error in translation.

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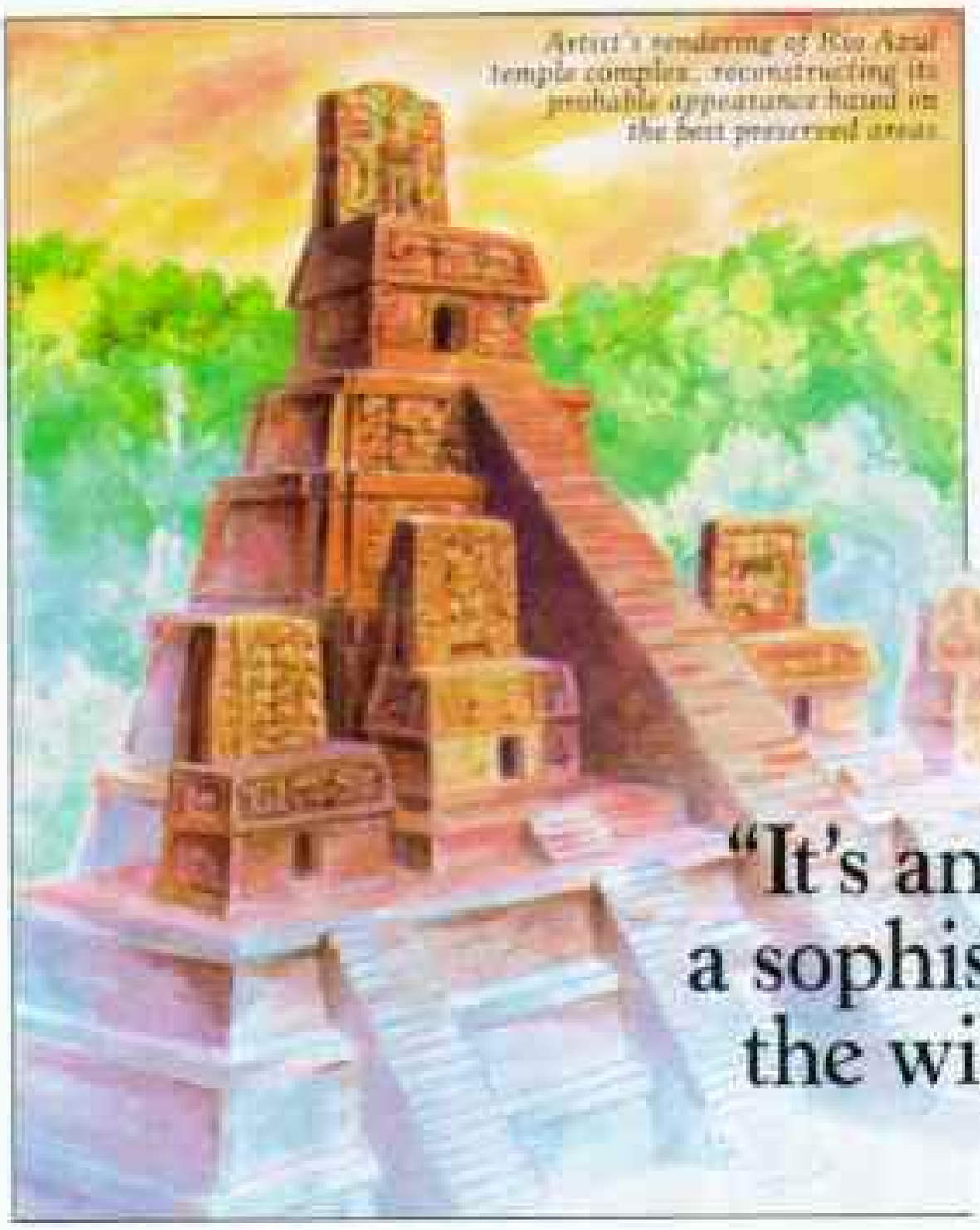


Artist's rendering of Rio Azul temple complex, reconstructing its probable appearance based on the best preserved areas.

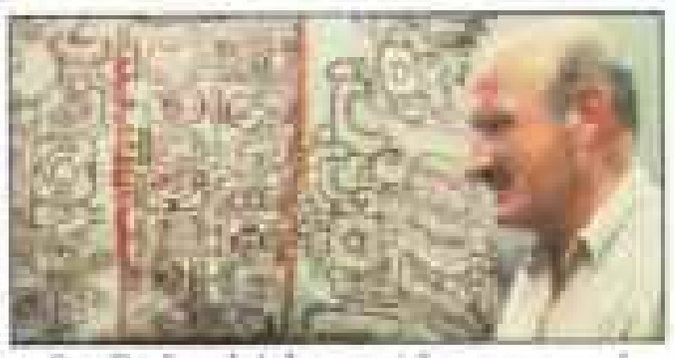
"It's an amazing story of a sophisticated people with the will to tame a jungle."

