

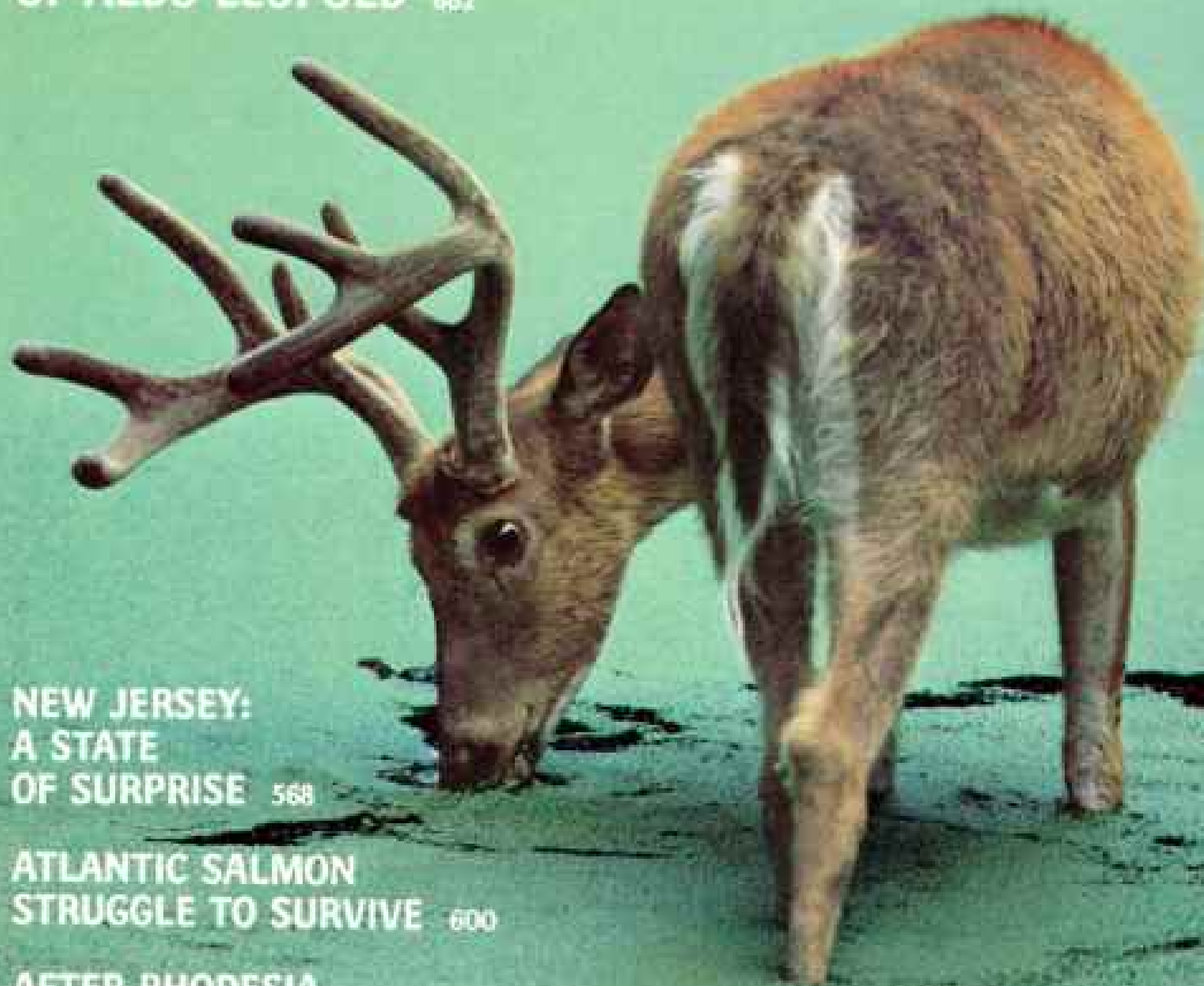
VOL. 160, NO. 5



NOVEMBER 1981

NATIONAL GEOGRAPHIC

THE NATURAL WORLD
OF ALDO LEOPOLD 682



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A STATE
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IN THIS ISSUE we meet two men, both former teachers, both soft-spoken, with much in common though worlds apart in time, place, and interests.

The first, Robert Mugabe, is Prime Minister of Zimbabwe, the new black nation in southeast Africa that once was Rhodesia.

Like other leaders of former colonies, including Gandhi and Nehru of India and Kenyatta of Kenya, Mugabe graduated from the British penal system—in his case literally, since he earned two university degrees during his ten years of detention.

Earlier this year I visited this self-avowed Marxist, leader of a guerrilla movement that terrorized Rhodesia and helped overthrow the Ian Smith government. He didn't look the part. He had the impeccable dress and bearing of an old-school British diplomat and spoke almost piously of peace, forgiveness, and racial harmony. I asked how he had survived the racial war and the prison years with so little apparent bitterness.

"A product of that school must be committed to moral principles," he said. "If you condemn injustice, you must not condemn it only as it applies to you."

Despite that, many whites fled when he took over. Most stayed on, though fearful. As author Charles Cobb reports, a common remark in Zimbabwe's white community is: "A year ago the idea that Mugabe would become Prime Minister terrified us. Now if we heard he was leaving, we'd be terrified."

When I told him the story, Mugabe smiled and sat silently for a few seconds. Then, noting that a year is such a short time, he said, "We still have to measure success in terms of concrete results. You start with education."

As I left his office, I noticed his army bodyguards studying geometry.

Back home and back in time we meet the second man, a teacher from Wisconsin who taught peace and harmony—not between people and races but between people and the environment—Aldo Leopold.

In contrast to the beauty of his thoughts, we also look at one of humanity's contributions to the environment—acid rain. How is it altering the world Leopold loved?

The teachings of both men provide much to ponder. The alternatives to racial harmony and the protection of the environment are unthinkable.

Wilbur E. Garrett

EDITOR

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November 1981

New Jersey: A State of Surprise 568

From factories and refineries to verdant farms and pinelands, from reclaimed garbage dumps to glittering gambling halls, journalist Jim Hartz discovers America in miniature in the state that turnpike tourists love to hate. Photographs by Bob Krist and Michael S. Yamashita.

Atlantic Salmon Struggle to Survive 600

The noble "leaper" is making a comeback in rivers of the northeastern United States, but man's dams, pollution, and fishing fleets continue to take a heavy toll on both sides of the Atlantic. By Art Lee, with photographs by Bianca Lavies.

A Nation Named Zimbabwe 616

Out of Rhodesia's long conflict has emerged a black-ruled republic faced with healing the wounds of war and fulfilling the promise of peace. Charles E. Cobb, Jr., assesses its progress thus far. Photographs by James L. Stanfield and LeRoy Woodson, Jr.

Acid Rain— How Great a Menace? 652

Fishless lakes in North America and Scandinavia raise concern about the chemical showers that observe no boundaries and pose many questions. Anne LaBastille and Ted Spiegel document an increasing problem of the industrial age.

"A Durable Scale of Values" 682

Naturalist, craftsman, teacher, conservationist, philosopher—Aldo Leopold was all these and more. Boyd Gibbons and photographer Jim Brandenburg portray the sage of Wisconsin's prairie and woodlands.

COVER: Serene as its surroundings, a deer nibbles delicately at duckweed in a Wisconsin pond. Photograph by Jim Brandenburg.



Dawn catches commuters streaming to Manhattan. Often overshadowed by New York,

New Jersey: A State



MICHAEL S. YAMASHITA

New Jersey fashions its own personality with industrial brawn and pastoral charm.

of Surprise

By JIM HARTZ

Photographs by BOB KRIST and
MICHAEL S. YAMASHITA



An eyeful of open space awaits those who venture away from the clamorous expressways to explore New Jersey's less traveled roads. Two-thirds of the nation's



MICHAEL S. YAMASHITA

most densely populated state is forest and farmland. In the southern coastal plain, a harrow prepares the soil for spring planting between strips of winter grain.



Elegance gets a face-lift as architecture students earn credit by refurbishing the Chalfonte Hotel in Cape May, one of the nation's oldest summer resorts.



MICHAEL S. YAMASHITA

The 105-year-old hotel offers free room and board for such work during the off-season. The city of Cape May, with 600 Victorian structures, is a national historic landmark.



Wings, wheels, and keels converge in Newark, the state's largest city. Opened in 1928, Newark International was the New York area's first major airport. The New Jersey Turnpike, logging 2.8 billion vehicle miles a year, is the nation's



most heavily traveled toll road—yet one of the safest. Containerized cargo was pioneered 25 years ago at Port Newark-Elizabeth. It remains the biggest port for containers in the United States, handling nearly three-quarters of a million a year.

BOB TRUST

FOR 13 YEARS I worked as a reporter just across the Hudson River in New York City. New Jersey was a place I had to drive through, or fly over, to get somewhere else. It was the home of places with faintly amusing names—Secaucus, Ho-Ho-Kus, Piscataway—and of noisy characters who moidered da language, and occasionally each other. For the life of me, I couldn't understand why it called itself the Garden State.

Well, after weeks of traveling round New Jersey, I now feel ashamed of my previous attitude. It calls itself the Garden State, I found, because its farms, most of them small and compact, are among the most productive per acre in the United States. Though it is an industrial powerhouse, it is a remarkably beautiful state, and a place of such stunning diversity that it is almost America in miniature. One of the nation's 13 original states, it is also one of its most progressive.

On a snowy day last winter Ed Rutsch drove me north on the New Jersey Turnpike, one of the world's most heavily traveled highways. Ed is a native of New Jersey, an industrial archaeologist dedicated to preserving the structures that embody the history of the industrial revolution in the state. He is a great bear of a man, 300 pounds and more, streetwise with a brass-knuckles opinion on everything.

We were traveling along the section of the turnpike where 12 lanes slice through the industrial heart of the state. As far as I could see, there were factories, rail yards, tank farms, towers of the largest refinery on the East Coast, high-tension lines spiderwebbing the sky.

"This is the place people love to hate," Ed remarked, "the part of New Jersey that turns so many people off. But this is where you find the real current and juice of the state. I know all the jokes about New Jersey. This place doesn't have to apologize. New Jersey produces. It hustles. It's tough."

During recent decades New Jersey has emerged as a fierce economic competitor in the Northeast. It has outstripped New York, Pennsylvania, Ohio, and Massachusetts in percentage population growth and exceeds them in per capita personal income. New Jersey is one of the major producers of goods and services. It is the nation's leader in

pharmaceuticals, second in chemicals, and among the top ten in output of electrical machinery, electronic equipment, rubber, plastics, clothes, and fine china.

And all this is packed into one of the smallest states, 1/34th the size of Texas. Only four states are smaller—Hawaii, Connecticut, Delaware, and Rhode Island. None is more densely populated or more urbanized.

"We're more densely populated than Japan," Ed said, as we meandered through crazy-quilt streets in Elizabeth, Bayonne, and Union City. In some places 40,000 people are jammed into a square mile. You can't tell when you go from one city to the next.

THIS CROWDING has given New Jerseyans a keen appreciation of open spaces. Traveling on its superb highways, you can be out of the industrial sector and, in minutes, in a serene countryside reminiscent of the rural Midwest.

In the Pine Barrens there is the scent of southern swamplands. "I get up at seven in the morning and drive 20 minutes before I hit a red light," one pinelands resident told me. To the north, 75 miles from the pines, spring thaws in the low, rounded mountains unleash a torrent of crystal streams that hint of the Pacific Northwest.

Farms? Pinelands? Mountain brooks? In New Jersey? Yes indeed, and oyster fleets, picturesque winding back roads, the Appalachian Trail, wildfowl in southern preserves, rattlesnakes in the hills, plus some of the finest beaches in the world.

Incredibly, two-thirds of New Jersey is still open spaces—lush farmlands and forests. It is possible, with a straight face, to describe New Jersey *accurately* as a small, largely underinhabited state.

Despite these blessings, New Jerseyans feel deprived. A lecturer on government and politics at Princeton University put it in a nutshell: "The state between the Liberty Bell and the Statue of Liberty has suffered because of its location. New Jersey has been called a state without an ego—a corridor between New York City and Philadelphia."

The lecturer, an old acquaintance of mine, dressed in a turtleneck sweater,

The author: Television commentator and journalist Jim Hartz turns to the printed medium after 20 years on the air.

New Jersey

“LIKE A BARREL tapped at both ends,” Benjamin Franklin said of New Jersey, referring to the influence of New York to the north and Philadelphia to the south. The analogy holds today, with more than 300,000 New Jerseyans crossing the Hudson and Delaware Rivers to go to work. But much remains in the barrel. Though only four states are smaller in area, New Jersey is a manufacturing giant, the nation’s largest producer of pharmaceuticals and second in chemicals. Its agricultural output is equally impressive, with farms, dairies, and orchards, upholding the nickname the Garden State.

AREA: 7,836 square miles.

POPULATION: 7,364,000.

ECONOMY: Chemicals, pharmaceuticals, petroleum products, electrical equipment, apparel, dairy products, vegetables, fruits, livestock, poultry. **CITIES:** Newark, pop. 329,000; Jersey City, 224,000; Paterson, 138,000; Elizabeth, 106,000; Trenton (capital), 92,000.



DRAWN BY JANE WOLFE
 COMPILED BY GRAHAM J. TRUSCOTT
 NATIONAL GEOGRAPHIC ART DIVISION

slacks, and loafers, was addressing a dozen or so students sprawled around the parlor of the governor's mansion, just down Nassau Street from the main campus and only a few miles from Trenton, the state capital. A fine way to behave in the governor's parlor? Well, the moonlighting part-time professor *was* the governor, Brendan Byrne, and he didn't mind.

He explained that being squeezed between two giants deprived New Jersey of the attention it deserves, and complained, jokingly, "most people whiz right through." He might have added that more than 300,000 residents whiz right out of the state each day to work in New York and Philadelphia.

"It's been an uphill battle from the beginning," the governor noted wryly. "In the Revolution they did the paperwork in Philadelphia and the fighting in New Jersey."

TRUE ENOUGH. Nearly 100 engagements were fought on New Jersey soil, including the all-day battle at Monmouth, longest of the war. Lexington, Concord, Valley Forge, and Yorktown may be more famous, but no state suffered more than New Jersey in the Revolution. General Washington spent nearly a quarter of the war, including three winters, in New Jersey.

Washington's crossing of the Delaware was the opening thrust of a campaign to recapture New Jersey after his ragtag army had been kicked all the way across the state by Lord Cornwallis. His first victory, over the Hessians, came at Trenton. His first defeat of British regulars occurred a few days later at the Battle of Princeton, fought a mile from where we sat that evening.

Though I respect Governor Byrne's thesis, I suspect that today the current is reversing, and the two giant neighbors may be suffering a bit from the tug of New Jersey's

The coffee's always hot at Rosie's 24-hour diner on Route 46 in Little Ferry. Built to resemble a railroad dining car, it has welcomed truckers and travelers here since 1945. Despite the growth of fast-food chains, New Jersey's three manufacturers of diners keep busy, building and trucking them in sections cross-country.

dynamism. For example, a large number of major corporations, including some corporate operations of American Telephone and Telegraph, have moved their headquarters from New York to New Jersey. The open spaces of the state are attractive, the land is cheaper, and the taxes are lower.

In the late 1960s New Jersey opened the Hackensack Meadowlands to development. Companies in modern new buildings, hotels, and housing developments are rising on what was once a marsh and a dump, only a few minutes from Times Square.

New Jersey lured the New York Giants professional football team out of Yankee Stadium to play its home games in a new stadium erected in the Meadowlands. The Cosmos soccer team plays there as well. And this season, the New Jersey Nets basketball team will play in the recently completed Meadowlands arena. New Yorkers come by droves to the new Meadowlands Racetrack, where some of the highest purses in racing are paid.

This spill-out of commerce and sports accelerated in 1976 when New Jersey legalized casino gambling in Atlantic City, the only such operation in the United States



outside Nevada. Resorts International, the first casino, bought the Chalfonte-Haddon Hall on the Boardwalk, refurbished it, and in May 1978 opened to long lines.

The casino is a cavern of crimson and chrome kitsch that covers 60,000 square feet. One Friday night I stood at the rail overlooking the gaming tables. They were jammed with players, but I had my eye on a pretty woman with shoulder-length dark hair. She headed straight for one of the 1,650 slot machines that stood in regimental rows. And within a few minutes, a few minor payoffs notwithstanding, I saw her turn away in disappointment.

"I've never gambled before, and I guess I should have quit when I was ahead," she said, when I asked her how she felt. "But winning makes you want to play more. And losing makes you want to get your money back." An astute woman, my wife.

Atlantic City could become the Las Vegas of the East. Eight casinos are already thriving. A dozen others are in the works. As of June, the state had collected more than 149 million dollars in taxes from gross winnings of 1.54 billion dollars.

The prosperity, so far, is confined to the

Boardwalk casinos. Atlantic City itself, which has been declining for more than a quarter of a century, is still hurting. Inflated prices are driving out long-term residents, many of whom are old, black, or Hispanic.

The Reverend Dante L. Girolami, pastor and prior of St. Nicholas of Tolentine Roman Catholic Church on Pacific Avenue, said, "This used to be a thriving parish. In Atlantic City's heyday, there were 11 Masses on Sunday. Today we are down to 180 parishioners, most of them over 65."

The high-paying jobs at the casinos are luring nurses and schoolteachers, skilled and unskilled Atlantic City residents out of productive jobs and into the gaming rooms. "I lost my housekeeper of nine years to the hatcheck room at Harrah's," Father Girolami lamented.

Others fear a more sinister influence. "Organized crime is definitely involved," said Joseph H. Rodriguez, former chairman of the New Jersey State Commission of Investigation. "I just hope Atlantic City doesn't become the government of the state. Right now we're blinded by the balance sheet."

The explosive growth of Atlantic City has sent shock waves into the Pine Barrens,



MICHAEL E. FARABO





MICHAEL S. YEMASHITA

Lured by dreams of fortune, Atlantic City gamblers turn Caesars Boardwalk Regency Hotel Casino into a blur of activity (left). Outside, the Boardwalk reflects from the hotel's mirrored facade (below). Casino gambling was legalized by a 1976 statewide vote. The stakes are high—the take from bettors topped 623 million dollars in 1980—and security is tight. Resorts International uses television (below left) to watch for suspicious behavior at the tables and in the counting rooms. The city's heyday as the queen of Atlantic resorts began in 1854 when a railroad linked it with Philadelphia, and by 1900 visitors could choose from 500 hotels and guesthouses. Over the years visitors enjoyed such amusements as men boxing kangaroos or jumping from blimps. Automobile and airplane travel led to a decline that, city fathers hope, has been reversed by the shuffle of the deck and the click of the dice.



NOB KRIST (ABOVE AND LEFT)

which fan out west from the resort. The pinelands, a still largely unsettled, ecologically fragile paradise of wildlife and exotic flora, are one of New Jersey's most valuable natural resources.* Now they are becoming an inviting target for development. Speculators, including some casinos, have taken options on vast tracts of land. But the state and federal governments have moved decisively to control growth.

A moratorium on construction, declared in 1979, extended all the way down to small landowners who wanted to build single-family houses. Restrictions were placed on how and to whom land could be sold. Such land-use provisions have incensed Atlantic City interests who need housing for employees, contractors who want to build it, farmers who fear their land will become worthless, and individuals who resent government intrusion into their lives.

"Can you believe they want to put a water meter on my well?" asked Marvin Matlack, who owns five acres in Chatsworth. The water beneath the pinelands—an aquifer big enough to supply most of the state—is a prime concern of the state and federal governments. "I'm all for preservation," Matlack contended. "I like this area the way it is, that's why I live here, but I want my children to be able to build here too."

Budd Wilson, an archaeologist who lives on the eastern edge of the pinelands, deplored the way the preservation act was drawn. "It's a law to protect something natural; it's not about the people who are here and the rights they might have. I'd rather have seen preservation through education and water and sewage regulation."

A parallel preservation problem in the industrialized north is how to save the older, decaying cities. Newark, the largest city, has lost 25 percent of its population since 1950. Why? Not only are tax and crime rates among the highest, but when Newarkers

*John McPhee described this 1,000-square-mile backyard of quiet rivers and near-empty acres in the January 1974 NATIONAL GEOGRAPHIC.

grow old, they want to leave the inner city and move to nearby suburbs.

"We have a nine-year wait for senior citizen housing," a county official told me. "Can you imagine telling someone who is 65 to come back when he's 74?"

Millions of dollars of federal money have been poured into Newark, yet it still languishes. Mayme Jurkat, an urban planner at the Stevens Institute of Technology in Hoboken, worries about the problem of institutionalizing poverty in places like Newark. "The federal money has had a negative impact. The city has come to depend on it," she said. "Newark has become a ward of the federal government. And if you get money for negative characteristics, then you don't want those characteristics to go away."

DESPITE this grass-roots poverty, Newark remains the banking capital of the state, a hub of manufacturing, the home of Prudential, the nation's fifth richest corporation and largest insurance company. And Newark is at the center of transportation on the East Coast. As Malcolm Forbes, a Jerseyan and owner of the business magazine that bears his name, put it: "There's no other transportation complex like this in the world. One-third of the American marketplace is within an overnight truck ride from New Jersey. While trucks are rolling down the turnpike, planes are coming into Newark International Airport on one side, and on the other are all these containerships and trains [pages 574-5]. This is the most essential piece of turf in the East Coast megalopolis."

Lewis Perlmutter, a laser engineer who lives in Jersey City, believes northern New Jersey cities can be renewed, for a simple reason: "It's a bargain living here." Lewis and Jackie Glock renovated a 120-year-old brick town house on Jersey City's Hamilton Park. They are pleased with their bargain.

"Used bricks are selling for 20 cents apiece today," Lewis said. "Why, the value of the bricks alone in this building is \$20,000, not

Pushing and pulling against the tide, a team from Lavallette sets out on a 300-yard course during the annual Bradley Beach Invitational Lifeguard Tournament. Drawing from New York and Philadelphia, New Jersey's 127 miles of public beaches attract more than two million visitors a day during the summer. BOB ARIST



Subduing a deadly foe, fire fighters hose down the remains of a dump site in Elizabeth that exploded, shooting barrels of illegally stored chemical wastes 200 feet in the air and polluting waters of the Arthur Kill. New Jersey ranks high among the states in the number of potentially hazardous waste sites.

counting the cost of putting them in place. We paid \$21,000 for the building in 1979, and today it's worth about \$150,000.

"Our move has certainly made sense. We're five minutes from Wall Street by train at half the price of the New York subway. Over here you can get ten times the space for the same price. Everything is cheaper."

Others are following their lead. On another side of Hamilton Park I saw 86 condominiums about to open, all carved out of buildings as old as theirs.

Another of New Jersey's aging industrial cities, Paterson, is saving its old buildings on a much larger and public scale. Paterson, the nation's first planned industrial city, was the brainchild of Alexander Hamilton, first Secretary of the Treasury, who contended that the United States would never be free of England until it had its own manufacturing capability. He urged that the power of the great falls of the Passaic River, site of present-day Paterson, be tapped and factories built.

Paterson became a cotton-mill center, then the silk-manufacturing capital of the nation. It also starred as the largest locomotive producer in the country. The engine that powered Charles A. Lindbergh's *Spirit of St. Louis* was built in Paterson; so was the first Colt revolver. During World War II it produced aircraft engines. But over the years manufacturers kept moving to greener pastures, abandoning the old red-brick factories that had been standing for a century.

In 1976 Paterson tried for a novel comeback. The entire region around the falls was declared a national historic landmark. With an infusion of federal funds and by the hands of the city's skilled craftsmen, the region is coming to life again. The city is gambling that the offices, shops, restaurants, and artists' lofts going into the old buildings will attract new businesses.



At the same time Paterson was developing into a manufacturing center, nearby Morris County, now a comfortable suburb, was a thriving iron-mining and smelting district—that is, until the 1820s when it was hit by an energy crisis. The trees that fueled the furnaces had been chopped down and burned.

Salvation was offered by the hard-coal fields in eastern Pennsylvania. The problem was getting the coal to Morris County, but



BOB BRIST

local businessmen had an audacious plan: the Morris Canal. Digging started in 1825, and within six years it was opened, running from Phillipsburg on the Pennsylvania border through Morris County to Newark. By 1836 it reached the Hudson River at Jersey City, a distance of 102 miles.

Surmounting the heights along the route was a stupendous engineering achievement. Boats entered the canal from the Delaware

River at Phillipsburg and, through a series of locks and ingenious inclined planes, were hauled up 760 feet to the topmost point near Lake Hopatcong, and then lowered 914 feet on the way to the Hudson.

"A one-way trip generally took about five days," said Jim Lee of Phillipsburg, a man who has made a lifelong study of the canal. When he was discharged at the end of World War II, Jim bought a portion of the old, then



abandoned canal. He still lives in a plane tender's house, a lovely cottage that sits atop a 1,500-foot-long inclined earthen plane, up which the canalboats were hauled.

"The boats were floated into wooden cradles attached to a three-inch-thick cable, then hauled to the top on rails," Jim said. "The whole thing could weigh 125 tons, pulled up by 3,000 feet of endless cable, but would take only about 12 minutes to reach the top. The power came from a water turbine connected to the cable. The canal was tapped at its upper level, and the water was channeled down here to spin the turbine."

The irony of Jim's devotion to the Morris Canal is that the railroads put it out of business, and he has been a railroad conductor for 40 years. "Like the ancient mariner who shot the albatross," Jim said, "maybe I'm fated to talk about the damn thing."

Canals, the Morris and later the Delaware and Raritan, as well as the early railroads, fueled New Jersey's expansion as an industrial empire. And with that came an explosion of science and technology in the state.

New Jersey today ranks among the top ten states in number of scientists and engineers. For a century it has been a research and development center. Indeed, the team concept of R & D began in New Jersey in the "invention factories" conceived by Thomas Alva Edison.

At his zenith Edison presided over a 29-acre research and manufacturing empire in West Orange. In his lifetime he amassed more than a thousand patents, a record no other inventor has matched. His goal, he once said, was "a minor invention every ten days and a big thing every six months."

Only one and a half acres of the complex



OUTH BY MICHAEL S. YAMASHITA

Idle hands symbolize the plight of Newark (left), suffering from a 13 percent unemployment rate. But boosters are heartened by industrial development along the New Jersey Turnpike and a boom in downtown office construction.

Jersey City's triple threat: the Koralja triplets (above)—Andrew, Joseph, and Robert, from left—combine 42 years of service on the police force.



Flurries of snow geese fill the spring sky over Dennis Creek Fish and Wildlife Management Area on Delaware Bay. Drawn by the rich cover of cordgrass, some



BOB BRINT

100,000 geese annually use state preserves as staging areas. New Jersey's 230,000 acres of salt marsh attract millions of waterfowl that travel the Atlantic flyway.

Red-carpet treatment: The heat of sunlamps helps soothe sore and injured horses at Showplace Farms in Englishtown (below). Organized in 1885, the Monmouth County Hunt Club hosts another club at a hunt breakfast (right).



survive, set aside as a national historic site. Preserved there for visitors are his ornate office filled with his books, a turn-of-the-century workshop, and a sampling of his inventions. Off limits to tourists is a massive underground vault, built during World War II when it was thought Germany might bomb the East Coast. There three and a half million pages of Edison's personal papers, correspondence, and patents, as well as patent models, are stored.

"It's one of the nation's real treasures," said archivist Reed Abel, as we strolled the aisles. Abel showed me some of the 9,000

glass-plate negatives of original Edison inventions, and models of devices that Edison patented: early light bulbs, phonographs, motion-picture cameras, storage batteries. In an inner sanctum, a vault within the vault, were Edison's 3,000 laboratory notebooks. Usually the time of a discovery, or the failure of an experiment, was noted, sometimes with an expletive, and the time was often in the wee hours of the morning. One notebook bore the inscription, "Not for small brained capitalists."

In 1876, three years before Edison patented the electric light bulb, another of the



REITH BY MARTHA COOPER

nation's earliest inventors, Alexander Graham Bell, had invented the telephone. Although he did not live in New Jersey, the Bell System, the sprawling giant that grew from Bell's invention, is today New Jersey's largest private employer. I found it interesting to compare its main research and development center, Bell Laboratories at Holmdel, with Edison's pioneering efforts.

"This is a shopping mall of technology," explained Lee Thomas, a specialist in VLSI (very large-scale integrated) circuits. "Every scientific discipline you can imagine is represented here. People work night and

day and on holidays. I love it." He was born in Texas, but says he'll never leave New Jersey. "The best brains in the nation are here."

Thomas handed me one of Bell Labs' latest inventions, a VLSI about the diameter of a penny, made of silicon, wafer thin and light as a feather. "There are 100,000 transistors on it," he said, "and soon we'll have 150,000. It will cost about \$100 to make, use half a watt of power, and control 10,000 telephone conversations simultaneously."

The transistor itself was invented at Bell Labs 34 years ago. Over lunch with the executive director of communications sciences

research, Arno Penzias, I jokingly asked what Bell Labs had done since then.

"Well, not a lot that our customers can see," he replied in the same vein. "But satellites, fiber optics, and digital technology now let you talk to a whole lot more people and keep your phone bill down. The complexity of that is hidden from view, but managing complexity is probably the most important single thing we do. Our worldwide communications system is, I think, the most efficient on earth."

Penzias shared the Nobel Prize in Physics in 1978 for his accidental discovery confirming the big bang theory of the creation of the universe. "We were trying to examine radio noise from the Milky Way. We found much more noise outside it, and that turned out to be the echo of the fire of creation." Bell Labs likes to dovetail pure and applied science. Such radio measurements helped determine how strong a signal Bell's communication satellites would need to rise above the background radiation.

WONDERED what other famous R & D operations had been doing since their early triumphs. Like Hoffmann-La Roche Inc., where one of the nation's largest selling prescription drugs, Valium, was developed not many years after the transistor. The firm occupies a 70-building complex at their corporate headquarters in Nutley.

It turns out Roche has recently produced a pure form of interferon that may be the long-sought substance to control certain types of cancers and viral infections. "Interferon is produced in the body naturally in response to viral invasion, but in very minute amounts," said Dr. John J. Burns, vice president for research at Roche. "Now we are making it by recombinant DNA technology, using a bacterium that is programmed to produce interferon by genetic engineering." The gene-splicing techniques used at Roche produced enough interferon to begin the first clinical tests in January 1981.

New Jersey is the nation's leader in the production of pharmaceuticals; it is also in the forefront of petroleum research. Though there is not a single oil well in the state, one of the world's largest petroleum research centers, Exxon Research and Engineering Company, sprawls along Route 1 at Linden.

Here scientists are studying how to stretch the world's remaining crude-oil reserves, and what to do when we run out. Exxon believes gasoline can eventually be made from coal at economical prices.

More fascinating than these energy researches is Exxon's probing into liquid membranes, tiny droplets of oil that behave like the walls of human cells, determining what to let pass in and out. The most promising application is in reducing the time kidney patients have to spend on hemodialysis machines. A liquid membrane, now being tested in animals, is swallowed in a milkshake-like preparation. It passes through



MARTHA COOPER

the stomach and into the small intestine, where it absorbs urea and then expels it in the stool. Eventually, liquid membranes may be used to absorb other body toxins, perhaps from drug overdoses.

In sewage treatment the oil membrane can be made to suck up contaminants, and someday may offer a solution to one of New Jersey's biggest problems—how to rid itself of toxic wastes. Chemical manufacturing is the state's largest industry, but safe disposal of chemical wastes and by-products was long neglected. Often they have been disposed of illegally by outfits known as "midnight dumpers." New Jersey Department of

Environmental Protection Commissioner Jerry Fitzgerald English said, "So far, we've identified more than 300 abandoned dumping sites in the state. We are in the process of determining what's in them in order to clean them up."

As a result of illegal dumping, New Jersey adopted a hazardous-waste bill and was the first state to prosecute illegal dumpers. "We treat it not only as a civil infraction but also as a very serious criminal activity. The penalties can run high, as much as \$25,000 in fines a day and prison sentences up to five years," Commissioner English said.

Enforcing the law is another thing, Marie

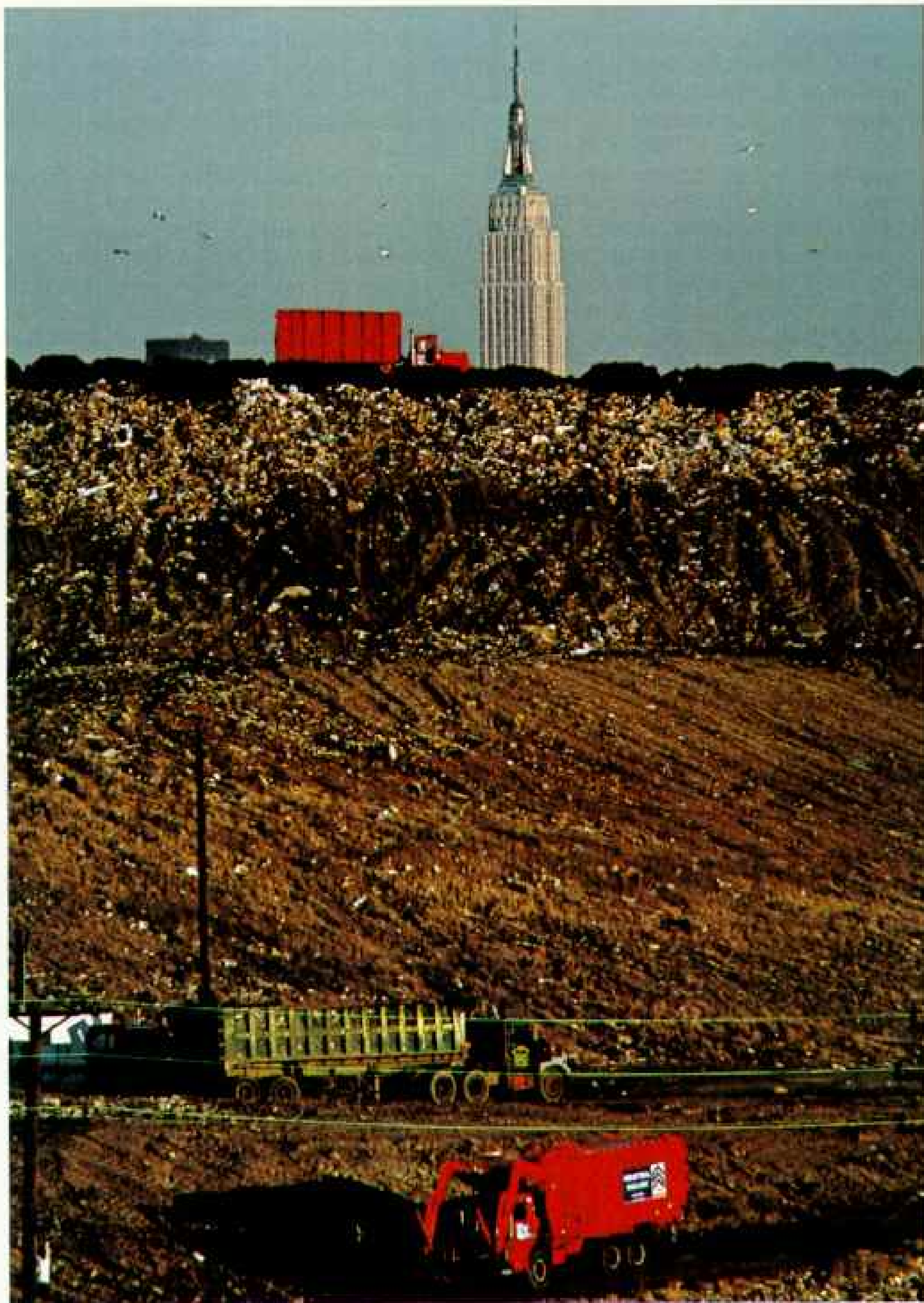


Harvesttime pride beams from Peter Chon (left), who picked a hefty radish on his family's farm near Malaga. His Korean-born father, Insu Chon, markets Oriental vegetables as far west as Chicago.

Plump blueberries (above) stain the hands of grower Albertus Pepper of Chatsworth. A helper, Bobby Bowker (right), temporarily beat his record of balancing 18 empty boxes. The Pepper family, selling through the Tru-Blu Cooperative, helps make New Jersey second only to Michigan in blueberry production. With rich soils intensively cultivated, New Jersey farms fetch an average \$3,000 an acre, far exceeding the U. S. average of \$790.

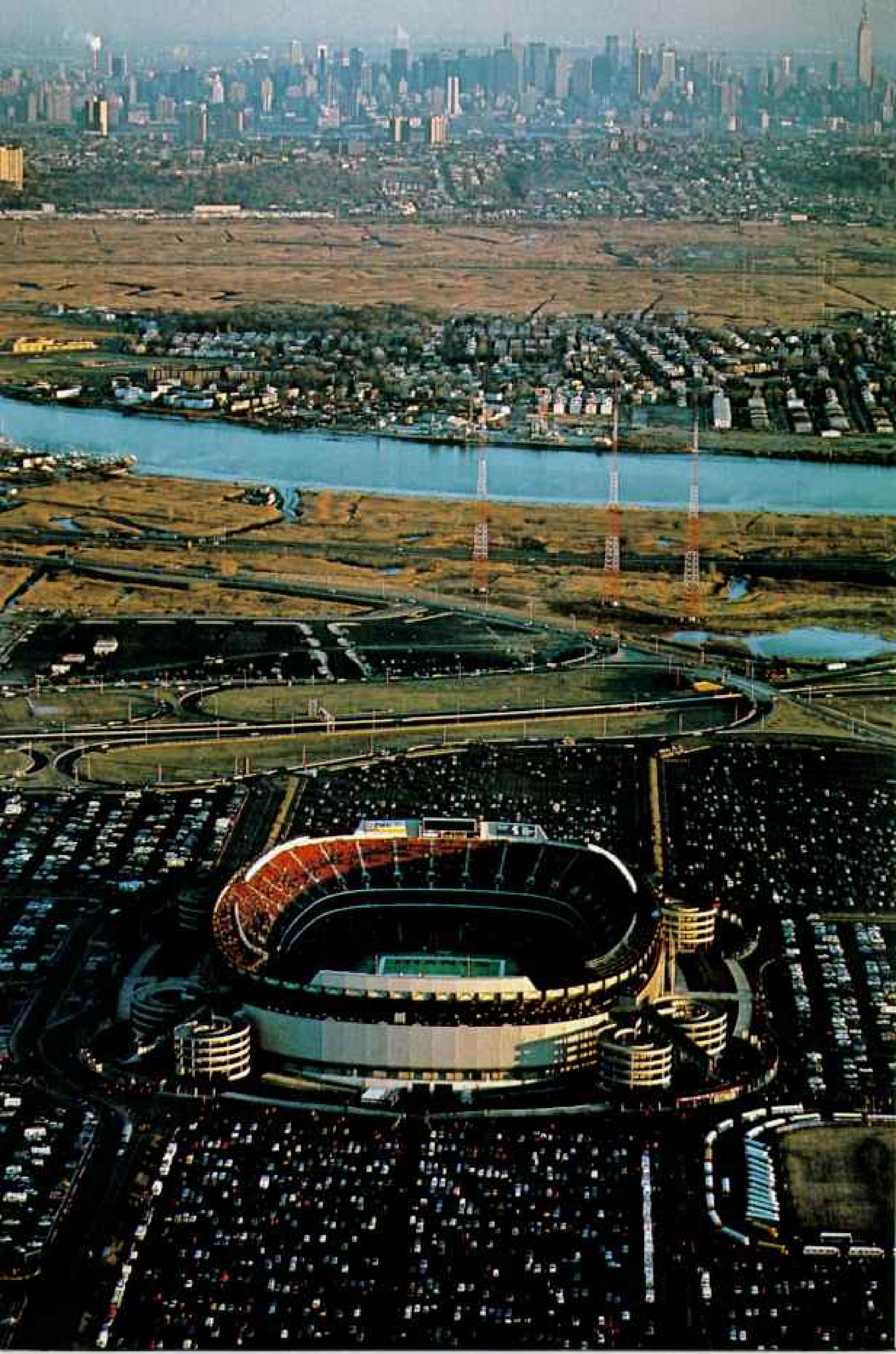


BOTH BY BOB KRIST



BOTH BY MICHAEL S. YAMASHITA

Marshland and garbage turn to pay dirt in the Hackensack Meadowlands, long used as a dump. Part of the planned 2,000-acre DeKorte State Park (above) will become a ski slope. Fans cross over from Manhattan (right, at top) to see the New York Giants compete in the stadium, also the home of the Cosmos soccer team. The New Jersey Nets play basketball in a nearby arena.



Newhard, who lives in Presidential Lakes on the edge of the pinelands, told me of trucks "dumping stuff in the lake behind our house in broad daylight. It's sickening. Someday that's going to be our drinking water, and we can't get anyone to stop it."

According to Edwin Stier, head of the criminal justice division of the state attorney general's office, some midnight (and daylight) dumpers are controlled by organized crime. "At first we went after the individual truckers," he said. "Now the campaign is against the higher-ups, and convictions have been obtained."

I asked Stier whether New Jersey's reputation as a haven for organized crime was deserved. "Like most big states we have our share," he said. "It got a foothold during Prohibition. We had a long, unguarded coastline that made smuggling easy. We had

the isolated Pine Barrens, where stills could operate. We had a large immigrant population that was an easy mark for organized crime. And until a few years ago New Jersey didn't have an adequate statewide force to prosecute large-scale crime. Local communities couldn't handle it."

The sheriff of rural Hunterdon County, in New Jersey's far west, never had such problems. Sheriff Ruth S. Carpenter, the first woman elected to that office in New Jersey, doesn't even carry a gun. "I can talk people out of most things," she laughed.

Her office is in the historic Flemington Courthouse, where the celebrated Lindbergh kidnapping trial, the so-called trial of the century, was held in 1935. "Law students still come here and read the transcripts and scan the old newspapers, but nobody much cares any more," she told me.



We looked at the faded pictures of Charles Lindbergh, the famous aviator, his wife, Anne Morrow Lindbergh, their baby, Charles Jr., and the man electrocuted for killing the child, Bruno Richard Hauptmann. How about the old Lindbergh mansion, I asked, the scene of the crime; was it still standing on the hilltop near Hopewell?

It was, but it was not easy to find. Charles Lindbergh prized seclusion. The house was at the end of a long, narrow road that penetrates a thick forest. It had changed little from the old newspaper photos.

"The mansion belongs to the state," said James Morrison, the young man who met me at the front door. "It's a home for youthful offenders." He was assistant superintendent in the program that gets young troublemakers off big-city streets and into a rural work atmosphere.

Jim showed me around the house and grounds, well kept and still elegant. "A few tourists make their way up here now and then," he said, "but not many realize what the house is used for now."

Another tragedy of the 1930s that catapulted New Jersey into the headlines was the crash of the dirigible *Hindenburg* at Lakehurst. Driving across the scrublands of central Jersey, I was attracted by the massive hangars of the onetime dirigible base. Nick Grand, a public affairs officer, gave me a tour. "This was the nation's major international airport," he said, "for dirigibles crossing the Atlantic in the 1920s and '30s."

Today the base is a U. S. Navy engineering and testing facility. We drove into the 800-foot-long main hangar, which dates from 1921. A good portion of its 36 million cubic feet was filled with a scaled-down deck

Queuing up to cool off, sisters stop for ice cream (left) during a summer stroll near Villa Maria by the Sea retreat house at Stone Harbor. Operated by the Sister Servants of the Immaculate Heart of Mary, a teaching order, Villa Maria holds seven ten-day retreats each summer, attracting participants from nine states.