Dr. Richard Adams

In the remote jungle of the Petén region of Guatemala, an intrepid band of archaeologists, led by Dr. Richard Adams, have unearthed the ancient Maya city of Rio Azul. Despite temperatures that rarely fell below 100 degrees Fahrenheit, humidity that hovered near 100 percent, and the thick tropical growth that impeded their efforts, Adams and his team were able to excavate a great deal of this two-thousand-year-old city. The result is new insight into a remarkable pre-Columbian civilization that predates both the Incas of South America and the Aztecs of Mexico.

The dig yielded a vivid picture of a highly advanced people who channeled rivers, terraced hillsides, and drained whole swamps, while converting hundreds of acres of dense jungle into arable land. The Adams' team discovered murals and carved stone monuments that recorded the history of the royal families. They also uncovered majestic temples as well as stone courts where the Maya competed in ritual ball games.

"The Maya fascinate us because they were so advanced for their time and place," said Adams. "They had a sophisticated writing, mathematical, and astronomy system; and they were skilled artisans, farmers, and builders. In short, they created a complex society in an extremely hostile jungle environment."



Dr. Richard Adams with a governor's tomb mural at Rio Azul.

Given its inhospitable climate and inaccessibility, Rio Azul is an archaeologist's nightmare. Resupply is so difficult, Dr. Richard Adams must rely on whatever equipment he takes with him on a dig. That's why it's not surprising he wears a rugged Rolex Oyster Perpetual timepiece.

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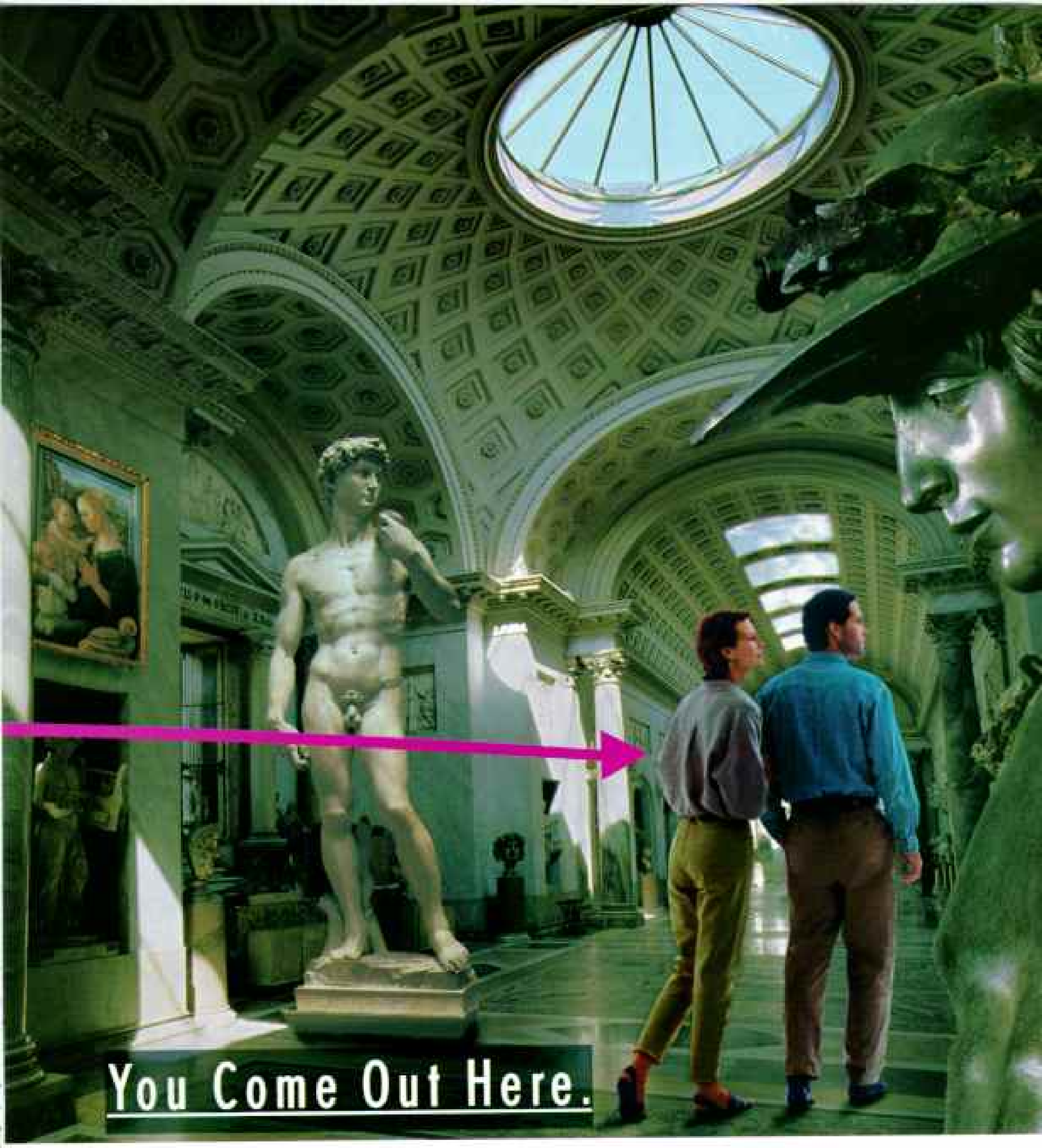