With knowing smiles, members of the nation's first all-female state police class watch as trooper Rudolph Chesko shows them how to fold their gear—in this case, undergarments. The agency swore in 30 troopers from the class, formed last year under pressure from the federal government to hire more women. Graduates from a coed class this year brought the number of women in the 1,910-member force to 40.



BOTH BY BOB KRIST

of an aircraft carrier, complete with real jet fighters, tractors, and catapults. "This is where all the Navy's flight-deck officers are trained," Nick said. "We can do everything except launch a plane out the door."

Once I got over the shock of finding an aircraft carrier in an old hangar in the center of the state, one big piece of the New Jersey puzzle fell into place. Industrial archaeologist Ed Rutsch had rhapsodized about the "adaptive reuse" of antiquated structures.



MICHAEL S. YAMASHITA (ABOVE) AND BOB KRIST

Rhythmic images dance on a screen linked to Stanley Jordan's guitar via a synthesizer the Princeton University music major built for concerts.

Her torch raised high over New York's harbor, the Statue of Liberty stands in New Jersey waters, her spirit undaunted by industrial Jersey City.

Lakehurst suggested that this blending of the old and new with hardly a shrug, with all the confidence that comes of maturity, was a central motive of New Jersey life. Cape May proved it.

"Cape May received a three-million-dollar urban-renewal grant to stay old," a local scholar of New Jersey's past and present told me. One of the nation's oldest summer resorts, renowned years ago as the watering place of Presidents—Buchanan, Pierce, Harrison, Grant—Cape May is today a Victorian architectural gem. More than 600 structures from the last century survive.

The well-kept, turreted, filigreed buildings grace winding, shaded streets. Hundreds of thousands of vacationers go there every summer to be transported back to a simpler, less hurried time.

I stayed at the Chalfonte Hotel, a three-story, hundred-room structure built in 1876 (pages 572-3). Things haven't changed much since: no elevators, no air conditioning, no room phones, and the "facilities" down the hall. It's still a grand old place and has the most wonderful cook in the world.

Helen Dickerson, 70, has been cooking three meals a day for a hotel full of guests for 45 years. "I've never used any recipes," she said, stirring up homemade mayonnaise. "I just quit when it looks good."

Her specialties are prime ribs, kidney stew, southern-fried chicken, and spoon bread. She gets up before dawn every morning and does all the shopping. That's New Jersey hustle. That's tough.

ONE EVENING, after the sun went down, I sat in a rocking chair on the hotel's wide veranda, watching strollers along Howard Street caught in the flickering reflections of the gaslights in the center of town. Hotel manager Judy Bartella came out and asked if I was bored.

"We have an old television somewhere," she said. "I'll get it if you need a fix."

I declined the offer, preferring instead to while the evening away, silently wondering how I could have missed so many things in New Jersey in all those years I lived so close. And, too, feeling a little sorry for all those people who never get off the road and see one of our most historic, productive, and elegant states. □



ATLANTIC SALMON

The "Leaper" Struggles to Survive

By ART LEE

Photographs by BIANCA LAVIES

NATIONAL GEOGRAPHIC PHOTOGRAPHER

QUEBEC'S CAUSAPSCAL RIVER thundered through the falls below granite cliffs. Despite a low tolerance for blackflies, I waited quietly. In such a beautiful and inspiring place, blackflies somehow don't seem so bad. Deep in the rushes of tea-colored water, salmon stirred; I knew that if I looked away the first might show, and I would miss it. It seemed essential to cheer the first one through the falls on this sunny mid-June day on the Gaspé Peninsula.

The water was too dark and deep to see them, but the salmon followed invisible threads of current in the hole below the falls. Some strange stimulus, one of many mysteries about Atlantic salmon, *Salmo salar*, the "leaper," would tell each when its time came to leap the falls and beat upstream.

As a fisherman, I had often challenged Atlantic salmon, attributing to them courage, determination, stamina. Yet I killed them. I teased them with flies dressed on hand-forged hooks by master craftsmen. I cursed them when they wouldn't be lured and felt a profound feeling of emptiness with each fish lost, as if there would never be another. And

yet, no feeling could compare to the one each time a salmon was lifted writhing from a landing net.

I waited at the falls, a sanctuary for returning fish 12 miles up this tributary of the Matapédia, with Richard Adams, a riverman and guide. The blackflies haven't eaten him since his skin turned to leather, and he waited placidly with abiding faith that the fish would come. Richard lived with the fish, he told me, and had learned to love them as a father loves his children, although, he said, salmon really belong only to the river.

Because Atlantic salmon are seldom seen at sea, it's easy to believe that they belong to fresh water more than to salt. But they do go to sea when still small to feed rapaciously for a year or more on such fish as capelin and on tiny crustaceans, to grow long, heavy, and powerful. Salmon are, however, anadromous, meaning "upward running" in Greek. Thus, without access to pure, cold rivers up which the fish migrate to spawn, there would be no Atlantic salmon.

Sometime during the second hour of waiting, I thought: There are no salmon here.

Fighting against odds, an Atlantic salmon in Newfoundland's Humber River returns to spawn. Conservation efforts have brought back the noble fish to several rivers, but ocean fishing has cut the annual catch by nearly half since 1967.





Sport of "sports"

COMPLEAT ANGLING at its most refined: John Lindsay (right), a gillie, or gentleman's fishing guide, assembles a rod for his "sport," Robert Soper of Edinburgh, on the Scottish estate of the Earl Haig of Bemersyde. The best "beats" on the River Tweed are privately owned or leased. Angler George Aithen (above), sampling waders at an exclusive Pall Mall shop, belongs to London's Flyfishers' Club, formed in 1884. The club motto: "There's more to fishing than catching a fish."







Mysterious trails lead salmon home from ocean feeding grounds as far as 2,500 miles away; odors in currents may help guide them. Just above Big Falls on the

Rivers may flow by you looking fine, even when they're dead.

Then the first salmon tried the falls. For fleet seconds only, it hung suspended in the spray, so close I might have touched it—a reaching, essential force, faithful to its destiny. Richard was grinning. "I'd be ashamed if I didn't respect the salmon," he shouted.

Europe Too Has Troubled Waters

"It is not until the salmon are few that you realize how you long to see them," Christian Vernes, a Paris banker, had said months earlier on his Brittany estate. We sat spreading *pâté de jambon* on fresh bread and looking through a bay window onto the Ellé River where it rolls over a small dam. "It is the same, I think, with all our rivers. Once many salmon were jumping this dam. Now

there are few. The pollution is very bad."

"Where is the pollution?" I asked.

"The worst is from a pea cannery far upstream," he answered.

"Can't the cannery owners be forced to stop polluting the river?" I asked.

"It is a difficult question of economics," he answered. "People here don't think of salmon. They think of jobs. So now the salmon are too few to fish for."

Scientists estimate that *Salmo salar*, a single species, may once have been as abundant as all five species of the Pacific Northwest. Two centuries ago hundreds of rivers above latitude 40°N with access to the sea, from Portugal to Connecticut as the southern limits, possessed Atlantic salmon runs.

France, Spain, the British Isles, Scandinavia, Russia, Iceland, Newfoundland,



Humber River, exhausted salmon—some gashed from falling on the rocks—struggle past the photographer, who tied herself to a boulder to capture this view.

Labrador, Quebec, the Canadian Maritimes, and New England had them. The Loire, Seine, Rhine, Thames, St. Lawrence, Kennebec, and Connecticut Rivers teemed with salmon. These were the days before dams and diversions, cutting of trees, overpopulation, and pollution ruined so many rivers.

"The Seine is finished," Pierre Affre, a French conservationist and salmon scholar, told me in Paris as we gazed at the muddy river gliding through its walled channel below the Pont Neuf.

"We French aren't conservationists by nature," Pierre said. "We are Latins, hot blooded, and we like to kill. We have killed the Seine as we kill hares during hunting season, just for fun.

"To see salmon in the Seine again is my

dream," he said. "Maybe there is a chance for the Loire and Allier—they still have a few. But the Seine, I don't know."

A couple were embracing on the cobblestone walk along the river below us. Pierre brightened. "When you are kissing, you cannot smell the river," he said.

Science Ponders Homing Methods

The life cycle of the salmon is an evolutionary miracle. Ideally, Atlantic salmon return to rivers of their birth at varying intervals—primarily spring, early summer, and fall. How they find their ancestral streams is one of the great mysteries of biology. There are many theories: that salmon follow sea currents until they are led back home; that they always swim toward colder water; that they use highly developed olfactory senses to



A hooked-jawed male fertilizes ova deposited in one of several nests, or redds, dug by the female in a Newfoundland brook. After fertilization she covers the eggs with gravel raked in by her tail. Of 7,500 alevins hatched in an average nest,



perhaps four will escape such predators as trout, seals, and mergansers to make the round trip to sea and return; only two may spawn. Unlike Pacific salmon, which die immediately after spawning, some Atlantic salmon live to spawn again.

sniff out home; that they are guided by the stars or the electric impulses of the earth's magnetic field. No one really knows.

Salmon frolic in estuaries off home rivers, gradually becoming accustomed to brackish water before making a run into fresh water. An old Canadian bush pilot told me of seals waiting for salmon in the estuary and lower pools of the Moisie River on the north shore of the St. Lawrence in Quebec, and how fancy sportsmen hired Indians to shoot the seals so that there would be more salmon in the river for them to catch.

Once in the rivers, salmon may stay the season just above tidewater or run far inland, traveling as far as 25 miles in a day. They are capable of running powerful rapids and jumping falls 12 feet high. Often when I caught them, I found their bodies badly bruised by this punishing travel. It's a myth that the very biggest fish, all females, enter rivers first, but the big females that do come first, along with the big males, seem to make long runs. An Atlantic salmon may run hundreds of miles from the sea to spawn.

As they migrate upriver, each salmon somehow finds the turnoff to its natal stream, no matter how many tributaries a river may have.

Fish Fail to Find New Home

"We sold some fish to a club 60 miles away, where they were released into the club's river," Thór Gudjónsson, Iceland's director of freshwater fisheries, recalled one day. "They went to sea, but after several days a few showed up here at our hatchery." He laughed. "The club refused to pay for those fish, and I couldn't blame them."

Returning Atlantic salmon give up eating after leaving salt water. In fresh water for as long as a year, they survive on fat built up on the feeding grounds at sea. Soon after entering the rivers, they begin to change. Internally, digestive organs shrink to make way for developing sexual equipment. Externally, they darken, silver sides turning tannish, then brown, and their blue or purple backs become almost black.

Changes are most striking among males, which develop wicked hooked lower jaws, called kypes. Shortly before spawning, males may take on impressive coloration, resembling giant brown trout with expansive

red and orange blotches on their sides, splashes of rich yellow on their bellies. Most fishermen, however, favor them fresh and silver, because it's then they are most willing to take a fly, fight hardest, and taste best.

When nights become frosty and water cools to about 40°F, salmon move at last to gravel bars to spawn. Spawning occurs from September to January, depending on the region. Sometimes they make runs upstream, but often they need only glide to bars nearby from pools where they were holding.

Before spawning, there's a lot of jockeying for position and fighting among females, called hen fish. The best conditioned usually claim the best spawning places. Males, called cocks, have terrific bouts. Some cocks maneuver well like true boxers, while others are tough but defensive like good counter-punchers. The most powerful are very aggressive, charging and butting until weaker fish are hurt badly or driven off.

The hens roll on their sides and flutter their tails in the gravel, making hollowed-out places called redds. There the hens are joined by males, which wait trembling. Mating salmon lie side by side, and the females deposit eggs, which are fertilized with milt, a milky liquid ejaculated by the males. A hen salmon lays between 700 and 800 eggs per pound of body weight, and when they are fertilized, she covers them with gravel. The cock fish may then go off to serve several other females.

Atlantic salmon, unlike the Pacific varieties, which are physiologically determined to die after spawning, aren't necessarily used up by the act, though many don't survive long. Some, mostly females, live to spawn again one or more times, making the same journey each time. The record is six. Fish that have spawned are called kelts, slinks, or black salmon.

In the spring about 60 percent of the eggs hatch, and the tiny fish, called alevins, remain in the gravel several weeks, nourished by their yolk sacs (right). They swim up when they are about an inch long and begin to live off the river, first on microscopic organisms and finally on insects and worms.

Young salmon spend several years in the rivers. Little salmon are first known as fry, then fingerlings, and finally parr, which is the longest freshwater stage. Parr look like



Budding strength shines through a ten-week-old salmon as it breaks free of its embryonic membrane. For several more weeks it lives off its yolk sac, then rises to eat microscopic plants and larvae. Turning silver two to four years later, it heads downstream, developing a tolerance for salt water as it enters the sea.

small brown trout but are much more aggressive, leaping clear of the water to glut themselves on insects. I've seen a three-inch fish impale itself on an artificial fly as long as it was, jumping without effort, carrying the heavy line and hook.

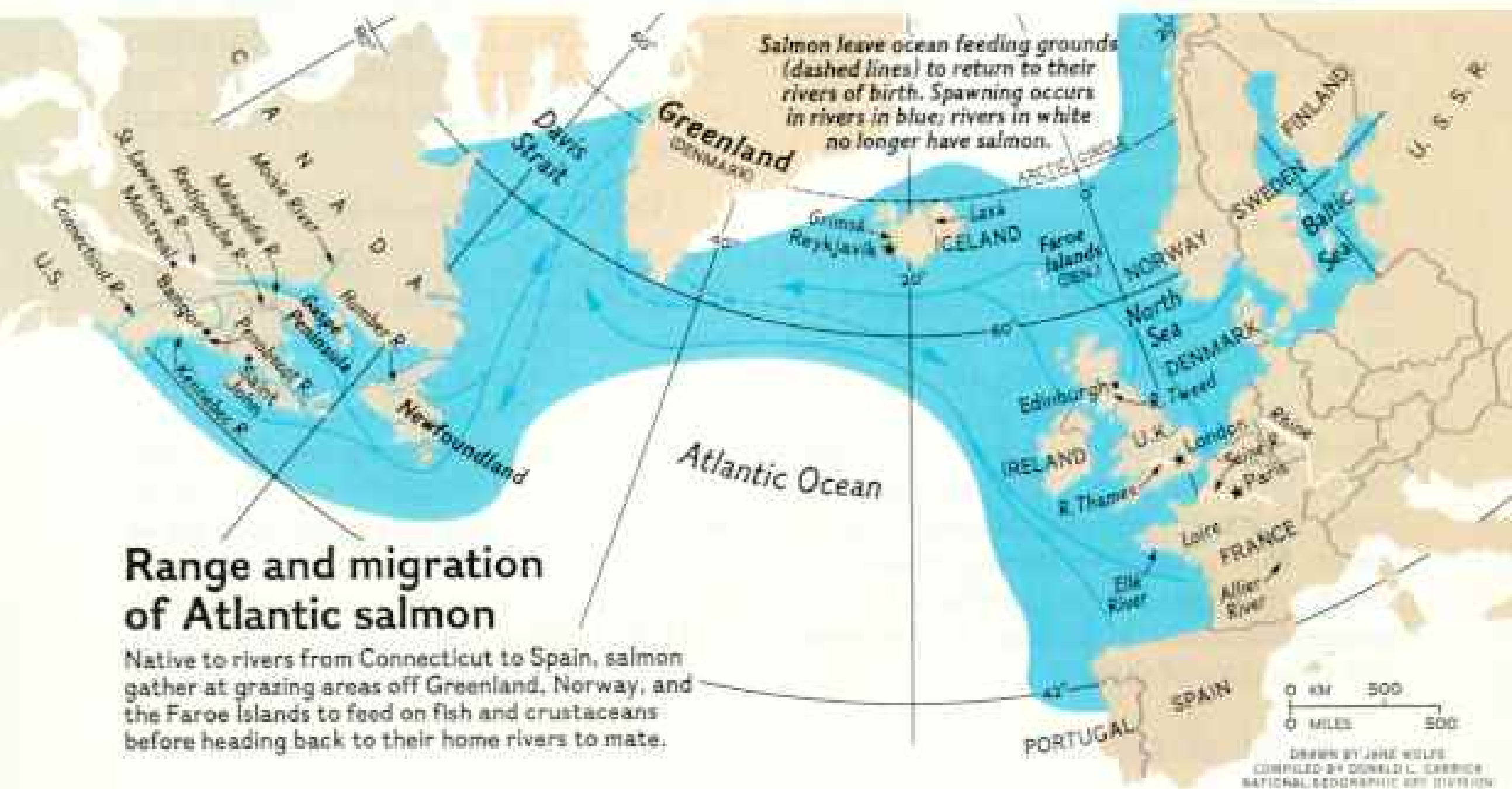
When salmon turn silver, at about six inches, they are ready for the sea. Known as smolts, they travel downriver and school in tidal pools before disappearing forever, or until ready to return to renew the species.

Odds are terrible against newborn Atlantic salmon making it through the cycle, even to return as grilse, fish of between three and six pounds that have spent only one winter at sea. Young salmon are food for many predators: trout, eels, mergansers, herons, otters, mink. At sea salmon often travel thousands of miles, to Greenland and the Faroe Islands (map, following page). Though some, like most Icelandic salmon, remain closer to home, they aren't free from predation. Of every 7,500 eggs hatched, perhaps 50 salmon survive to the smolt stage, four to return to a river, two of them to spawn.

"Man is the most relentless predator," Richard Buck, chairman of Restoration of Atlantic Salmon in America, said to me. Dick spearheaded a successful international effort to curb high-seas fishing off Greenland, after commercial interests discovered the salmon's feeding grounds there in the late 1950s. Now Dick is devoting his efforts to helping secure a multilateral treaty that would protect Atlantic salmon from ocean overkill anywhere.

Despite Problems, a Little Hope

"Conservation that limits kill isn't enough," he said. "The decline of salmon has gone too far. Conservation must be extended; that means restoration. You can't dam rivers and have salmon. You can't pollute rivers and have salmon. You can't poach rivers and have salmon. Hatcheries help some, but where do you get stock for all the hatcheries? Even cleaning up the rivers won't help unless we convince dammers to build fish ladders. Clean water doesn't mean anything to salmon unless they can get to it."





BOTH BY CHRIS LEE

Iceland: conservation leader

STRICT CONTROLS on commercial fishermen—as well as on anglers like the author, here fly-casting on the Grimsá—allow Icelanders to maintain their salmon stock even as the world catch declines. Because of massive ocean netting, reported home-water harvests fell more than 40 percent from 1967 to 1980—from 2.9 million to 1.65 million fish.

Also increasingly hard to find are speckled bustard feathers and 27 other materials needed to tie this popular Jock Scott salmon fly.



While only Iceland's salmon stocks appeared secure to me, Dick Buck and others indicated "guarded optimism" for the northeastern United States, notably Maine, where restoration has been going on since 1948. During the past few seasons Bangor residents were dazzled when, after 30 years, great numbers of fish showed in the Bangor Pool on the Penobscot River. They were migrating from now cleaned-up coastal waters where pollution was so devastating two decades ago that scientists insisted salmon couldn't survive it.

State fisheries officials worked through the summer capturing fish for brood stock. The salmon piled into traps faster than they could handle them, and more than two thousand were trucked upriver and released to fend for themselves.

34 Fish, 125,000 Eggs

Farther south, on the Connecticut River, perhaps North America's greatest Atlantic salmon river 200 years ago, the return of 58 salmon in 1979 overjoyed biologists and conservationists. Of the returning fish, 34 spawned successfully, giving fisheries managers more than 125,000 pure-strain Connecticut River salmon eggs for use in a salmon restoration program. By the end of July 1981, 515 fish had already been captured after entering the river.

David Egan, president of the Connecticut River Salmon Association, told me, "The key to success now is how adequately this fishery is managed. In the 1870s an attempt to restore salmon to the Connecticut was initially successful, but because of overfishing and poor management, stocks weren't allowed to build up, and the run was destroyed. If this restoration is to succeed, we must maintain the necessary brood stock. Enough salmon, beginning as eggs, must be allowed to grow to smolts, go to sea, and return to spawn successfully. We've had trouble already: A fish was shot and one was stoned below the Holyoke Dam."

Maine faced similar trouble, Bud Leavitt, outdoor editor of the *Bangor Daily News*, confided. "We had a one-week massacre on Kenduskeag Stream, a tributary of the Penobscot, during low water." A few Bangor residents with an uncontrolled lust for salmon turned out with baseball bats and other

weapons to meet fish navigating riffles.

"But maybe it wasn't all bad," Bud said. "There were 44 arrests, 28 convictions, and decent citizens were agonized. Some convicted were sentenced to conservation classes given by yours truly."

Bud Leavitt, Dick Buck, and David Egan, like scores of Atlantic salmon conservationists worldwide, are sport fishermen. It's doubtful that substantial Atlantic salmon stocks would survive anywhere had not such sportsmen regarded the "king of game fish, game fish of kings" as more than prey.

"The salmon is everything beautiful to me," Gordon Lesenger told me in his Scottish brogue on the bank of the River Tweed. He wore a Donegal jacket and knickers with matching stalker hat, traditional dress of a gillie, servant and companion to visiting fishermen.

The river was low, flowing beneath the putty-colored embankments of the village of Kelso. I could see black stains on the walls from sewage seeping into a pool.

"Has the fishing changed over the years?" I asked.

"Everything is changing," Gordon declared. "Look at them coming down the river in bluidy canoes."

"Do canoeists bother salmon?" I asked.

"They bluidy well stir them up. Sir, salmon get no peace. They're netted like crazy down below; there's pollution in the river, swimmers in the salmon pools, and then, these brats and their canoes."

"What about the disease," I asked, "the UDN?" I referred to ulcerative dermal necrosis, which has ravaged British salmon since the late 1960s.

"We've picked thousands out of the Tweed, sir. Dead. A horrible sight it was, too—all white and falling apart. It's better now, but all we can do is bluidy well pray."