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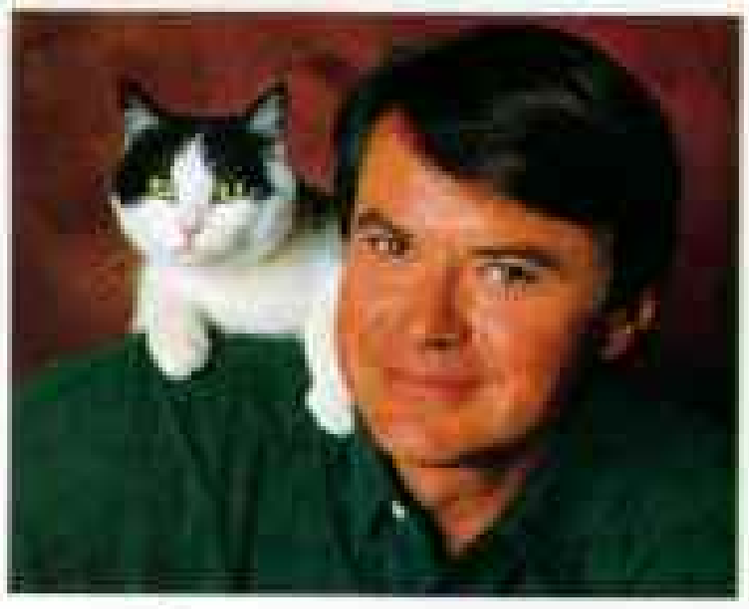

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—*Robert Urich*

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Roberta J. Nichols, Ph.D
Ford Environmental Engineer

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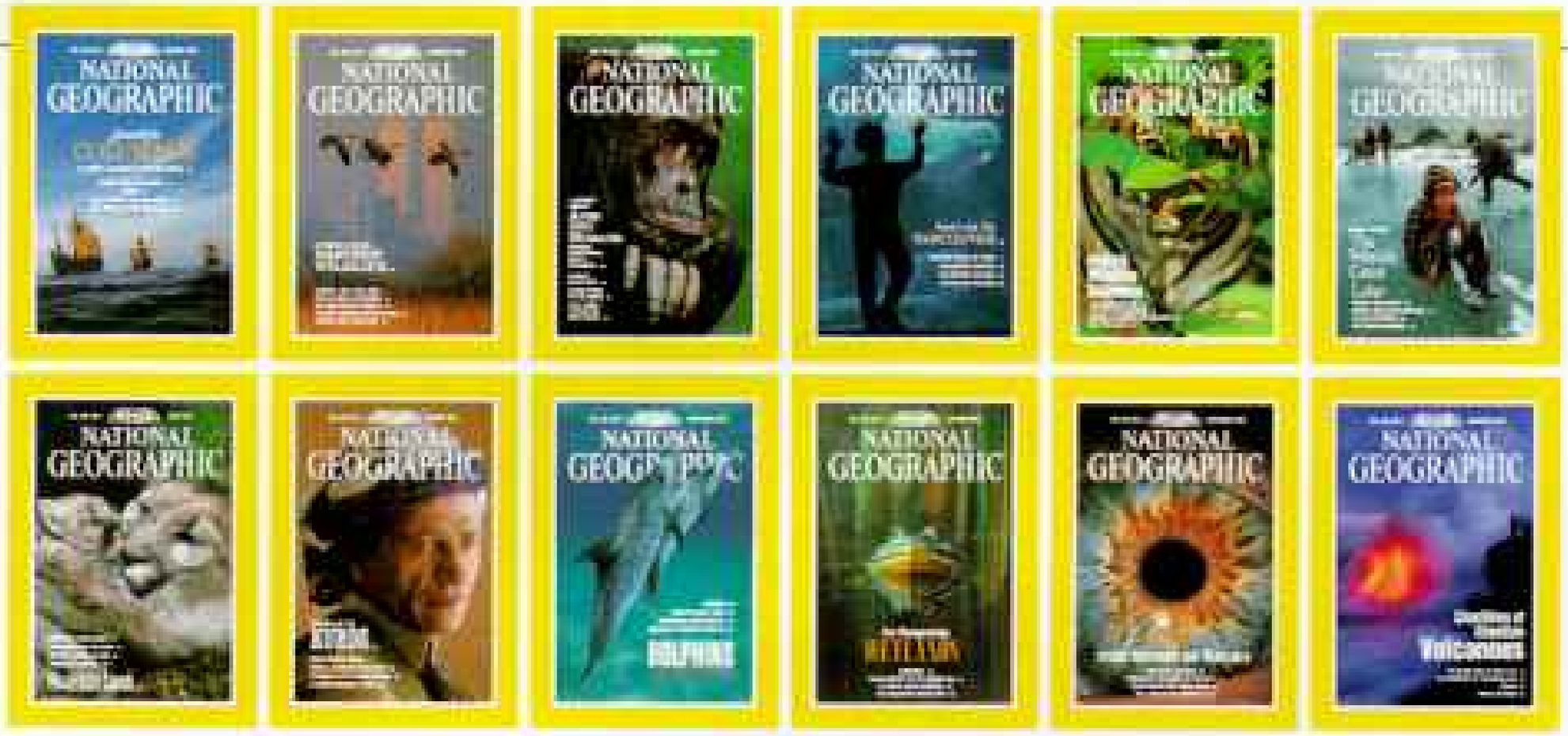

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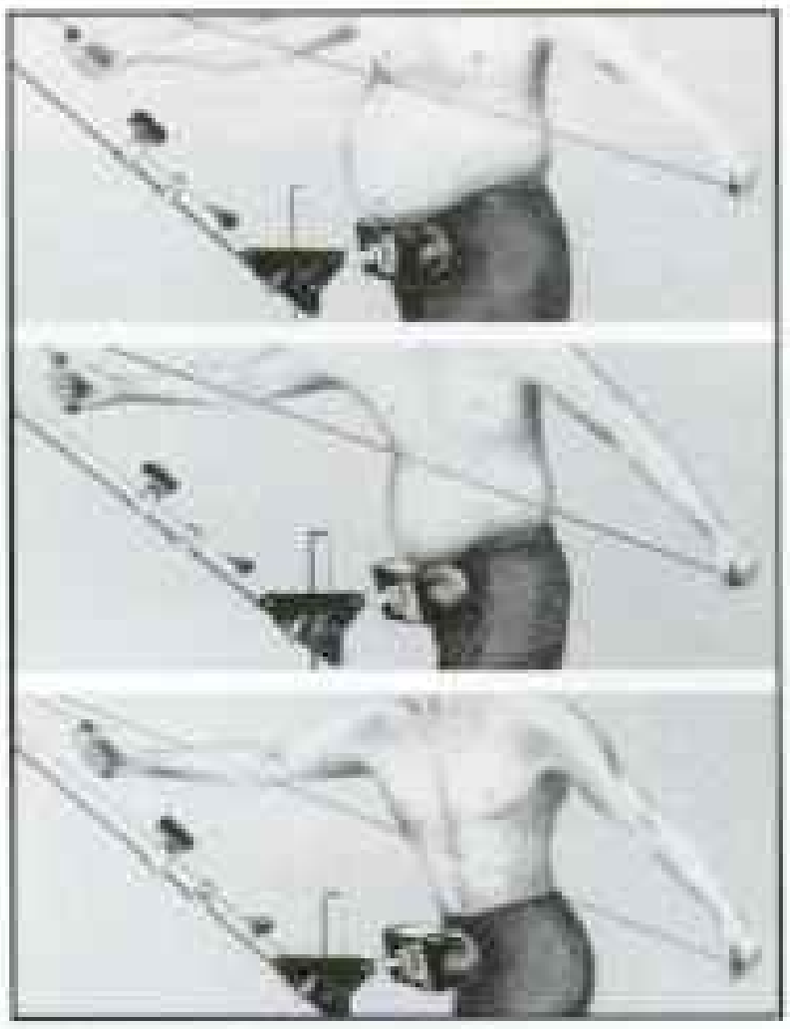

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On Television

BRUCE DAVIDSON, SURVIVAL ANGLIA

Children and Okapi: Lights in the Forest

Playing at being grown-up, eight-year-old Rebekah Hart and friends (above) practice a dance from the *elima*, a rite of passage to adulthood for Mbuti Pygmy women of the Ituri Forest in northeastern Zaire. Bekah's parents, John and Terese Hart, came to the Ituri some 20 years ago to study the hunting economy of the Mbuti.