Anglers Talk Economics

Many gillies and some sport fishermen maintain that international Atlantic salmon stocks are too limited to permit any commercial catch. A salmon has greater economic value caught on rod and reel, they argue, than the maximum, perhaps \$12 a pound, it brings at retail. The Atlantic Salmon Association of Montreal contends that each salmon caught on a fly, the only legal sportfishing

method in Canada, benefits local economies by \$200 or more.

Quite a few Canadian salmon, however, are intercepted before they see a fly. The commercial fishery off Newfoundland nets some 600,000 salmon a year, many of them tagged fish migrating to rivers in Quebec and New Brunswick, where most commercial netting was banned for nine years.

Commercial fishermen, troubled by the net ban, charge political pressure from sportsmen and conservation groups. "It's a question of human rights," said Leonard Wilson, a drift netter from Saint John, New Brunswick. "If we can't fish, then nobody should be allowed to. That's the way it's going to be. Wait and see."

At 68 Leonard has known no other life but commercial fishing. "My father dropped dead fishing alone on his boat at 78," he said. "His father was a fisherman."

I mentioned the subsidy the government was then paying to commercial fishermen not to fish, for the sake of conservation.

"Listen to me," Leonard growled. "Fishermen don't want compensation, not that it's adequate. It's based on the market price in 1968. But that's not the point. We don't want government handouts. We're fishermen, and we want to fish.

"We can't fish, but how many fish do the poachers take every year? And look at the fishery off Newfoundland. There's no quota on Newfoundlanders. How about salmon the Indians net in river mouths? We're opposed to anybody netting the rivers. Where is brood stock to come from?

"If government cut out what Indians take and sell for ten dollars a fish and what poachers steal from us all, we could take a thousand salmon per boat a year, and there'd be plenty for everybody. This is pure discrimination in favor of Indians and so-called sportsmen."

Although permitted by law to net salmon for their own use, Québec and Maritime Indians consider themselves persecuted. "Indians want to preserve stocks, but we want access to resources rightfully belonging to us," said Anthony Dedam, one of about 1,600 Micmacs living at the mouth of the Restigouche River in Quebec.

The provincial government permits the tribe a seasonal quota. The fish are netted by

about 75 tribe members. Dedam allowed that more than the quota are probably taken and that some Indians sell their catch, which is illegal. "You must understand, though," he explained. "We have 80 percent unemployment, and we benefit from salmon. The Indian doesn't want welfare. We want jobs, and we believe the Great Spirit put resources here for our use."

I asked why there no longer seem to be Indian guides on the Restigouche and the Matapédia Rivers.

"That looks like more discrimination, doesn't it? The clubs aren't interested in Indian guides. But if we were guiding, fewer of us would fish with nets. The more fish, the better the fishing, the better for guides. The clubs talk conservation. Conservation is part of Indian heritage. Like poling a canoe, it was taught by our grandfathers. We can help—policing ourselves, taking fewer fish, sticking to quota—but we want help too. We want something to do with our lives. We must eat, so we eat salmon; and we catch them the best we can."

Iceland Leads the Way

You can eat Atlantic salmon often in Reykjavík, the capital of Iceland. It is especially delicious smoked over fires of dried sheep manure and straw. Icelanders know salmon, and each has an opinion of how it's best prepared. Icelanders also have an unconditional commitment to preserving Atlantic salmon stocks.

"It's possible you had your fishing tackle treated in Formalin solution before you arrived?" a young customs agent asked.

"No, why?" I answered.

"All tackle must be treated before it leaves the airport," he said. "We must protect salmon rivers against disease."

I toted my equipment to a cubbyhole for examination. "What are the chances of spreading UDN on a salmon fly—a billion to one?" I asked.

"More than we wish to take," the agent answered formally.

He took my gear and a long time later returned it smelling mightily of disinfectant.

Iceland permits no salmon netting within her coastal waters and only limited netting in a few glacial streams impossible to fish with a rod. Most of the fish for market are

Unpredictability and fighting spirit make the salmon a prized freshwater trophy earnestly fished for by young and old (**right**) near Big Falls in Newfoundland.

Across the sea, tension shatters into smiles when apprentice gillie Christopher Hanson, delayed two hours by a snowstorm, strides into a River Tweed fishing "hut" with a handsome catch (**bottom right**). A 1935 photograph (**bottom left**) on the hut wall recalls when Lady Joan Joicey hooked 26 salmon in a day. Such plentitude may never be seen again, however, if world diplomacy fails to protect this international resource.



provided by sport fishermen, although the number of rods permitted on each river is limited and monitored to preserve stocks.

"We would be honored if you would fish for our hatchery," Baldur Kristjánsson translated for his father, Kristján Benediktsson. Kristján, a farmer in the valley of the Laxá, was at once robust and gentle. His smile, like his offer, was generous.

"Tell your father it is I who am honored," I said. There was new snow on the mountaintops, and Stifla, the pool I was to fish, was full of salmon. Fishing Icelandic rivers is very expensive, under a complex letting system, and to be invited as a guest isn't to be taken lightly.

Thórdur Pétursson, a gillie nicknamed "Doddi," had dressed a fly in my name. He said the salmon I caught were to be kept alive in a cache anchored to the riverbank until October, when they would be taken to one of fifteen hatcheries throughout the country that supplement stocks of smolts for Iceland's 60 salmon rivers.

The salmon I hooked, as Kristján cheered, were powerful, mostly seasoned males with big, twisted jaws. A hen was a prize, because she would provide many eggs for the hatcheries. I played the fish deliberately to preserve their strength, and the gillie treated each as if the fate of all the world's salmon rivers were linked to its survival. He sped them all to the cache, and not until each was swimming round the pen did he take time to thump my back and proclaim, "Very good fisherman, you, Art Lee." □





After Rhodesia, a



Nation Named Zimbabwe



NATIONAL GEOGRAPHIC PHOTOGRAPHER JAMES L. STAFFIELD

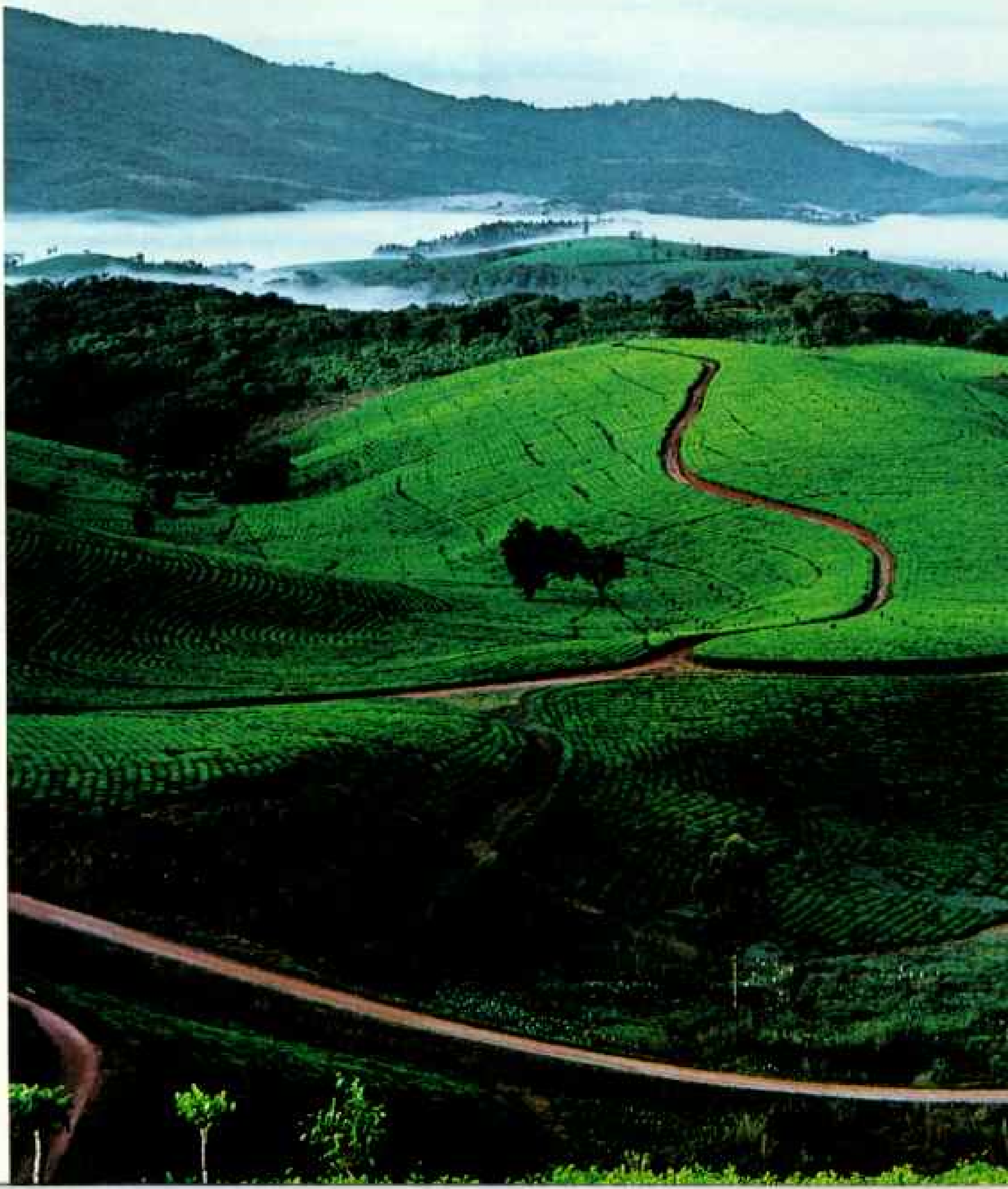
HIS HANDS share the power now. His eyes, weary from war, behold the return of peace. For the first time in more than seven years, ranch hand Moses Sibanda (left) and his countrymen can hope for a future without bloodshed.

The fighting ended in 1979, when, after years of negotiations, guerrilla leaders and white officials agreed to a new constitution at British-sponsored talks in London. Then in a February 1980 election the government passed from the hands of the nation's 220,000 whites to those of its 7.2 million blacks.

It was the end of the Rhodesia created by financier Cecil Rhodes nine decades ago to spread British civilization in Africa. And it was the beginning of the Zimbabwe envisioned by blacks who have not forgotten an African kingdom that built a stately capital of stone 800 years ago.



BOTH BY JAMES L. STANFIELD



A marriage of European skills and African labor transformed the rolling hillsides of the Pungwe Valley into manicured fields of tea (below). Modern farms and vigorous industry have made Zimbabwe's economy one of the strongest in Africa and have brought prosperity to whites

such as former government minister Geoffrey Ellman-Brown and his wife, Hilda (left); their comfortable home lies on 35 acres outside Salisbury. Nevertheless, since independence some 1,500 whites a month have chosen to leave the country rather than face its uncertain future.





Among Zimbabwe's natural treasures, Victoria Falls is the brightest jewel. This mile-wide curtain of the Zambezi River, crashing 350 feet into a narrow gorge, was



JAMES L. STANFIELD

named for the British queen by Scottish explorer David Livingstone in 1855. The Kololo people who lived there called it Mosi-oa-tunya, or “smoke that thunders.”

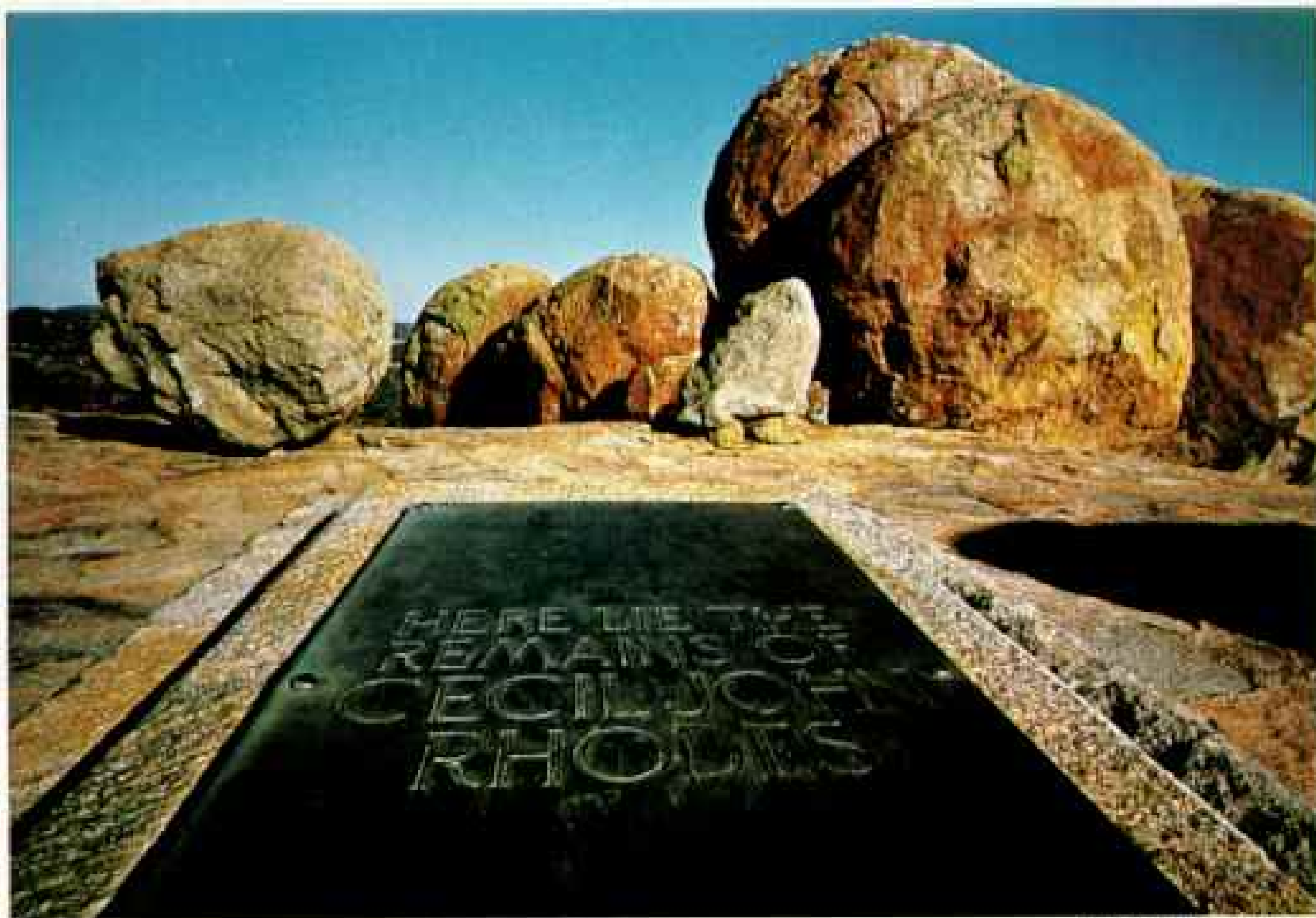


You cannot overhaul capitalism overnight," says Prime Minister Robert Mugabe (above). Thus for the present, the pragmatic Marxist has encouraged private industry to remain active in Zimbabwe—

in part to help pay for new social programs.

Mugabe was jailed for ten years under former Prime Minister Ian Smith, who declared Rhodesian independence in 1965 vowing no majority rule for 1,000 years. This action provoked international trade sanctions and helped spark the war that cost 27,000 lives and displaced more than a million people.

Peaceful reconciliation is official policy today. The grave site of Cecil Rhodes (below) lies undisturbed on a hill long revered by black Zimbabweans. From that quiet spot one can look far across this country, where blacks and whites are attempting a new start.



BOTH BY LEROY WOODSON, JR.



**LAND CLASSIFICATION
ZIMBABWE 1981**

- PROTECTED LANDS** consist of former European and African park, forest, and wildlife lands and former national areas.
- COMMERCIAL LANDS** include farmland formerly reserved for Europeans and smaller areas reserved for freehold tenure by Africans.
- TRIBAL TRUST LANDS (TTLs)** consist of reserves formerly set aside for Africans on a communal basis.



Zimbabwe

The nation's new name first belonged to a medieval state of the Shonas, today's ethnic majority. From the 12th into the 18th centuries the Shonas forged loose confederations to control gold-mining areas and trade routes to the coast. The Ndebeles, Zimbabwe's other major ethnic group, swept into Shona lands in the 1840s from the exploding Zulu empire to the south. Then half a century later Cecil Rhodes sent forth white pioneers from South Africa, and within five years the whole territory bore his name.

AREA: 390,580 sq km (150,804 sq mi). **POPULATION:** 7,700,000. **CAPITAL:** Salisbury, pop. 670,000. **RELIGION:** Traditional, Christian. **LANGUAGE:** English, Shona, Ndebele. **ECONOMY:** Industries: gold, asbestos, nickel, copper, coal, and chromite, food processing, textiles. Export crops: tobacco, cotton, sugar. Domestic consumption: corn, livestock, millet. **CLIMATE:** Moderate subtropical.

- National park
- Industrial center
- Mine

Two major ethnic groups named in brown; 77% of the population is Shona.



DRAWN BY JOHN S. WEBER
COMPILED BY MARILLEITE B. HUNTER
NATIONAL GEOGRAPHIC ART DIVISION



Reunited after 15 years, expatriate author Wilson Katiyo, left, and his father, Tigere—separated by the war like thousands of others in Zimbabwe—begin to fit together



LEROY WOODSON, JR.

the missing pieces of their lives at the family's new homestead at Makaha.

By CHARLES E. COBB, JR.

Photographs by

JAMES L. STANFIELD

NATIONAL GEOGRAPHIC STAFF

and LEROY WOODSON, JR.

ONE BY ONE with the sudden drop of the sun, flickering fires made tiny pinpoints of light in the hills of Mudzi Tribal Trust Land. A baby's cry drifted faintly across the distance. I could not tell from what distance because nothing is clearly near or far in Zimbabwe's rural nights. Even the stars seem to hang low enough to reach up and touch.

Before the sun had set, Tigere Katiyo and his son Wilson had been invoking ancestral spirits in a small hut. The mountain cold had already descended as I listened outside to their soft murmurs, standing as near as I could to a fire. Their words were to come to me often during my travels in Zimbabwe:

"Welcome your little man home with everything he has, wife and children, and the nothing that he has."

Wilson had recently returned home to Zimbabwe after a 15-year exile in Europe and the United States. His father and 21 other families had come to this place called Makaha to resettle.

Tigere Katiyo's prayer is an apt metaphor for Zimbabwe. It was a prayer he had often longed to make while separated from his son. During those years a bitter conflict raged between black and white in what was then Rhodesia. It drove Wilson into exile and his father from the family land.

Now Zimbabwe is turning away from the

After Rhodesia, a Nation Named Zimbabwe

war toward the exhilarating possibilities of a land blessed with mineral riches and productive soil. Although the deep wounds of the struggle have not yet healed, there is, if not love, a fellowship between black and white and black and black slowly being built on a binding commitment to all that seems possible in this abundant land.

Villages like Makaha, home of the Katiyos, are where most of Zimbabwe's black population lives. They were the chief battlegrounds of the war, and they are where the peace is being welcomed with both prayer and hope. The people in these places talk of

simple plans that seemed impossible a short while ago.

In dim candlelight in his hut, Tigere Katiyo proudly told me he intends to plant not only corn for food but also cash crops of cotton and soybeans. "With a tractor we can grow much and sell much," he said, expressing one of his larger ambitions.

But the village is already renting a tractor, and not everyone is agreed on the practicality of buying one. Wilson explained that no villager earns more than 130 Zimbabwean dollars a year (\$195 in U. S. currency).

In Europe, Wilson, who had intended to



PHOTO BY JAMES L. STANTFIELD

Official symbols of the new Zimbabwe, these noble soapstone birds once perched in a ritual enclosure of the old Zimbabwe—royal center of the Shonas—whose ruins spread across 100 acres. Within the kingly quarters, a 30-foot-high tower (right) was erected sometime around the 14th century, when the gold and ivory trade with Arab merchants was nearing its zenith.



study chemistry, became a writer instead. Two of his novels have been published but have not meant much money in his pockets, and his long absence had created self-doubt about where he fits now that he's back home. He can't give his father the money he expects for the tractor he wants.

"That's difficult for him to understand," Wilson explained. "Everybody here wanted a bit of what they thought I had. I had to explain that I don't have a job, I had just moved, I have a wife and two kids."

I first met the Katiyos in July 1980. Nine months later I returned. Wilson had found a

job writing educational scripts for the Ministry of Information, and he was more secure and confident. He also had been asked to conduct literature workshops for former guerrillas. "Ah Charlie, the plays and novels to be written. We'll be able to really do something."

The village of Makaha still did not own a tractor, but seed, fertilizer, and a training program had combined with better than normal rains to make this year's crop the best in memory. The corn, Tigere Katiyo exclaimed: "Much taller than a man!"

My search for the real Zimbabwe began



three years ago when I came to what was then Rhodesia to cover a war that looked as if it would go on forever. Now that search would take me from the green hills of the Inyanga Mountains in the northeast to the rocky majesty of the Matopos in the south (map, page 623). At Lake Kariba, one of the world's largest man-made lakes, I watched elephants splash and swim. I entered the black depths of gold and chromite mines.

I stood in the mist and spray of Victoria Falls. Mosi-oa-tunya, the Kololo people called the falls—"smoke that thunders." Water from this great wonder roars down a

350-foot chasm into the Zambezi River, which along with Lake Kariba forms the northwestern border with Zambia.

"Scenes so lovely," African missionary and explorer Dr. David Livingstone said of the falls, "must have been gazed upon by angels in their flight."

No one can fail to fall in love with the great and varied beauty of this land. When the complexities of Zimbabwe's first steps of independence threatened to knot my brain, there was always some resplendent, not yet seen piece of the country to embrace me.

Yet Zimbabwe is more than a land of



LEROY WOODSON, JR.

Only the bitter shell remains of a farm building blown up by its white owner in frustration as he fled the country. But it's enough to shelter these students while a new school is built nearby. Enrollment has doubled across the country since the fighting ended and the government eliminated primary-school tuition. About 2,000 of 2,500 rural schools were damaged during the war, along with 180 of 243 rural clinics, whose loss led to more malaria, measles, and schistosomiasis.

beautiful scenes. In the south are also the ruins of Great Zimbabwe, whence the country's name. From A.D. 1100 to 1450, Great Zimbabwe was a center of trade for the Shona people and became the heart of their powerful state. Around 1500 this state split into two rival kingdoms. The coming of the Portuguese soon thereafter signaled their decline. The main ruins near Fort Victoria are dominated by a massive fortlike structure of stones fitted without mortar. Similar but lesser ruins spread over a radius of a hundred miles, into Mozambique.

Blacks give more than one meaning to the name Zimbabwe: "venerated houses," "house of stones." And if the history of this site remains misty, it remains a monument to greatness for all blacks in Zimbabwe today. Ritual ceremonies still take place among the ruins. Spirits. Ancestor worship—a prevalent cultural reality. Spirits of recently dead relatives or tribal leaders or historical figures may possess humans and speak and be consulted.

Spirits Share Dwelling Place

While in the south I visited John Sithole on his farm in one of the valleys shadowed by the massive wind-sculpted granite boulders of the Matopo Hills. He lives near a hill called Malindidzimu by blacks—"dwelling place of spirits." It's the same hill where Cecil Rhodes is buried and is called View of the World by whites. Amid these spirits of the past, Sithole is pulling his life together again in much the same way as Tigere Katiyo.

He came home one night three years ago and found his house burned down. He waited until the war's end before rebuilding it. I asked him: "What's changed for you now that there is independence?" His answer was instant: "The shooting has stopped." I got that same quick response from virtually everyone I asked in Zimbabwe.

Both Sithole and Tigere Katiyo wore warm smiles as we talked. Yet each gave me the impression that he was holding some deeper conversation within himself. Their eyes would flit away from mine and stay averted for silent moments that felt longer than they were. The war had ended, but the men would seek these private foxholes of the mind until the peace was certain.

At war's end some 33,000 guerrillas, still

armed, were grouped in assembly points, or APs, around Zimbabwe. They were to be integrated into a new army. It included members of former Rhodesian forces and of both guerrilla armies that had fought the war: the Zimbabwe African National Liberation Army (ZANLA), which was the military wing of Robert Mugabe's Zimbabwe African National Union (ZANU), and the Zimbabwe People's Revolutionary Army (ZIPRA), the military wing of Joshua Nkomo's Zimbabwe African People's Union (ZAPU).

Nkomo became, for a time, Minister of Home Affairs in Prime Minister Mugabe's government. And Mugabe once had served in ZAPU as Nkomo's publicity secretary. The politics of the black nationalist movement have been a jumble of conflicting tribal, political, and personality interests.

During the war the two guerrilla armies nominally fought together under the banner of the Patriotic Front, but in fact they fought separately, and sometimes against each other. Each was supported by different ethnic groups: Mugabe's ZANLA mainly by the Shonas, who compose 77 percent of Zimbabwe's population, and Nkomo's ZIPRA mainly by the Ndebeles. Both groups had fought Cecil Rhodes and lost.

ZIPRA and ZANLA guerrillas, or freedom fighters as they called themselves, did not share the same APs. They have shared the same frustrations as they waited to become a part of the national army.

"It's a different situation from walking triumphantly into Zimbabwe," said a long-time Nkomo associate who now edits a major newspaper in Salisbury, the capital. "They can't understand why they are where they are. They fought. They thought it would be milk and honey now."

The government moved to gentle the mix of youth, frustration, and alienation in the APs by speeding the guerrillas' entry into the new army. Thirty thousand-man battalions made up of ZANLA and ZIPRA forces had been formed by June 1981.

"We are producing a battalion every fortnight," Prime Minister Mugabe told me. "With the help of the British we hope to retrain every guerrilla who would want to be integrated into the national army." In addition to British help, a group of North Korean military advisers arrived in August.

Thousands of guerrillas were also moved from the assembly points into housing projects in African townships near Salisbury and Bulawayo—a risky move that placed ZANLA and ZIPRA forces together. Sometimes their rivalry has burst into violence.

Last November, 58 persons were killed in clashes between ZIPRA and ZANLA guerrillas who spilled out of Entumbane, an African township where 3,000 guerrillas from both forces were housed. The violence began simply enough. Entumbane is near Bulawayo, Zimbabwe's second largest city and a ZAPU stronghold. Government ministers from Mugabe's ZANU spoke at a rally and were heckled by ZAPU supporters. Fistfights ensued. Soon there was shooting—mortars, machine guns, automatic weapons, grenades.

Mugabe called on the fledgling national army to quell the disorder. "I cannot allow hooliganism and lawlessness to establish a reign of terror in the country," he declared in a national broadcast.

Fiery statements by ranking ZANU ministers were reported in local newspapers. The time had come for the party "to flex its muscles," declared Finance Minister Enos Nkala. "If it means a few blows, we shall deliver them."

Soon after, Joshua Nkomo was removed as Minister of Home Affairs and made Minister Without Portfolio. Nine senior members of his ZAPU were arrested, becoming the first political detainees of Mugabe's government. In February came further violence. In the Bulawayo area a four-day clash between ZIPRA and ZANLA factions following a beer-hall argument left 300 dead.

Former Guerrillas Still Uneasy

Although the guerrillas have been successfully disarmed now, it is not surprising that many of them doubt whether Zimbabwe really exists yet. "I think what we have is a Zimbabwean flag only," a guerrilla told me in Salisbury. He had left his assembly point against orders to look for a job in the city. "We are still waiting," said another when I gave him a lift to Chipinga.

ZIPRA commander Soneni Mdlalosse reached into his pocket and pulled out his 9-mm Soviet-made pistol as we talked. Cocking the gun, *(Continued on page 636)*





ILL. BY LEROY WOODSON, JR.

Winning in war but losing in peace, former guerrilla leader Joshua Nkomo (left) was defeated at the ballot box in his bid to lead the government. Friction between Nkomo's forces and Mugabe's men (above) led to fighting near Bulawayo in February that cost 300 lives before Nkomo's persuasion and the regular army stopped it. Soneni Mdlalosse (right, at left) commanded a battalion in Gokwe, which hunted bands of former guerrillas turned thugs.





BOTH BY JAMES L. STANFIELD

Saluting the infant nation, a nursing mother waves Zimbabwe's new flag on the republic's first birthday (above). Her group sang in a stadium outside Salisbury at one of the many Independence Day celebrations held throughout the country on April 18. Thousands in Salisbury took advantage of the long Easter weekend to visit relatives in rural areas, crowding buses at the terminal (right).







JAMES L. STANFIELD (ABOVE); LEROY WOODSON, JR.



Newly energized, the heart of Salisbury (left) reflects a business boom prompted by the end of hostilities and trade sanctions. The city was named for the British prime minister holding office on September 12, 1890, when white pioneers hoisted the Union Jack over that spot on the plains. Today wide, tree-lined boulevards have been renamed for heroes of more recent African history, such as socialist Presidents Julius Nyerere of Tanzania and Samora Machel of Mozambique, who supported Zimbabwe's black nationalists in the 1970s.



Moment of truth draws near for a poised contestant (above) in the semifinal round of Salisbury's first "Miss Zimbabwe" pageant. At a downtown shopping mall, two Saturday-morning chess strategists (left) find another kind of beauty in a battle of epic-size kings and queens.

Blacks and whites mingle more freely now in Salisbury's shops and cafés, though few suburbs have been integrated. Nearly half the nation's European population lives in this metropolitan area of 670,000 people. Yet Africans still outnumber them six to one. Higher wages have stimulated a spending spree nationwide; domestic consumption last year rose 40 percent.

(Continued from page 630) he used its open chamber to lever the top off a bottle of beer. He smiled, handing me the beer. "This is my baby," he said, looking from me to the pistol.

At 25, Soneni now commands Gwai River Camp. When we first met in Gokwe Tribal Trust Land, he headed a 365-man unit sent to put down a violent band of ZIPRA dissidents. He thought some of the trouble had stemmed from men "infiltrated into our ranks by the Security Forces," meaning by the former Rhodesian government.

Soneni explained to me why he and the guerrillas aren't completely happy with the peace pact. They believe, he said, that they could have won a complete military victory. "But there is a Zimbabwe now, and we have to give it a chance."

Still, there was pain in his voice as he talked of men bewildered by a government they fought for and now don't completely understand. The agreement that ended the war had led to a black government, but bound that government to much of the structure of the old Rhodesia.

"The long-awaited aftermath is here," Soneni told me, "but little has changed. Those little boys you see running around with crooked feet, those old men you see in tattered clothing, with ox and donkey carts—they have to realize they are a part of this world. And what do they have now? Nothing, nothing, nothing!"

Soneni himself had changed vividly in the war. No longer the boy who had joined the guerrillas six years earlier, he was now a piece of the future, perhaps to become one of the leaders who would improve the lives of the people he spoke of so movingly.

Pamela Hondoyakura was another. Describing her experiences as a ZANLA commander, Pamela told me, "Women like myself have become used to leading men. We feel like colleagues, like comrades. We have a male friend just as we'd have a friend who is a woman." Then, with a charming giggle, she concluded, "I used to be so shy you wouldn't believe it. Now it's different."

The war has changed Pamela and Soneni, as it has Zimbabwe. Many of the old inequities are gradually being erased.

But the war committed most guerrillas to radical, revolutionary change. Many worry

that this hasn't happened fast enough. Whites too worry about radical and revolutionary change. They ask: If the government is committed to revolution, will Zimbabwe be a place they can live? They are hopeful, but their hopes are tentative.

Often whites insisted to me that they had long accommodated themselves to change. Aubrey Bower, manager of the Kariba Breezes Hotel at Lake Kariba, said, "We're prepared to accept the situation on the condition that the African brings himself up to our standard of living."

Whites Fear Nationalization

The situation that worries him and other whites is not so much having a black government as having a guerrilla government. "If they start nationalizing things, then there will be problems," Bower avowed, expressing the most commonly held fear of whites.

John Landau, party whip of former Prime Minister Ian Smith's Republican Front, which has 20 seats in parliament, spoke more bluntly: "I know why we had the war. We were fighting against Communism."

There often seemed to me to be an unresolved twoness among whites: them and us. Darrel Plowes, an official with the Department of Agricultural Development (DEVAG), took me through the Honde-Pungwe Valley of Zimbabwe's northeast—tea-growing country, whose lovely emerald green hills seem to roll out endlessly. Along the way I could not help but be captured by his great love for the land, his pride in its development, and his dreams for its future. Nor could I avoid asking him why whites couldn't have accommodated themselves to change earlier.

"Most Africans I worked with didn't want the war," Darrel Plowes replied. "You ask them. They were happy."

A shadow passed across his face as we were leaving a small village. Our car was surrounded by women singing, "We thank you Julius Nyerere [of Tanzania], we thank you Samora Machel [of Mozambique] for helping us win our freedom."

Darrel Plowes is not unfeeling and uncaring, but I wondered just what it will take for him and many other whites to understand the real feelings of blacks now that the old Rhodesia is vanishing.



JAMES L. STANFIELD

The mystique of big-game hunting is alive and well at the workshop of T. W. Coffin-Grey in Bulawayo, where 20 craftsmen fashion trophies of the chase. Sport hunters are restricted mainly to private game ranches and state safari areas; Zimbabwe sets aside 12 percent of its land for game reserves and parks. Herds of as many as 100 elephants roam Wankie National Park, the nation's largest.





For all the troubled circumstances of Zimbabwe, the late David Spain, who headed the white Commercial Farmers Union until an automobile accident claimed his life, believed that the outlook was getting better. He tried to soothe his worried membership: "If we're honest, we will see that we haven't got the war now, we haven't got petrol rationing, we haven't got sanctions."

And indeed, this year's corn crop may reach a record three million tons, and Zimbabwe is again exporting grain.

John Landau gave me the reason why most whites intend to stay: "Where can I find a country with the climate, good living, and facilities I have here? I would have to be a millionaire anyplace else. We don't want to give it up." The facts bear him out. In the first 15 months after independence, fewer than 25,000 whites left the country.

Trying to Implement the Three R's

Prime Minister Mugabe's three R's—reconciliation, reconstruction, and rehabilitation—are watchwords today. But for blacks as well as whites they are easier said than done. According to Economic Planning and Development Minister Dr. Bernard Chidzero, the per capita income of urban blacks is only 10 percent that of whites; that of rural blacks is only one percent. "So how," a ZANLA guerrilla asked me, "do you coexist with somebody who has something and another who has nothing?"

Part of the answer to that question—no reconciliation without reconstruction—was demonstrated to me about 20 miles from Salisbury. At the Domboshawa Training Center, run by the Ministry of Local Government and Housing, 80 blacks from around the country were in the midst of a three-month "multiskilled training program." The purpose was straightforward: Use the men from areas most damaged by the war to perform reconstruction. At Domboshawa all learn the use of tools. They

Safe from safari hunters, an elephant family ambles through Matusadona National Park, where impala, buffalo, waterbuck, and kudu are also abundant. Park officials warn visitors to keep an eye open for crocodiles too.

LEROY WOODSON, JR.



Big future for little fish: A rapidly expanding supply of sardines in Lake Kariba promises to increase employment at fishing villages such as Chalala, where early morning workers spread a catch on drying racks (above) and a fisherman

are trained as bricklayers, welders, automobile mechanics.

The program works largely because its teachers, like Ed Barnes, do what still too few whites do. He reaches out to blacks and works hard to make a connection with them, enabling him to pass on his skills.

The men have little formal education, and in some instances none. So he designs his own teaching materials—mimeographed pictures of engines and tools and machines. They carry only a few words; the men who can read help those who can't. "They're

quick," Barnes said. "There is remarkable intelligence here. And there are lots of people like this throughout the country."

To find and train them is a paramount need. The key sectors of the economy are hungry for skilled labor. Alan Marsh, director of the gold- and copper-mining Lonrho company, calls this shortage his biggest problem. His company has enrolled former guerrillas, some of whom will be trained as surveyors.

In the wild and haunting bush country of the lowveld, Sister L. E. Mouritzen, a



BOTH BY JAMES L. STANFIELD

tunes his guitar before breakfast (right). The 175-mile-long man-made lake was created in 1958 by damming the Zambezi River. Since 1960 the dam's generators have supplied much needed power to both Zambia and Zimbabwe.

nurse, is helping to rebuild the shattered health system. She is retraining guerrilla medics. "I agree with Dr. Ushewokunze [Minister of Health]," she remarked, "that the old government had its priorities wrong in spending all that money on a big hospital in Salisbury."

And for the first time, local governing councils have been set up throughout the country by popular vote. The once-virtually autonomous district commissioners (DCs) are losing much of their authority. Gordon McIntyre, District Commissioner for Bikita

Tribal Trust Land, acknowledged that local government makes administration stronger. "The ZANU party now runs most things here, and we're getting to places we never got to before. Fine."

In Chiredzi, District Commissioner Geoff Higgs observed that while suspicion of DCs lingers, there is greater understanding.

How, I asked, has his role changed with independence? His reply: "Now we inform, not order, the people."

Some whites are learning—and there is hope in this—that they may have misread





JAMES L. STARFIELD (ABOVE); LEROY WOODSEN, JR.

Zimbabwe's largest coalfield runs in seams averaging 30 feet thick beneath the mining town of Wankie, where huge ovens (left) process 240,000 tons of coke a year. Gold, however, still leads a long list of mineral resources in value of production, followed by asbestos, nickel, and copper. More than 80 percent of the world's known reserves of high-grade chromite also lie within its borders.

The mining industry is controlled in part by interests in white-ruled South Africa, which remains the nation's biggest trading partner despite animosities between the governments. Nearly all Zimbabwe's exports and imports pass through South Africa's ports or along its railways. An annual inflation rate of 15 percent, fueled by high government spending, also concerns Zimbabwe's leaders. Even so, the economy expanded at a brisk rate of 10 percent last year.



Passing along skills for the future, Edward Barnes (left) teaches welding to Jabulani Ngandu at a government trade school. The blue-collar white exodus has drained Zimbabwe's skilled work force. But countering this flow are blacks coming home again—blacks such as Cornelius Sanyanga (above), who returned from Zambia to work with mining executive Alan Marsh.

the face of placidity worn by blacks as acceptance of white rule. The real feelings of blacks flow in deep, hidden channels.

Consider the black waiter at the Meikles Hotel in Salisbury. There one evening a white man spoke loudly and disparagingly of blacks to a companion while drinking. Unknowingly, he knocked his cigarettes to the floor. The black waiter saw this, but had heard his comments and stepped over the pack several times while politely serving the man his drinks.

This Zimbabwe of blacks is largely invisible to the increasing number of tourists coming to enjoy the wildlife and beauty of the

country. Zimbabwe, like the old Rhodesia, remains two nations. One is rich, white, and powerful, still largely in control of the land's vast resources. The other Zimbabwe is poor, black, and torn by war.

In Salisbury the two Zimbabwes meet, at least on the surface. The city—one of the world's loveliest, with its parks ringed by purple jacaranda trees—bustles with easy contact between black and white. Shops are crowded and busy.

Roads leading out of the capital take you to other sparkling cities. They also take you past the Tribal Trust Lands (TTLs), where most of the war was fought. Most blacks live

Although free to live where they want now that racial restrictions are illegal, most blacks working in the cities still dwell in densely populated townships like Chitungwiza (below), 13 miles south of Salisbury. The reasons are mainly



in the TTLs because until 1979 it was illegal for them to own land in white areas. Rhodesian law divided the country's land roughly half and half between white and black, and each race was forbidden to own land in areas assigned to the other. But whites still held most of the best land.

The government estimates the cost of reconstructing the TTLs at 300 million dollars. Clinics, hospitals, schools, bridges, and water-supply sources were destroyed, as well as more than 1,800 miles of roads.

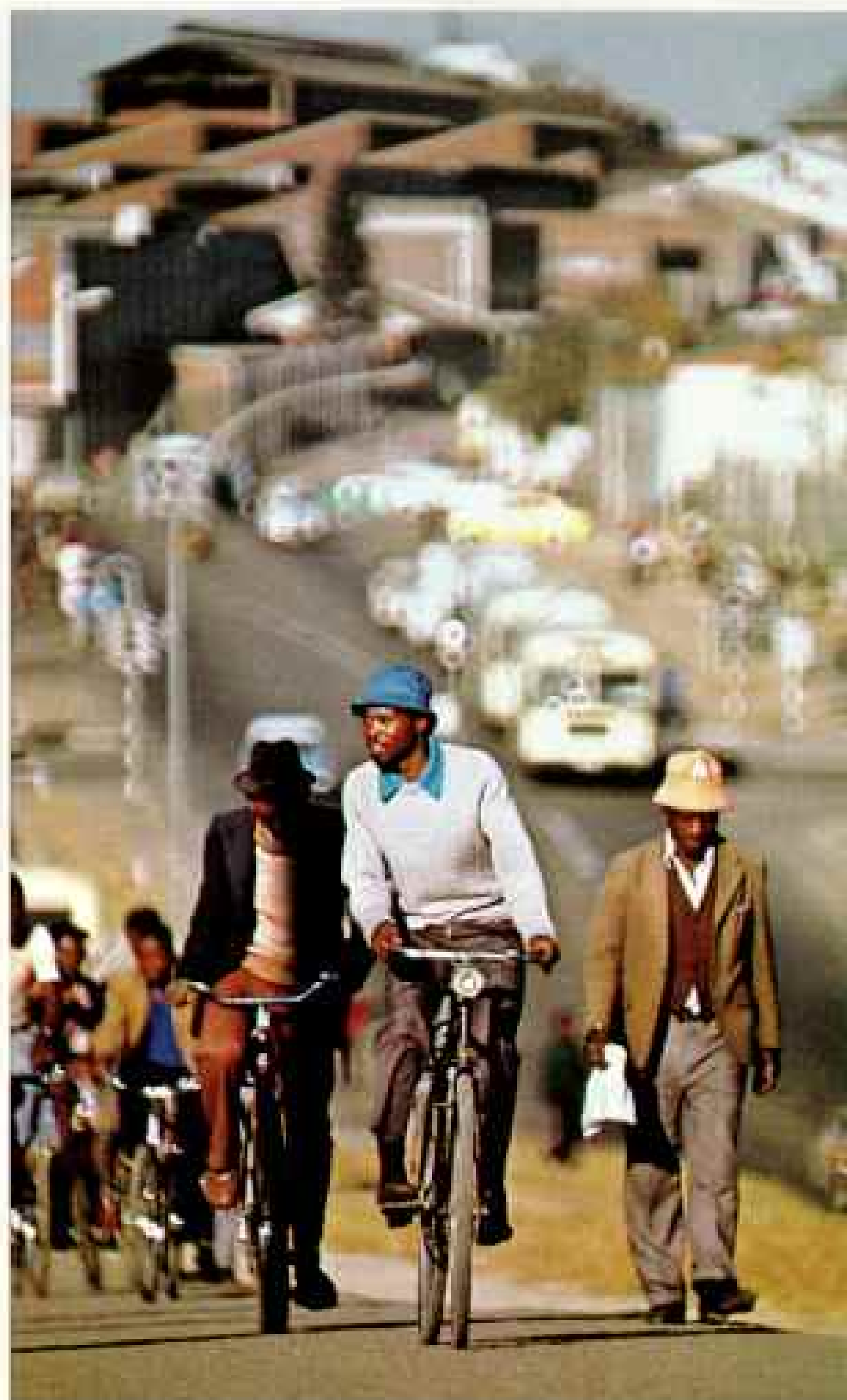
More than a million persons were displaced by the war. Many thousands fled to the cities; almost 300,000 made their way to

neighboring countries, and 700,000 were placed in "protected villages"—the equivalent of strategic hamlets in Vietnam.

They began to return home immediately after the election of Mugabe. In August 1980 the Department of Social Services estimated that it was bringing 10,000 persons a month back to their tribal homes.