Natural history filmmaker Alan Root came to the 20,000-square-mile wilderness and found the Harts and the Mbuti working together in a remarkable collaboration that is uncovering the secrets of one of the largest and least settled forests of Africa. Deep in the Congo Basin, the setting for Joseph Conrad's brooding tale "Heart of Darkness," Root filmed a way of life that prompted him to call his production for National Geographic EXPLORER "Heart of Brightness."

John and Terese have been able to combine career and family—even when the commute is between New York City and the village of Epulu in Zaire—because the Mbuti have welcomed the Hart children into their lives. Bekah, Sarah (12), and Jo-Jo (four months) are growing up intimate with two cultures.

During years of research in wildlife ecology, the Harts became intrigued with one of earth's most elusive animals. Found only in Zaire, the okapi is cousin to the familiar savanna-dwelling giraffe but sports zebra-like markings.

The Harts and the Mbuti blend modern field methods with ancient forest skills. Digging large pits nearly seven feet deep, the Mbuti capture the okapis while the Harts collar the docile animals for radio-tracking. Together they are learning about this forest giraffe, whose ancestry predates the Pleistocene but whose existence became known to the scientific world only in 1900.

Root has filmed the joyous story of people whose life and work celebrate the Ituri Forest, where more than 5,000 square miles have recently been declared an Okapi wildlife reserve.

"Heart of Brightness" airs December 20 on EXPLORER, TBS SuperStation, 9 p.m. ET.

"Splendid Stones" Shine in Home Video Club

Negligible in size and weight, yet among the world's costliest items, gems have tantalized us since the beginning of time. This 1991 National Geographic Special, now available on video, unveils the mystique of possessing and the business of trading precious gemstones forged millions of years ago out of the molten caldron of earth's interior.

"Splendid Stones" is a December selection of the National Geographic Video Club: U. S. and Canada only (1-800-343-6610).

From here on in, every luxury sedan in the world will have to rejustify its price.

The BMW 525i: $35,600. The Mercedes 300E: $42,950. The Lexus LS400: $44,300.[1] That's what people believe they have to pay for a high-quality, high-performance luxury sedan. But the time has now come to take a long, hard look at the relationship between a car's price and its value. The reason? The Chrysler Concorde. It's a new luxury sedan with more horsepower than a BMW 525i.

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Geoguide

ALL BY ROGER H. REISMEYER, STARLIGHT; NGS CARTOGRAPHIC DIVISION (RIGHT)

FIERY LAVA FROM A KILAUEA VENT GENERATES A CLOUD OF STEAM AS IT HITS THE OCEAN ALONG HAWAII'S SHORELINE (ABOVE). SCHOOLGIRLS' HARD HATS IN SAKURAJIMA, JAPAN (LEFT), PROTECT AGAINST THE CONSTANT THREAT OF ASH AND ROCKS FALLING FROM A NEARBY VOLCANO. VOLCANOES RING THE PACIFIC OCEAN (RIGHT) ALONG THE EDGES OF HUGE PLATES THAT MAKE UP EARTH'S CRUST. STUCK IN STONE, A TRUCK (BELOW) IS PERMANENTLY PARKED ON THE ISLAND OF HAWAII—TRAPPED BY HARDENED LAVA.

• Seismic activity

Volcanoes

• To simulate a volcano's lava flow, first make a simple model of a steep hill by crumpling a piece of paper. Put it on a cardboard base. For realism, include details such as toy houses, trees, and cars. Mix two cups of cornstarch with a cup of water, and stir it into a thick paste. Pour the "lava" paste over the model hill. It will flow across the landscape much like real lava. (Dispose of the paste in the trash, not down a drain.)

• Volcanoes can dump thick layers of ash on communities. To see what that's like, shake cornstarch on the roof of a house made by taping together three-by-five-inch cards. Sprinkle water on the "ash" to simulate rain. What happens? What other dangers do you think people living near volcanoes face?

• Volcanoes are found in many densely populated areas around the Pacific. Why do so many millions of people live so close to volcanic peaks in spite of the dangers and disruptions? (Consider volcanic soil, population pressure, chance.) Compare the dangers from volcanoes with other natural risks people face around the world (hurricanes, floods, fires).

USE THE GEOGUIDE PAGE ALONG WITH THE ARTICLE "VOLCANOES: CRUCIBLES OF CREATION" IN THIS ISSUE TO HELP CAPTURE THE INTEREST OF YOUNG READERS AND STIMULATE DISCUSSION WITH THEM. GEOGUIDE IS PUBLISHED FOUR TIMES A YEAR.