"We left everything full, but we came back empty," Mrs. Theresa Mandeya said to me. We were in Chiduku TTL near the town of Rusape. With her nine children she had fled to Mozambique when her husband was killed after police had accused him of using his bus to ferry guerrilla recruits.

economic: In 1978 the average income of a black urban worker was less than \$900, roughly a tenth of a white worker's. For commuters on their way home from Bulawayo (right), that kind of budget makes a bicycle the best transportation.



JAMES L. STANFIELD (LEFT); LEROY WOODSON, JR.



Tall stalks of corn dwarfed her. Behind the house stood a small grove of orange trees. She and thousands of other returning refugees had been given packs of seed and fertilizer by the United Nations High Commissioner for Refugees. The Department of Agricultural Development had instituted a major training program to accompany the seed-pack distribution. Using simple visual materials, staff workers were teaching proper planting procedures in the TTLs.

Ironically, while the training program was available to all, the seed packs and fertilizer were available only to refugees. As a result, many of the best crops on TTLs were found among refugees. Of greater long-term significance is the interest other government agencies are showing in the department's teaching methods, which in their most sophisticated form involve bringing people to centers to watch lessons on videotape.

For all of the new techniques aimed at



Still boss, P. Clive Nicolle (left) dispatches 600 workers to pick peanuts on one of his family's farms—as prosperous in Zimbabwe as it had been in Rhodesia. Tea grower Tourie Willemsee (right), however, asks what the future will hold for his son, should he want to farm. The government's answer has encouraged the 5,300 white farmers who produce nearly 80 percent of the nation's agriculture. Raising official prices last year, it prompted growers to double the average corn crop. The future looks good for tobacco too, which once made the barns in Salisbury (below) the world's largest tobacco-auction floor.



JAMES L. STANFIELD (LEFT), LEROY WOODS, JR.

increasing food production, the land in the TTLs won't support the population. It is the issue of land that has most divided whites and blacks in Zimbabwe. Chief Rekayi Tangwena and his people, a Shona clan who live in the beautiful Inyanga Mountains, symbolize this agonizing conflict.

In August I found them clustering around the shell-shattered buildings of Nyafaru Mission School in tents that offered small protection against the bitter cold of the

mountains. They were beginning to resettle their traditional homeland, which years before had been declared a white farming area.

In the early 1970s, when they refused to leave, police and army helicopters swooped down. Land-Rovers and bulldozers leveled their huts. Most of the clan fled into the hills, but some were caught, including Raymond Masonga, 72, and his brother Tiki.

"After they arrested us, they took us to Inyanga and tried us in the magistrate's court.



They said we were refusing to leave a white-owned farm," Raymond told me. "I said it's not a farm, it's our own land! I asked the police, 'Who is the older in this country, Rhodes or my two grandfathers? My great-grandfather never saw Cecil Rhodes.'

"In court I said, 'You got this land to graze, not to own. If you can tell me where the Nyamagaya and Jora Rivers meet, take the whole land.' He couldn't," Masonga said, laughing. "They're the same river. Up there it's the Nyamagaya, down there it's the Jora." Still, he and the others went to jail. "We might have won the case on facts," Masonga told me bitterly, "but the magistrate decided an African is an African."

Squatters Claim Land Rights

The end of the war has given them back their land, but some tribesmen have begun making inroads on the nearby Gaeresi Ranch, a 32,000-acre pine plantation. The land has been owned by whites since 1905. Tribesmen claim the land was theirs before the first whites came.

Whites continue to operate the ranch. The squatters have settled on only one of its extreme edges. The chief declared he would not order his people to leave. Most of the Tangwena people, however, are building on the sites they had been forced to abandon. About 200 families had built or were building homes when I arrived.

At the hut of Chief Tangwena's uncle, Satagaza, the smoke from the early morning fire was split by shafts of sunlight as I talked with the chief and some of his headmen. They predicted it will take three or four years to become self-sufficient. Satagaza explained, "We are still busy rebuilding. We haven't planted anything yet. We will try to do whatever we can with our hands."

Chief Tangwena related that he and his people had fled to Mozambique after being driven from the land a decade ago. "There we had one big field. I used to say once I get back home we should be given a tractor and one big field. Everyone agrees with this."

In most of the country, however, the tradition of collective assistance seems stronger than that of collective ownership and works against a communally owned field or tractor. Family groups or even entire villages help other groups with certain tasks, but consider the land they work their own.

The government continues to push toward what Prime Minister Mugabe terms the "system of collective agriculture we envisage." But Mugabe, though referring to his government as socialist, insisted to me that he does not intend to force people into collective agriculture.

Zimbabwe feeds itself, but nearly 80 percent of its agricultural output is produced by whites. Furthermore, a mere 10 to 12 percent of the commercial farms generate almost half the agricultural output. The government does not want to threaten, or appear to be threatening, this production.

At the same time the government feels great pressure from blacks to redistribute land. Thousands of squatter families have moved onto farms and estates.

"There will always be pressures," said Eddison Zvobgo, Minister of Local Government and Housing and a ZANU spokesman. But faith in the government, he believes, will provide time to organize a program of land reform and redistribution while keeping the commercial farmers producing.

David Spain, who headed the white-dominated Commercial Farmers Union, felt that the two concerns need not conflict. He told me that the new government had taken the right steps to encourage farmers like himself to stay, such as last year's increase in the government price for corn. He remained somewhat surprised. "All we ever heard about Mugabe before he took over," he said, "was alarmist stuff in the news media about socialism."

"The next thing that the government has to do is find more land and settle people on it," Spain continued. He estimated that about 30 percent of the white commercial farms were empty or underutilized and

Harvesting a bumper crop of youth, Zimbabwe strives to open doors for the 55 percent of its population under 15. This young laborer may someday work his own cotton farm. Yet progress has been slow in a three-year government plan to buy 4.4 million acres from white owners for redistribution to poor black farmers.



Playful halo from Devil's Cataract teases a photographer and his assistant who came prepared for the drenching mist of Victoria Falls. No photographs,

thought this was where the government should begin.

For its part the government has asked commercial farmers to help with black farmers' plowing in the TTLs. In addition, the master farmers training program is being expanded. "On the surface this looks collaborationist with the system we have fought," Eddison Zvobgo said to me, "but people who want land will get it."

The government has already spent about 12.8 million dollars to buy 950,000 acres of white farmland. It will likely be worked as cooperatives or collectives. A year ago a program involving 40,000 people was launched near Shamva, and at another site near Gutu, not far from the Great Zimbabwe ruins.

Last March Zimbabwe unveiled a three-year plan aimed at reconstructing and developing all sectors of the country. Declaring

that in the first ten months of independence Zimbabwe had demonstrated its vigor and resourcefulness, Prime Minister Mugabe called on the international community for funds to help assure Zimbabwe's success.

He asked for 1.2 billion dollars, and it was pledged. He said he was overwhelmed.

Worries Remain as Hope Grows

A problem greater than money now is the volatile political situation, which continues to worry whites and blacks.

True, guerrilla dissidence, the flash point of political conflagration, has eased considerably. The last camp was disarmed in May. The commanders of both ZANLA and ZIPRA have been made top officers in the new national army. And in August Mugabe appointed Gen. Alexander Maclean, former head of the Rhodesian army, to head the



JAMES L. STANFIELD

though, ever capture the sound and fury of the Zambezi River that—like the power of Zimbabwe in its second year—may be beautiful or perilous.

new force. Talks on merging ZAPU and ZANU were begun last November.

And the attitudes of some whites are slowly changing, particularly toward Mugabe. It's not uncommon to hear something like this: "Two years ago I was terrified at the thought of a Mugabe government. Now I'm terrified at the thought of a government without Mugabe leading it."

But it's also not uncommon to hear the opinion of people like tobacco farmer Nancy Guild: "Sometimes I think I've been living on the edge of a volcano." She spoke of harassment by youthful guerrillas who were "trying to show they have some authority when they don't have any at all." She almost seemed to say she preferred a shooting war: "Then, after a few shots, at least your neighbors came and helped you drive them off."

I couldn't help smiling. Conversations

heard separately have a way of linking peculiar moments. I recalled overhearing in the Meikles Hotel a woman explain how her husband had caught a burglar in the act of robbing their house. When her friend asked why the husband hadn't shot the robber, she replied, "My dear, it's not the way it was 20 years ago."

No, it's not. Large problems, deep divisions still exist, but there is room for cautious optimism. Zimbabwe is more than anything a land of possibilities and, despite the lingering effects of war and colonial rule, those possibilities are being seized.

There are lessons in Zimbabwe's efforts to come to grips with its future and in the tangled relations of its people that many of us, in societies whose edges are beginning to curl from the smolder of disenchantment, perhaps can draw upon. □



Deadly waters: In an Adirondack stream, brook trout confined in a wire cage succumb to asphyxiation—a result of the water being polluted by rain- and snow-borne sulfuric and nitric acids. Acid rain has eliminated fish in thousands of lakes in Scandinavia and hundreds in the U. S. and Canada. Scientists believe acid rain comes from the burning of fossil fuels, but its environmental pathways and effects are still a puzzle.

By ANNE LABASTILLE

Photographs by TED SPIEGEL
BLACK STAR

ACID RAIN How Great a Menace?



EVENINGS, I OFTEN STROLL out on my cabin dock to enjoy the view of an Adirondack lake. But the scene is not as I remember it. No trout rise to the water's surface, swirling sunset colors. No ospreys quest along the shoreline, scanning for fish. No otters sprawl on my rocky point, crunching bullheads for dinner.

North and south of where I live are at least 180 fishless ponds, about 6 percent of all the ponds and lakes in the Adirondack Mountains of New York.

Four thousand miles away I recently overlooked a silent lake in Sweden. Gnarled pines framed its sparkling, too blue waters. Dr. William Dickson, an aquatic chemist with the Swedish National Environment

Protection Board, pointed to an ancient rock wall skirting the steep shore.

"The Vikings built this defense line a thousand years ago," he said, "and survived a long siege here. They had wood, water, and all the trout they could eat. But now, for the first time since the Ice Age, Stone Lake doesn't hold a single trout. I estimate that 20,000 lakes of the 100,000 in our country are fishless or about to become so."

It wasn't always this way. Earlier in this century Adirondack lakes and those of Scandinavia produced prime trout, and wildlife was plentiful. Then, as if a curtain were drawing slowly across a stage, aquatic organisms began to die in some of them, and other animals dependent on them declined.



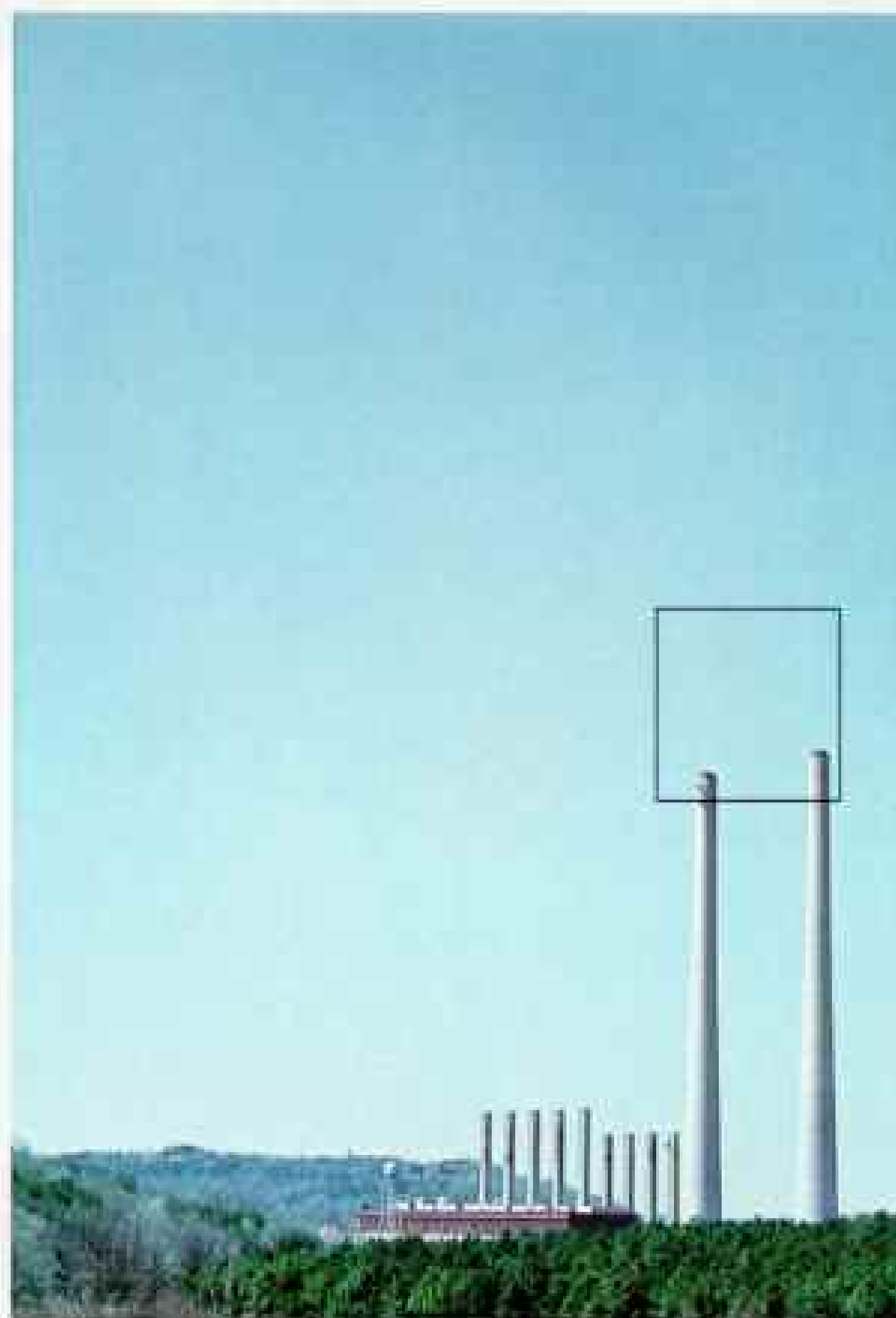
Now you see it, now you don't

SULFUR DIOXIDE, photographed through a special ultraviolet filter, streams from the stacks of a TVA coal-fired power plant near Kingston, Tennessee (left). But to the naked eye, as well as an unfiltered camera lens, the gas—some 8,000 tons of it the month these photographs were made—issues unseen from the same stacks (below), accompanied by invisible oxides of nitrogen.

Seen or unseen, the gases waft into the atmosphere, where, through complex chemical interactions, they can become dilute sulfuric and nitric acids. Because scientific understanding of how this occurs is incomplete, argument ensues over how to reduce acidity.

"We must understand such processes before taking action," says one viewpoint. "That will take years," says another. "Fish are dying, lakes are acidifying. Emissions should be reduced now."

The wrangle extends to the halls of Congress, where officials are evaluating revisions to the Clean Air Act.





Why? An energy-related problem called acid rain (or, more correctly, acid deposition, which encompasses dry as well as wet acidic substances). How great this menace is, no one is certain. But it now engages the efforts of hundreds of scientists from a range of disciplines, and a broad-brush picture of the problem is emerging.

Certainly, acid rain is affecting surface waters in the eastern United States, Canada, and Scandinavia. *Probably* it is affecting surface waters elsewhere, across wide areas of the Northern Hemisphere, and also corroding buildings; it *may* be threatening forests and croplands, the soils and groundwater that support them, even human health itself.

Despite these many qualifiers, the fact is irrefutable that fish in sensitive lakes are being destroyed by acid rain (as measured on a pH scale of 0 to 14). Thus the feisty brook trout of troubled Adirondack waters plays the role of the proverbial canary in the coal mine, warning us of impending peril.

Culprit: Breath of the Machine Age

The problem of acid deposition starts, most experts agree, with the worldwide burning of coal, oil, and natural gas. Despite general adherence to existing environmental controls, the smokestacks of electrical generating plants, industrial boilers, and smelters release sulfur dioxide and nitrogen oxides, the chief precursors of acid rain. Nitrogen oxides also puff from the exhaust pipes of motor vehicles and slowly escape from chemical fertilizers.

Other contaminants also are discharged; of particular concern are acidic soots and specks of toxic metals such as lead and cadmium. But it is the oxides of sulfur and nitrogen that are the major culprits in forming acid deposition, both wet and dry.

Some of these pollutants hover above the city or industrial plant that spawned them, creating clouds that sometimes settle on the local landscape. Moistened by dew or a local

shower, these emissions may transform into acids and damage vegetation and wildlife, etch car finishes, and corrode buildings and bridges. This short-range fallout leaves the blight and tarnish that we associate with the smoky cities of an earlier industrial era.

High-flying Pollution Aids Acid Rain

More sulfur dioxide (SO₂) and nitrogen oxides (NO_x), along with other combustion products, climb skyward, especially when vented upward by tall stacks. There they circulate with the great air masses that form our weather systems. It is these venturesome travelers that become the chief contributors to acid precipitation.

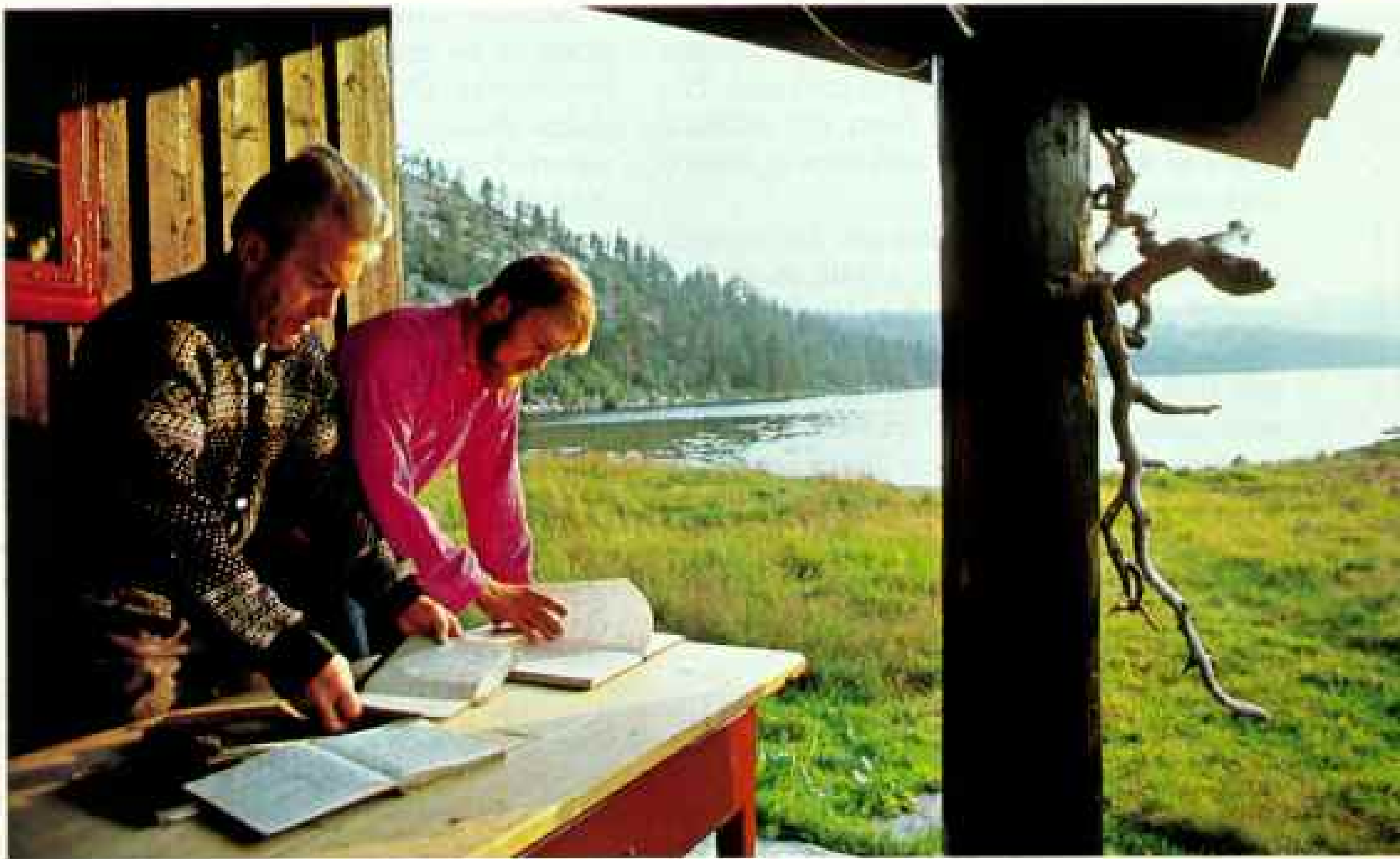
Their flights may last for days and take them hundreds, even thousands of miles. En route, the pollutant molecules interact chemically with sunlight, moisture, oxidants, and catalysts to change into other compounds of sulfur and nitrogen. Eventually some of the compounds are captured within clouds or by raindrops and snowflakes to form acid rain and snow—which in reality are dilute solutions of nitric and sulfuric acids.

The remaining sulfur and nitrogen compounds sift down as gases and dry particles, awaiting the first rainstorm or dewfall to transform them into droplets of acid.

Because of these long journeys, acid deposition is no respecter of state or national boundaries. Dr. Anthony Knap of the Bermuda Biological Station for Research has reported acid rain on that mid-ocean, non-industrial island, as has Dr. John M. Miller of the National Oceanic and Atmospheric Administration (NOAA) atop Mauna Loa volcano in Hawaii.

Perplexingly, certain sites in the less industrialized Southern Hemisphere receive rains as acidic as those of Hawaii and Bermuda. This suggests that the sulfur compounds are also released by biologic activity occurring in the oceans or that they are carried long distances.

Sooty scum on the hand of ecologist Hans Hultberg at Lake Gardsjön in southern Sweden contains sulfur, fly ash, heavy metals, and other by-products of coal and oil burning. "Some 4,000 lakes in Sweden are fishless," says Dr. Hultberg, "while another 14,000 have been acidified to some degree." Swedish scientists calculate that most of the pollutants are borne by winds from other countries.