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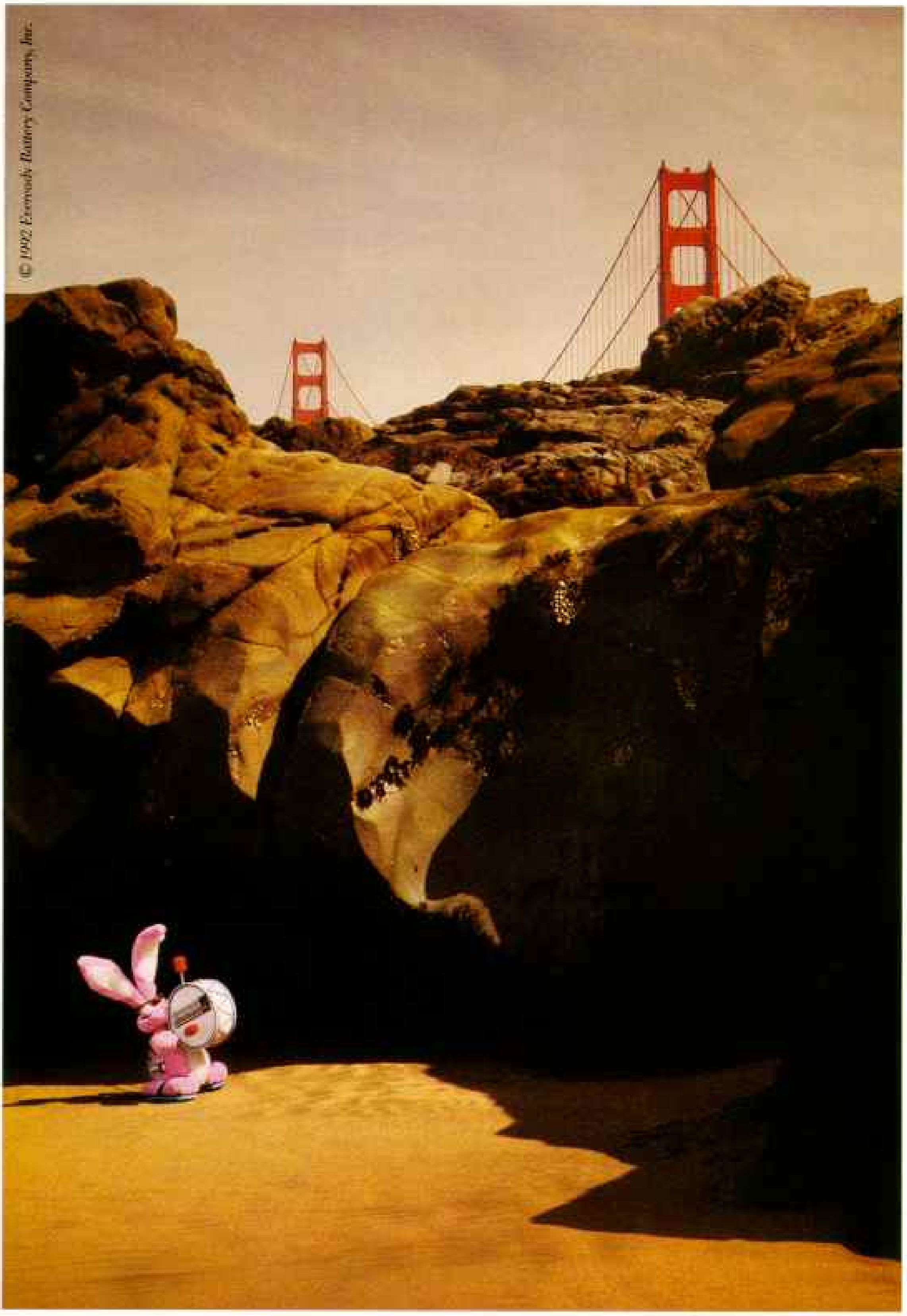

SAN FRANCISCO, CALIFORNIA. 11:28 A.M. STILL GOING.
NOTHING OUTLASTS THE ENERGIZER BATTERY.

Earth Almanac

What's Black and White and Used All Over?

Is the love affair with China's giant pandas suffocating the already endangered species? Public exposure has become commercial exploitation in the Shanghai Circus, where a trained panda, WeyWey, performs. Elsewhere the zeal of zoos and other organizations to rent pandas from China is out of control, critics charge.

Last summer, despite objections from wildlife-protection groups, the Columbus Zoo in Ohio obtained two pandas to display during the Christopher Columbus quincentenary. After the legal smoke cleared, the U. S. Fish and Wildlife Service, which issues import permits, agreed to review its rules governing use of the animals.

"In my opinion, every panda has arrived strictly for commercial purposes—against endangered species laws," says George B. Schaller of Wildlife Conservation International and once a researcher at China's Wolong Natural Reserve. "Even state fairs want them."

Only about a thousand pandas remain in the wild; for rentals China draws from a captive but not self-sustaining population of about 90, charging $50,000 a month each. To keep up with the rent-a-panda syndrome, the Chinese take more from the wild. "We need a successful breeding program before animals go on tour," says Schaller.

China's Yangtze Dam: Torrent of Controversy

"Above the gorges, one thread of sky: Cascades in the gorges twine a thousand cords." So the eighth-century poet Meng Chaio exalts one of China's most famous scenic wonders, the Three Gorges (below) in Hubei and Sichuan Provinces, through which the Yangtze River hurls its might. But China's need to generate power and reduce flooding, which has killed 300,000 people in this century alone, may drown the scene beneath the world's largest hydroelectric project.

Conceived by statesman Sun Yat-sen in 1919, the controversial Three Gorges Dam was approved last spring by the National People's Congress. Construction, beginning in 1996, would take 15 years and cost more than ten billion dollars. A million people would be relocated to make way for a hundred-square-mile reservoir.

The dam could provide 18,000 megawatts of electricity, 18 percent of the nation's present generating capacity. Critics point out that 520 million tons of silt carried through Three Gorges each year will accumulate behind the dam and may exacerbate flooding.

National Geographic, December 1992

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BERRY ELLIS, THE WILDLIFE COLLECTION

Population Explosion Turns Roos Into Pests

Rebounding after a devastating drought in 1982 and 1983, Australia's kangaroos—20 million strong—are competing with livestock for grass and water and creating road hazards.

Well-adapted to the fickle climate, kangaroos like these eastern grays (above) often stop breeding in severe dry spells. But seven days after rain begins, females can conceive again. Population increases 40 percent in the first year after a drought, one study says.

To reduce the five most common species, four states have licensed hunters to cull up to 5.2 million roos for skins and meat. Animal rights groups are protesting. But proponents argue that shooting is the most humane method of control. Says wildlife service biologist Jerry Maynes, "We're convinced we're doing the right thing."

Bright Idea for Conservation

Building a better light bulb could leave the United States with energy to spare. The potential is bright because one-fourth of all electricity generated in the U. S. goes to light homes, offices, or factories.

SYGMA

The latest invention to generate interest among residential users is Intersource Technologies' electronic light bulb, or E-Lamp (left). To produce light, it emits a high-frequency radio signal inside the gas-filled bulb, unlike the familiar incandescent bulb, which heats a metal filament.

The company says that a 25-watt E-Lamp shines like a 100-watt incandescent bulb; it would cost $15 to $20 and last 14 years when used four hours a day. This energy-saving bulb joins another innovation on the market, the compact fluorescent bulb. Initial acceptance of that efficient, long-lived bulb has been slow because of its $20 price tag.

Can Vaccine-laced Baits Slow Rabies in the Wild?

Rabies, a dread disease that contorts this raccoon's face, claims some 25,000 humans a year around the world; they suffer painful deaths after they are bitten by infected animals, mainly dogs. Fatalities in the U. S. are rare, however, since most pets are inoculated. But a rabies epidemic carried by raccoons has spread along the East Coast. This year 1,100 rabid raccoons were found in New York State. In New Jersey 1,900 have been counted since November 1989.

In Europe and Canada cube-shaped, chicken-flavored baits filled with a rabies vaccine have been air-dropped in the wild, and the spread of rabies by foxes has been nearly halted. In the U. S. fish-flavored vaccines for raccoons—at a dollar a dose—have been tested in Virginia, Pennsylvania, and New Jersey and are planned for upstate New York.

—JOHN L. ELIOT

TOM STAFFORD

National Geographic, December 1992

Tie one on.

This holiday season, some 150 million people will tie a simple red ribbon on their car antennas, to express their commitment to safe, sober driving. It's part of the "Tie One On For Safety™" campaign sponsored by Mothers Against Drunk Driving (MADD) and The Good Hands People of Allstate.

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On Assignment

ROGER H. RESSMEYER, STARLIGHT

Steps from the inferno, freelance photographer ROGER H. RESSMEYER could tolerate only a few moments while recording Etna's lava flows before jumping away from the searing heat and into the freezing wind atop Sicily's famous volcano. "I flapped my arms to cool off, then went back to my tripod to snap a few more frames," he recalls.

Photographing eruptions was actually just another space story for Roger, who has been hooked on astronomical phenomena since grade school. "Remember that, like earth, many of the other planets and several moons in the solar system have volcanoes," he says.

By age 11 Roger was building his own telescopes and photographing stars. "I was a very shy kid. The camera made me comfortable around people." In 1970 a science teacher took Roger and his Long Island classmates to Mexico to view a total solar eclipse. The trip started the young man down the road as an inveterate eclipse chaser (see "The Great Eclipse" and "The Moon's Racing Shadow" in the May 1992 GEOGRAPHIC).