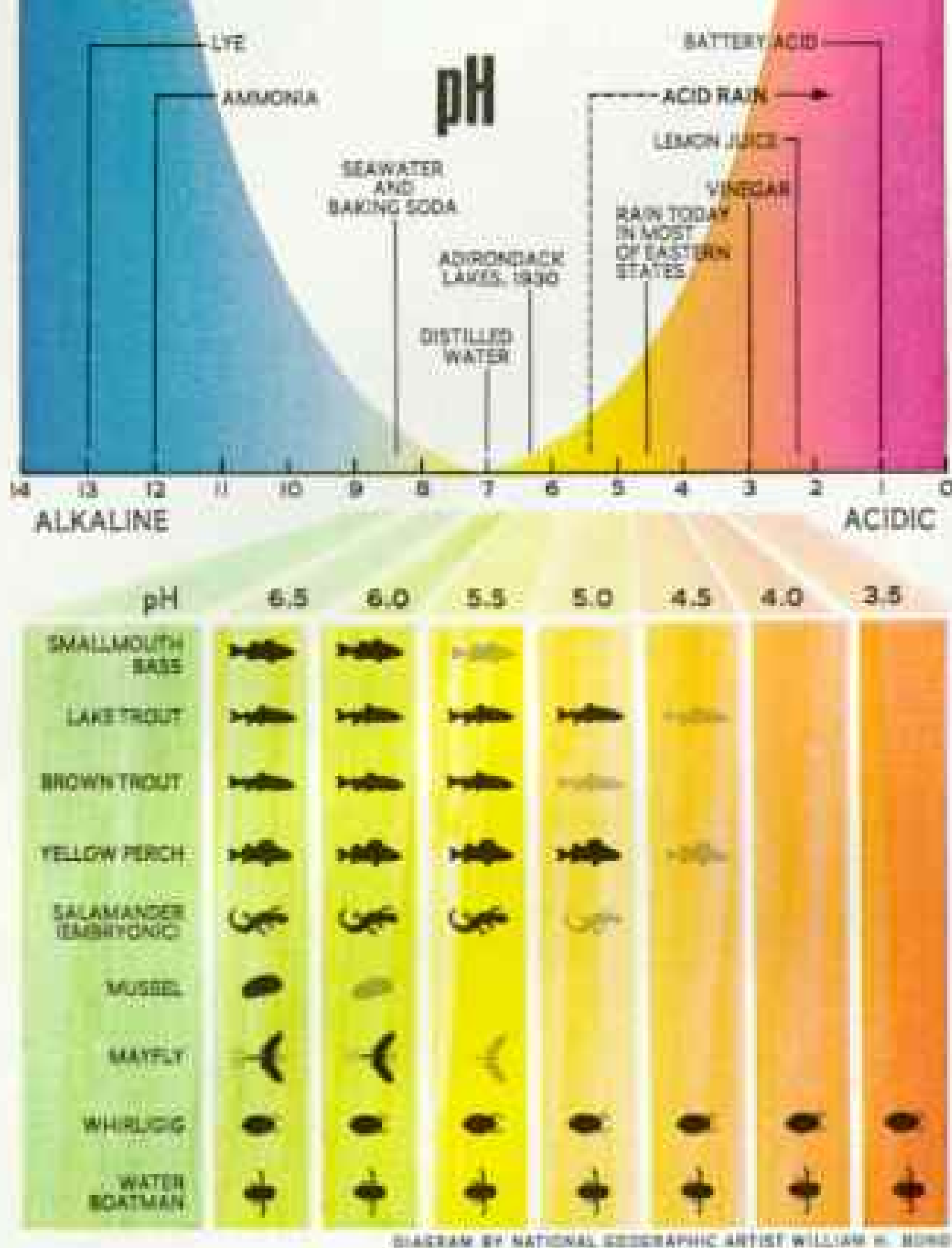




To sweeten a sour lake, Swedes pump lime—a ton each minute—that will neutralize acidity in Boksjö (above) and permit later restocking of fish. A thousand severely affected lakes have been limed, a stop-gap measure that restores productivity for about five years. By 1985 Sweden expects to be spending 40 million dollars a year on the program.

For the Wallin family (left) and thousands of others in southern Sweden, acid rain seeps into shallow wells and corrodes copper plumbing. The resulting copper sulfate tints tap water—and the blond hair of people who wash in it—green. Families have little recourse except to replace the plumbing and install filters or dig deeper wells.

In the Telemark district of Norway, Olav Valebjorg and his son (far left) examine cabin diaries that record catches in their lake. The entry for the last fish caught was in 1964. "Here is your lake," the father told his son in bequeathing the inheritance, "but no fish."



Scientific shorthand for the level of acidity, a pH scale (left, upper) ranges from highly acidic—battery acid at pH 1.0, right—to highly alkaline—lye at pH 13, left. Distilled water, at pH 7.0, is neutral, neither acidic nor alkaline. Because pH values are logarithmic, lemon juice at pH 2.3 is ten times as acidic as vinegar at pH 3.3.

Even uncontaminated rain is slightly acidic—pH 5.6—containing carbonic acid formed by the reaction of water with carbon dioxide. Acid rain is anything less than that.

A graph relating water acidity to its aquatic effects (left, lower) shows mussels dying at pH 6.0, mayflies and smallmouth bass at pH 5.5, and so on. Acid-tolerant insects such as water boatmen and whirligig beetles survive and multiply even at pH 3.5.

Despite the insidious ease with which acid rain precursors can travel, regions where its impacts are noticeable are, as yet, relatively few and predictable. They lie mainly in the industrialized belt of the Northern Hemisphere, downwind from dense concentrations of power plants, smelters, and urban sprawls. Often they are mountainous, and as such they frequently bathe in rains and snows. Well watered, these areas are typically clothed in forests and laced with lakes and streams. Their soils often are thin—a fragile flesh spread over a skeleton of glaciated bedrock.

This describes the Adirondack Mountains almost perfectly. It also fits other acid rain hot spots, such as rock-ribbed Nova Scotia, where nine acidified rivers no longer support salmon reproduction, and the Canadian shield country of southern Ontario and Quebec.

Other vulnerable areas include the Great Smoky Mountains, hundreds of sensitive lakes in Wisconsin and Minnesota, the Pacific Northwest, the Colorado Rockies, and the Pine Barrens of New Jersey. A striking parallel to New York's Adirondacks exists

in Scandinavia, where galaxies of lakes glint among low mountains watered by acid precipitation drifting northward from Europe's industrial belt.

Conversely, certain areas can tolerate acid fallout because of the neutralizing effect of their alkaline soils—a natural resistance known as buffering. Limestone regions such as the Allegheny Mountains enjoy this immunity. A similar buffering takes place in much of the Midwest, where alkaline dust blown from the West can also neutralize acid rain before it falls to the ground.

Nature Far Outdone by Man

How long have we had acidic rain? Probably since the first rains fell on a new-formed planet. Volcanic eruptions, forest fires, and even the slow bacterial decomposition of organic matter produce sulfur or nitrogen compounds. Lightning bolts form NO_x from the nitrogen in earth's atmosphere.

When administered in nature's measured doses, this atmospheric "pollution" can serve as a wholesome, gentle way of fertilizing the landscape. In good faith could Shakespeare extol the "gentle rain from

New breed: A biologist hoists a wild Canadian brook trout, *Salvelinus fontinalis*, one of many transplanted into Adirondack lakes and ponds in an attempt to revive sportfishing.

Cornell University scientists are artificially breeding the hardy newcomers with local hatchery fish in hopes of producing an improved strain of trout that will have a greater tolerance to acidic waters. Some hatchery trout lack the ability to survive the spring shock—the sudden upsurge in acidity levels from rain and melting snow.

Though acid rain has yet to be proved guilty of damage to crops, scientists ask whether dead trout—like canaries in a coal mine—serve as an early warning signal of potentially extensive injury to the environment.



heaven" in *The Merchant of Venice*, and Robert Frost write of downy flakes in his "Stopping by Woods on a Snowy Evening."

But this natural cycle began to give way about two centuries ago, when man intruded with the cloud of coal smoke that signaled the start of the industrial revolution. Suddenly, sulfur and nitrogen that had accumulated in fossil fuels for millions of years were released as rapidly as coal could be burned. Swiftly the volume of man-made pollutants gained on nature's. Today, a large coal-fired power plant can emit in a single year as much sulfur dioxide as was blown out by the May 18, 1980, eruption of Mount St. Helens in Washington State—some 400,000 tons.

The total amounts of SO_2 and NO_x that mankind releases are staggering. In 1980 the U. S. ejected more than 26 million tons of sulfur dioxide into the air in addition to nearly 22 million tons of nitrogen oxides. For Canada the figures were five million and two million tons. Last year the two nations, along with Europe, pumped almost 100 million tons of SO_2 into the atmosphere.

As early as 1852 an observant English

chemist, Robert Angus Smith, discovered a relationship between the increasingly sooty skies of industrial Manchester and the acidity he found in precipitation. Twenty years later he used the term acid rain in a 600-page book on the subject.

This remarkable work was neglected until Dr. Eville Gorham, a Canadian ecologist now at the University of Minnesota, elaborated on Smith's work in the late 1950s. He too was initially ignored.

Scientific Interest Piqued by Swede

Acid rain's deserved notoriety finally came in 1967 when a Swedish soil scientist named Svante Odén reported a pattern of increasingly acid precipitation over time and geographic area. From his studies, he prophesied serious impacts on soils, waters, forests, and structures.

Employing colorful language that characterized acid rain as "chemical war," Dr. Odén provoked a fallout of concern that sparked the intense interest found among today's scientists. His findings established him as the father of acid rain research. In all fairness, however, Dr. Gorham must be



Glistening chunk of sulfide poses an environmental challenge for Inco Ltd. at Sudbury, Ontario (facing page), which produces sulfuric acid from the wastes of its copper and nickel operations. The company now manufactures 3.5 times as much sulfuric acid, by tonnage, as nickel and copper. Steam issues from the acid plant's cooling towers, foreground. Sulfur dioxide emissions from the 1,250-foot-high stack are limited to an average of 2,500 tons a day, down from 7,000.

A Pennsylvania highway crew uses waste sulfur to replace part of the asphalt for road resurfacing (above). Clockwise in the tray, the mix includes yellow sulfur, black asphalt, sand, and gravel. The hand holds a disk of finished pavement.

considered the grandfather and Robert Angus Smith the great-grandfather.

Acid precipitation in North America found an early student in Dr. Gene Likens, an ecology professor at Cornell University. In 1963 Dr. Likens and Dr. F. Herbert Bor-mann of Yale had begun a multidisciplinary study of forest productivity in a small watershed of the Hubbard Brook Experimental Forest in New Hampshire. Their initial precipitation records revealed surprisingly strong acid content, considering the remoteness of the site.

The Hubbard Brook study provides the longest continuous record of acid precipitation chemistry in North America—a record that accurately shows annual fluctuations in acidity but no clear trend as to worsening or improving conditions through 1981.

Trouble From Tall Stacks

Until a few decades ago, air pollution was largely an urban concern. The economic surge that began with World War II brought increasing use of fossil fuels, and a corresponding increase in pollutants.

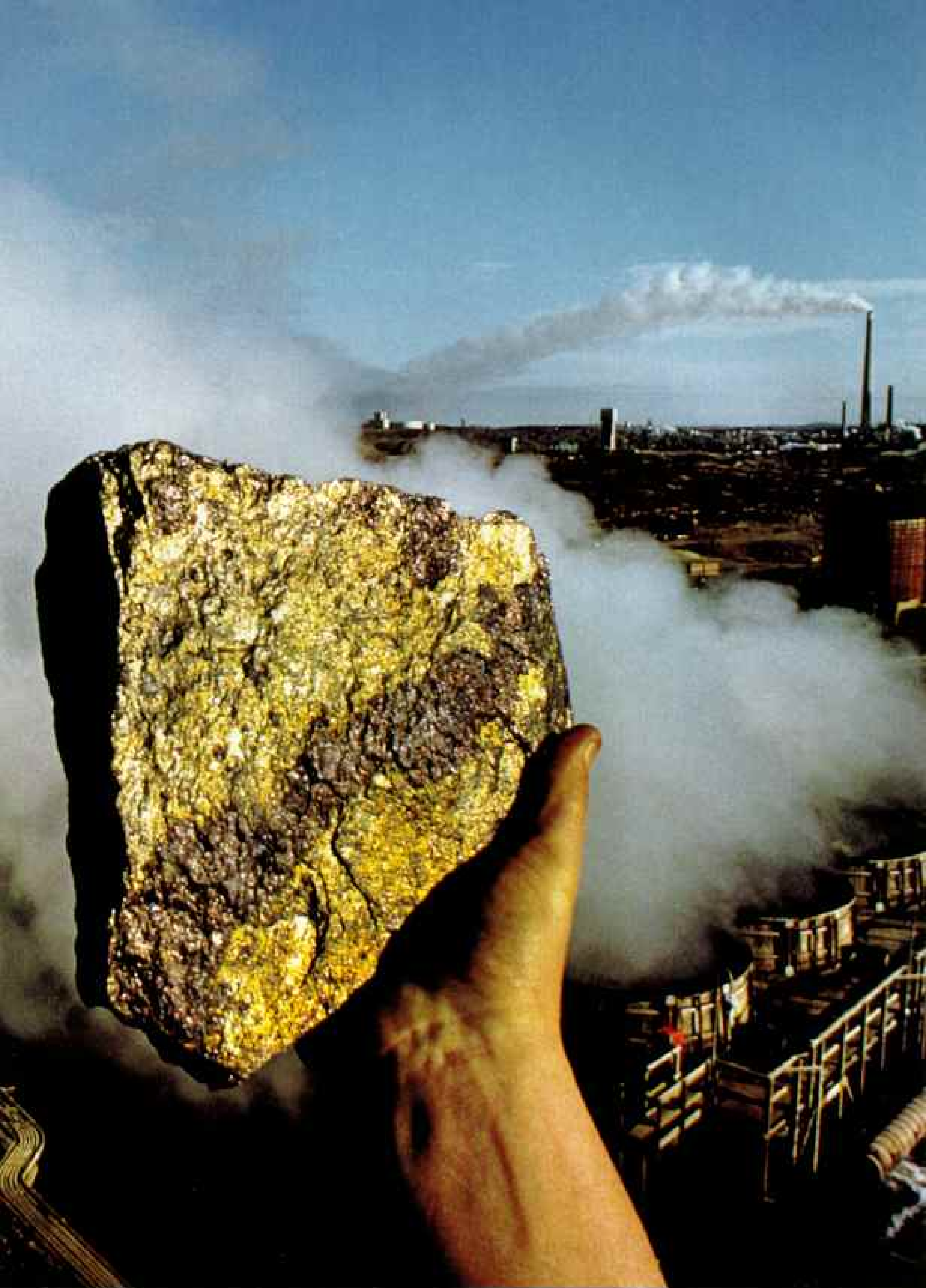
Well-intended regulations may unwittingly have aggravated the problem. New Environmental Protection Agency (EPA) rules in 1970 caused plants to increase the height of their stacks; thus winds carried pollutants far from local sources. Today in the U. S., 179 stacks tower 500 feet high or more, including 20 that reach 1,000 feet.

The record stack, a 1,250-foot giant at a nickel smelter in Sudbury, Ontario (right), also holds the record as the free world's single greatest source of SO₂ pollution—2,500 tons a day (albeit a welcome reduction from the 7,000 tons daily in earlier years). Such huge stacks, spewing contaminants into large weather systems, have helped make air pollution an international phenomenon.

Nevertheless, experts acknowledge that much remains to be learned about acid rain, even such basic questions as: Where, exactly, are the specific sources of acid-causing pollutants? The answer is disputed, for it could involve the expenditure of large sums of money, and possibly even redirect the nation's energy policy.

"One of the major issues," explains Dr. Fred Lipfert, a scientist at Brookhaven National

(Continued on page 668)







Creeping blight on Canadian Parliament buildings in Ottawa (left) also encrusts a gargoyle (above). Blame is laid to the stone's reaction to a mix of airborne pollutants—acid rain included—from both local and distant sources. But which pollutants, and from where?

The search for such answers pits state against state and country against country. An Ohio newspaper asks an ominous question (top), though no deaths can actually be ascribed to acid rain. Nevertheless, several states are bringing suit for alleged

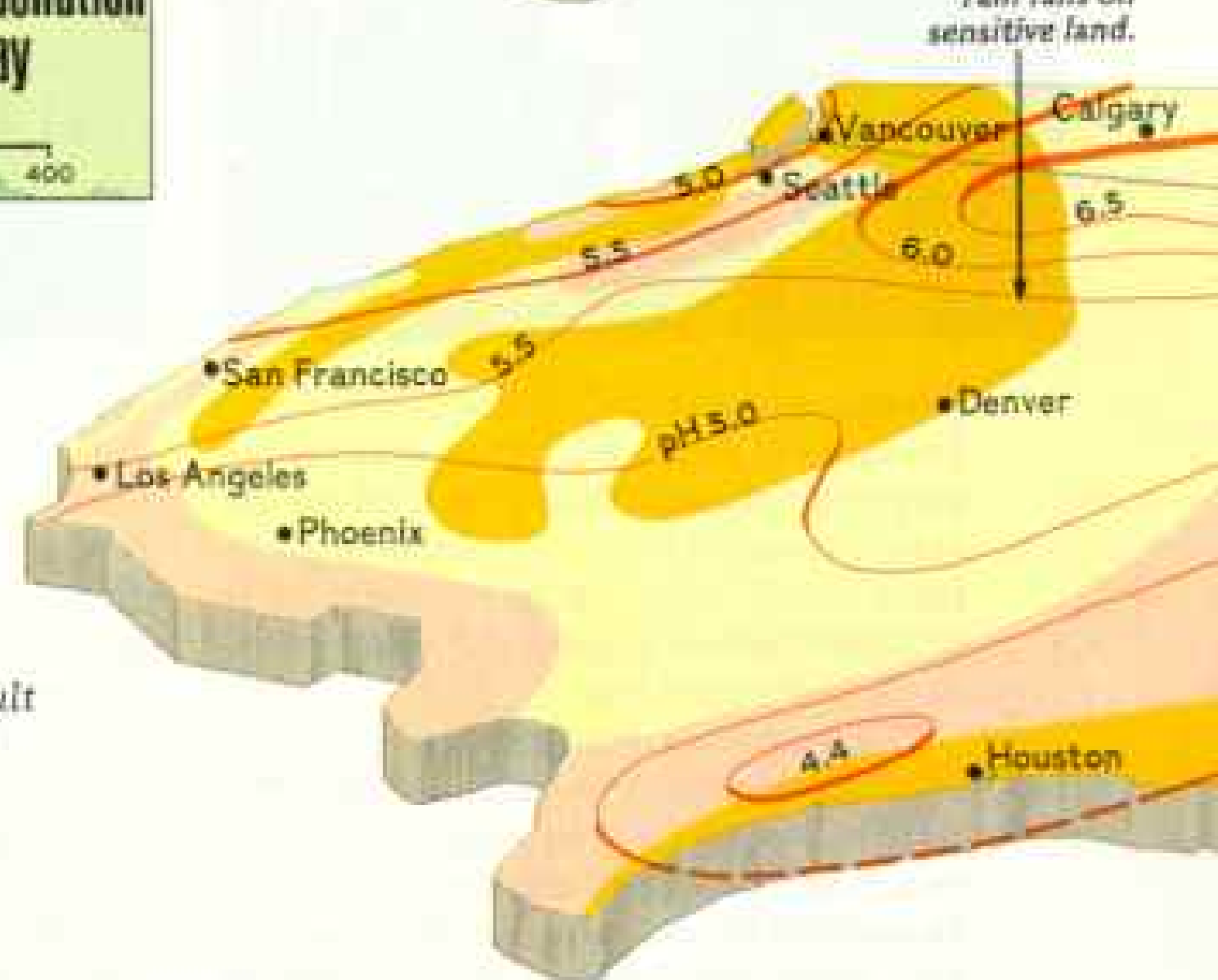
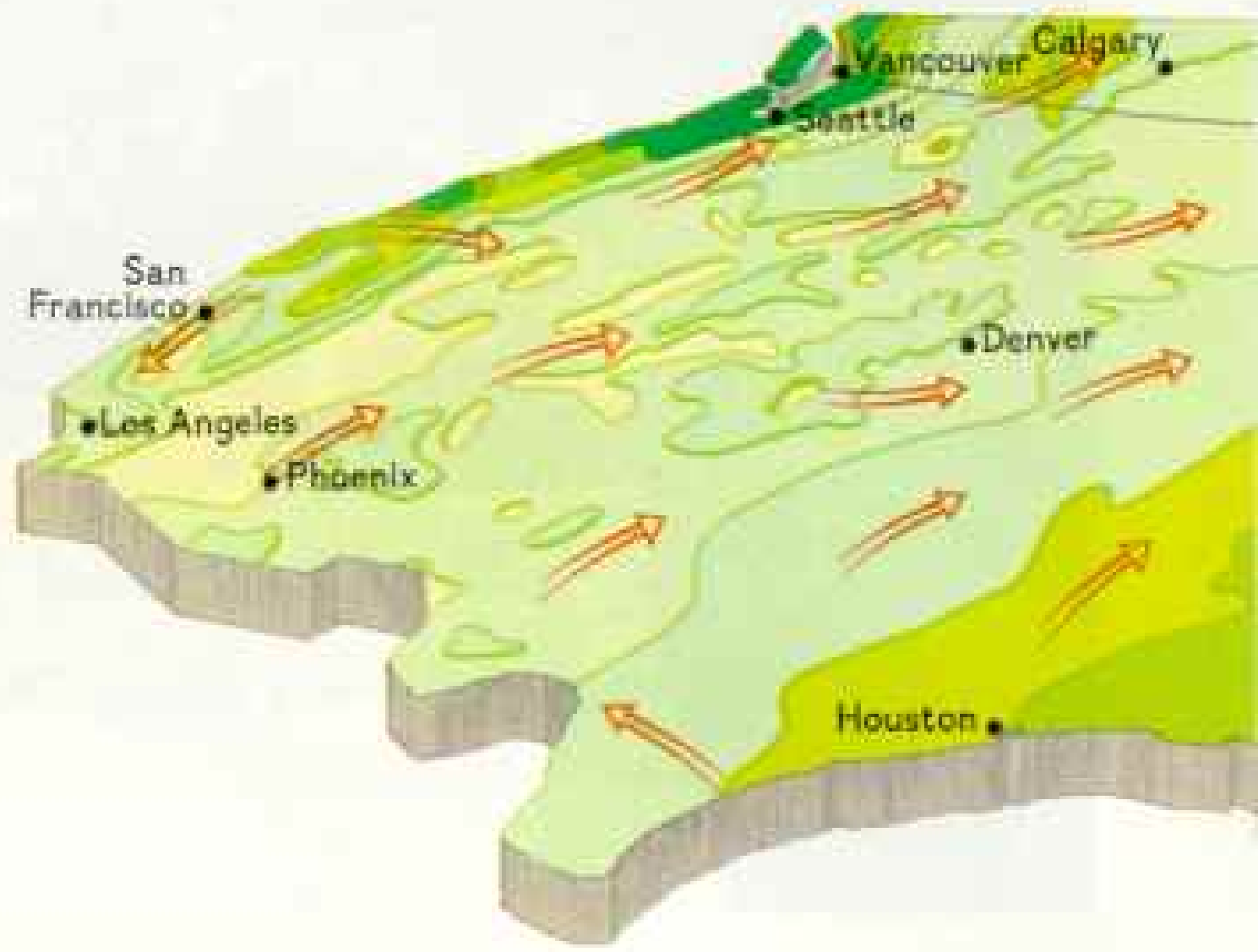
violations of the Clean Air Act in Ohio.