After college Roger focused his lens on stars of another magnitude—celebrities such as Madonna—as he sought portraits for book covers or record jackets. Authors Danielle Steel and Shirley MacLaine became regular clients. During the next few years Roger split his time between portraiture for *People*, *Time*, and *Rolling Stone* and various science projects. He says the volcano assignment got him away from studio work and back into the spontaneous side of photography. "I became a street shooter again, traveling without an assistant or a whole lot of gear."

After being on call for the GEOGRAPHIC for a year, ready to travel anywhere in the world to a new eruption, Roger is glad to hang up his hiking boots for a while—he went through three pairs during this assignment. The former San Francisco resident, who saw his Marina district home nearly destroyed by the October 1989 quake, has moved with his wife, Jain, to the quiet—geologically speaking—of Sag Harbor on Long Island. Roger's newest challenge: teaching NASA astronauts inside the shuttle simulator how to set up their equipment to photograph the activities around the space vehicle. That's another kind of mission he wouldn't mind going on himself.

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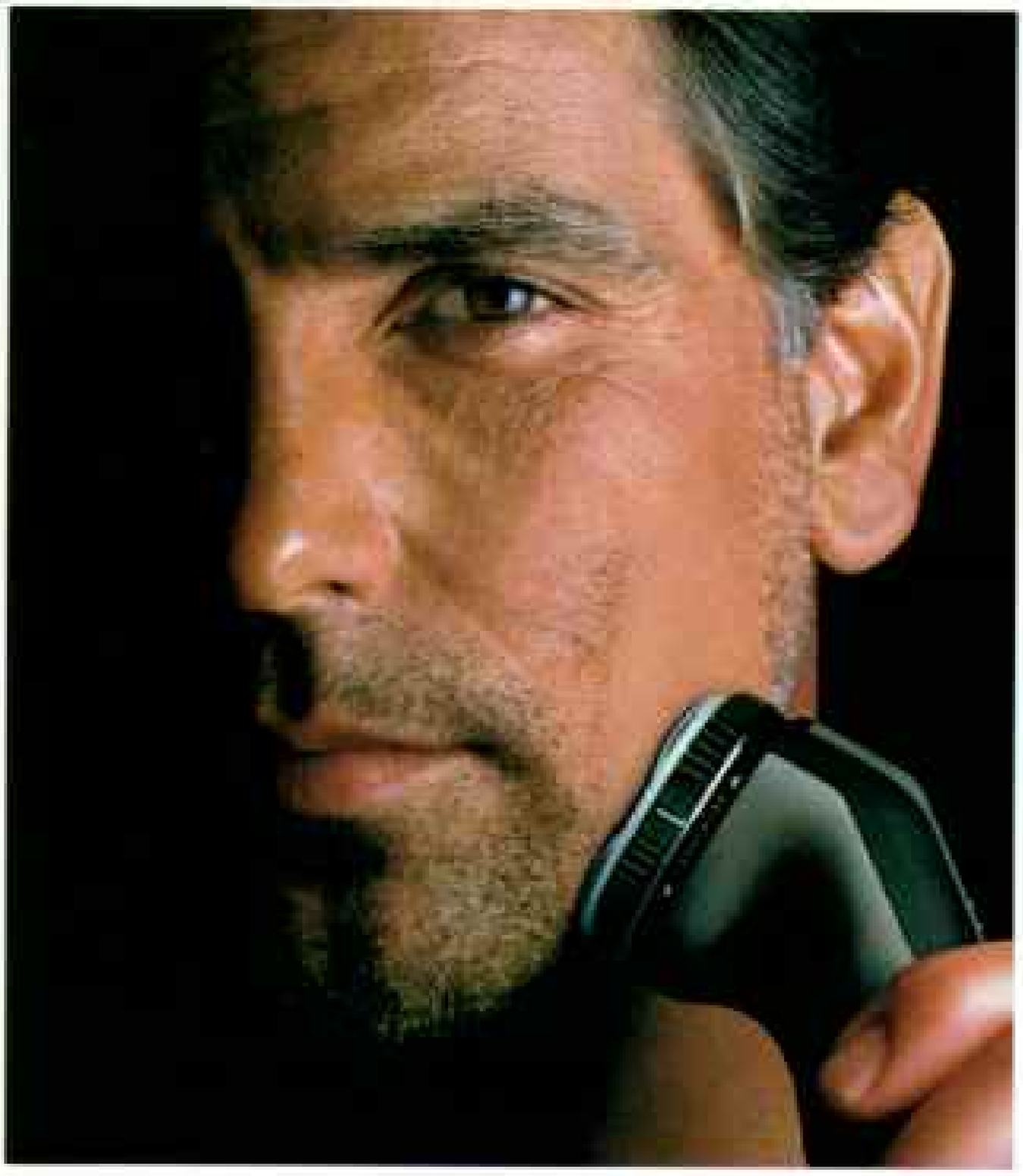

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