In February Canadian scientists in Ottawa briefed visiting U.S. officials (above) on accelerating environmental damage. Though no one has shown a quantitative relation between, say, what goes up from the Ohio River Valley and what comes down in Canada, the Canadians have little doubt about the U.S. connection. "We are absolutely convinced it is true," says Raymond M. Robinson, head of Canada's Environmental Protection Service, "and we are darned worried."

The acid rain equation

FACTORS of the acid rain equation—rainfall patterns, winds, emission sources, and soil sensitivity—combine to determine the impact of acidity on the environment.

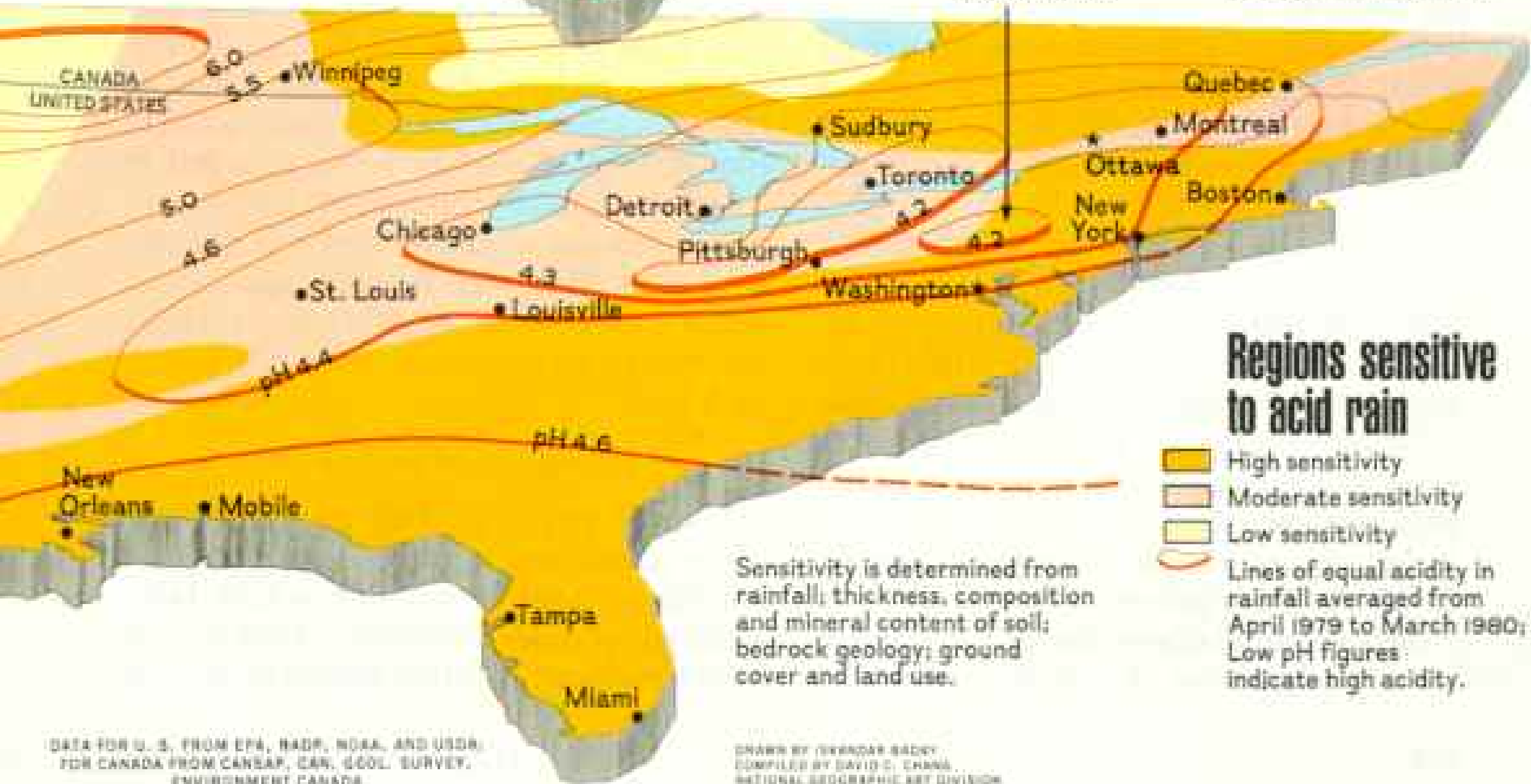
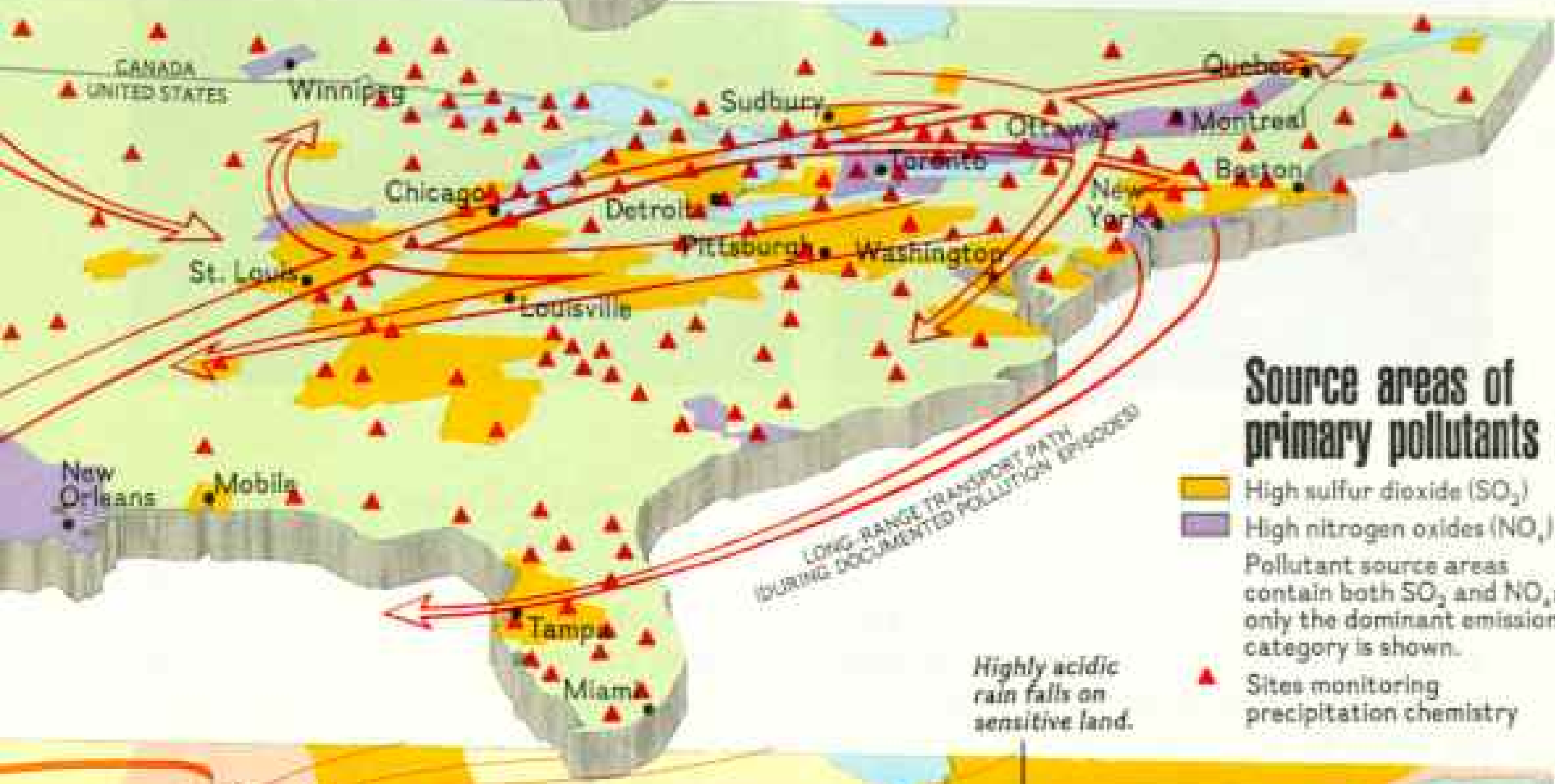
In North America the major target of acid rain is the northeast U. S. and eastern Canada, a region that experiences only moderate rainfall (right). Heavy emissions from the Midwest are ferried on storm



tracks, indicated by long arrows (middle), that can dump their acidic brew hundreds of miles away, many scientists believe.

Whether the rain does damage depends on the ground's capacity to neutralize or buffer it. Where high rainfall acidity meets poor buffering, as in the Northeast, environmental insult can ensue (right). Alkaline soils of the plains generally neutralize the rain.

Scandinavia, particularly Norway, becomes the target of wind-borne emissions (above) from European industrial centers.



DATA FOR U. S. FROM EPA, NADP, NOAA, AND USDR; FOR CANADA FROM CANSAP, CAN. GEOL. SURVEY, ENVIRONMENT CANADA.

DRAWN BY BRADDER BADEY; COMPILED BY DAVID C. CHANG, NATIONAL GEOGRAPHIC ART DIVISION.



RONALD J. FERER (TOP AND ABOVE)



(Continued from page 662) Laboratory on Long Island, "is the mechanics by which air pollutants enter rain.

"It's natural to assume that the fossil fuel-burning regions of the eastern United States are responsible for their own acid rain. But the Ohio River Valley is a huge industrial user of coal, and because it has prevailing winds that carry its emissions eastward, it may, under certain conditions, be more important than eastern industry to such sensitive areas as the Adirondacks.

"Also," Dr. Lipfert continued, "the EPA in the 1970s permitted widely varying emission amounts from pre-existing smokestacks, with the tighter standards being applied in the heavily populated East. Some Midwest sources were allowed to disperse as much as 200 pounds of SO_2 per ton of coal. Because new sources are now allowed only 15 pounds per ton, the older plants remain the biggest contributors."

Not everyone believes the blame can be so handily pinpointed. Those who argue the

point represent, in large measure, the nation's energy companies and power utilities.

Says John M. Wooten, environmental director for the giant Peabody Coal Company: "Nobody has yet *proved* a direct relationship between the level of sulfur emissions in the Midwest and the amount of acid rain that falls in the northeastern U. S. and Canada. And until we have this proof, we should go slowly in order to develop the most prudent control scheme. Before being required to retrofit expensive scrubbers to reduce emissions, we want assurance they will do some good—say, that a 20 percent reduction in sulfur emissions in the Ohio River Valley will bring a 10 percent decrease in acid rain back East."

Detectives of Dirty Skies

How do you prove that a specific Ohio power plant is sending out the emissions that are killing trout in my Adirondack lake, hundreds of miles downwind? How do you trace a molecule of sulfur dioxide on its long

Airborne scientist pours water droplets (right) collected inside a cloud over southern Ohio, while other instruments in the airplane sample gaseous and particulate pollutants. A small balloon (left), tracked by radar, floats along with a polluted air mass traveling northeast from Columbus.

A part of the Environmental Protection Agency's program to follow and identify wind-borne pollutants, these efforts address key questions: What is the chemistry of acid rain formation in clouds? What is the link between emissions in one area and depositions in another?

Electron micrographs document the presence of sulfuric acid in aerosols collected above the industrialized Ohio River Valley (far left, upper), as well as over the Adirondacks (far left, lower). The knotty question is: Where did the Adirondack acid come from?



journey through dark and turbulent clouds?

To track pollutants, scientists engage in aerobatics that do credit to the flying circuses of old. Ducking in and out of drifting pollution plumes from urban areas and power plants, they take air and water samples in attempts to identify and track the flow. Computer-generated models then predict the pollutants' trajectories.

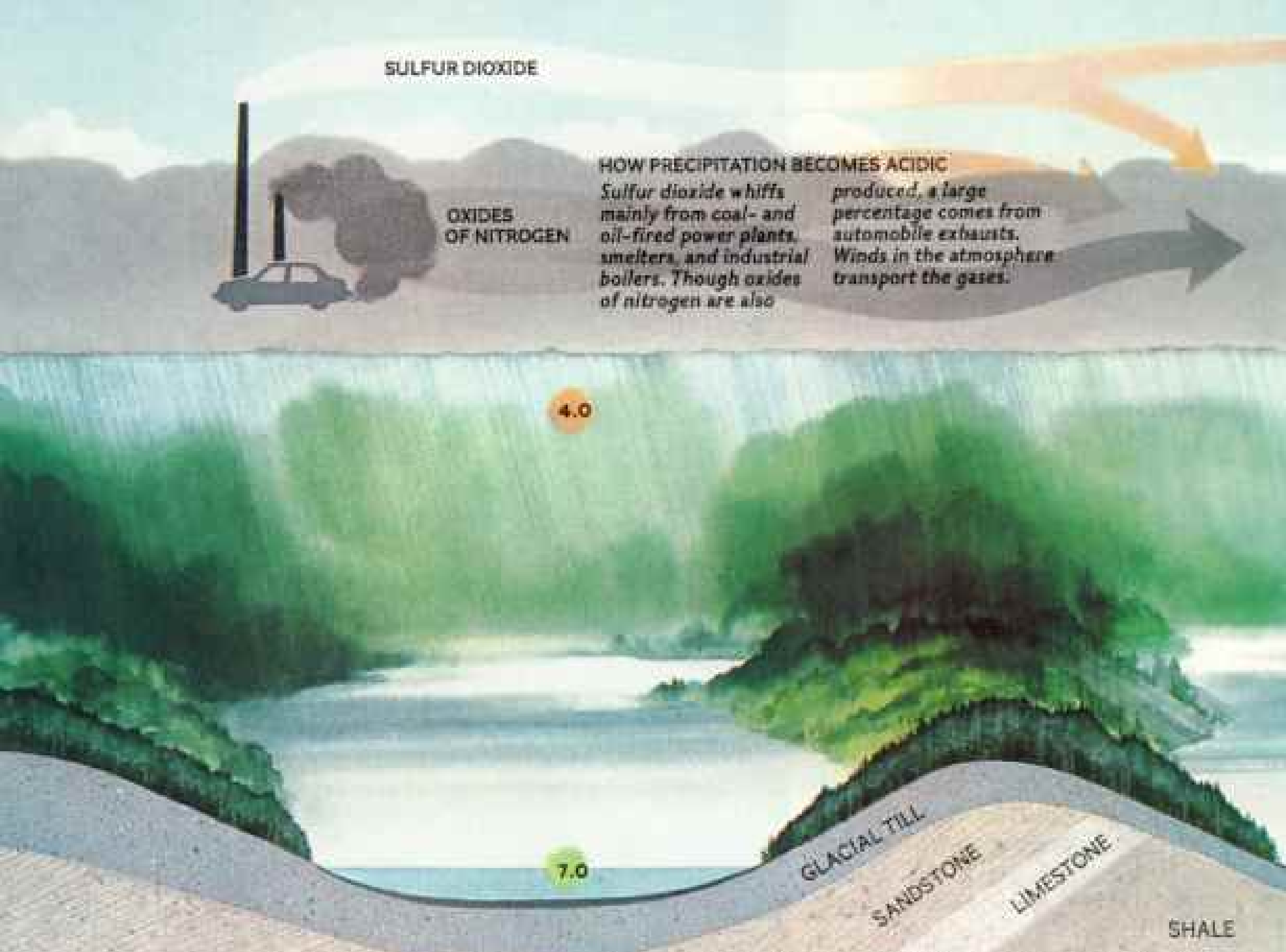
One of the most valuable tools in this sleuthing is a growing nationwide network of 84 acid rain monitoring stations, set up in the late 1970s under the guiding hand of Dr. Ellis B. Cowling of the School of Forest Resources at North Carolina State University. A private organization known as the National Atmospheric Deposition Program (NADP), it analyzes samples of rain, snow, and dry fallout from 32 states. A companion survey, the Canadian Network for Sampling Precipitation (CANSAP), covers 55 locales in Canada.

These monitors reveal that virtually all the eastern U. S. and much of southeastern

Canada are receiving highly acidic precipitation. Measured on the pH scale, where 7.0 equals a perfect balance between acidity and alkalinity (diagram, page 660), the rains range from 4.1 to 4.6—ten to thirty times as acid as uncontaminated rain. Specific storms have dumped pH 2.7 precipitation—as acid as vinegar—on Kane, Pennsylvania, and pH 1.5 precipitation—stronger than lemon juice—on Wheeling, West Virginia.

Three Lakes, Three Results

I can visit, conveniently close to my cabin, a lake acidification study (one of 20 separate research projects in the Adirondacks) that is taking a five-million-dollar look at the chemistry of wild lakes as a result of acid deposition. Sponsored by the Electric Power Research Institute, a nonprofit research arm for 600 electrical utility companies, the study traces what happens to three lakes and their watersheds from the moment acid rain and snow hit the treetops to their final flow from the outlets.



Buffer factor: one rain – three lakes

NATURE's infinite variety provides that, while some lakes become acidic, others do not. The reason is buffering—the neutralizing of acid as it percolates through a lake's watershed.

Though all three lakes in this stylized drawing experience pH 4.0 acid rain, the lake at the left

"What we're finding," explained Dr. James N. Galloway, an environmental chemist from the University of Virginia, "is that each lake is personalized in its reaction to acid rain. For example, no one has caught any brook trout at Woods Lake, which has had a pH of 4.7, for years—this is too acid for fish. But brookies thrive at Sagamore—pH 5.8—and at Panther—pH 7.0. Yet all three lie at roughly the same elevation within 20 miles of one another and receive the same kind of acid deposition.

"Many factors control this reaction: size and shape of the watersheds, type of vegetation, bedrock, and soils, and the residence time of precipitation in the soil. Fishless Woods Lake, with its shallow soil and steep

slopes, provides little residence time and thus little buffering of the acid rain."

An important breakthrough in acid rain research came in 1977 from Adirondack studies by Dr. Carl Schofield of Cornell. Investigating how acidity actually killed lake fish, he observed that aluminum compounds were collecting in the gills of fry. To combat the pollutant, the fry exuded a mucus in such amounts it finally strangled them. Acid precipitation, Dr. Schofield concluded, was leaching aluminum from surrounding soils—a process known as mobilization—and bearing it into the lake water. Today soil scientists recognize that acid rain mobilizes many toxic metals, including mercury and lead.



DIAGRAM BY WILLIAM H. BOND

Acid rain and its companion heavy metals produce a long laundry list of suspected threats to the environment. These extend far beyond aquatic ecosystems, to forests, crops, soils, wildlife, groundwater, man-made materials, and perhaps human health.

Many of these ills beset Scandinavia, where I went to see them firsthand. Aquatic chemist Dr. Arne Henriksen guided me on an hour's hike around the rocky shores of Norway's Hovatn Lake. The surface stretched mercury smooth, ebony black to a stony mountain.

"It's 60 miles to the sea," gestured Dr. Henriksen, "and hundreds more miles to the nearest pollution sources. But watch." He took my pH meter, a small gauge resembling

a battery tester, and dipped its probe into the water. It read 4.4. "That acidity has come from somewhere!" he exclaimed, looking southward toward industrial Europe.

For Fish, Spring Can Be Deadly

Quietly we rowed to a lone cabin on a peninsula, on loan for use as a field station for a massive acid rain research program known by its initials, SNSF. It was launched in 1972 following the disappearance of fish in southern Norway. As I stepped inside the shadowy building, outlines of two enormous brown trout on the wall caught my eye. Both were longer than my forearm with fingers outstretched.

Dr. Henriksen said, "Those were caught

in the early 1930s. Not a fish has been taken by any method from Hovatn since 1945."

He started a fire in the corner hearth and picked up a worn cabin journal. "Here it tells that the owners often tried restocking the lake, introducing thousands of fish, but none survived. By 1967 they suspected acid rain. Discouraged, they offered their cabin and lake to the research project."

Dr. Henriksen explained how the most severe fish kills occur in early spring. All winter, the pollutant load from storms accumulates in the snowpack as if in a great white sponge. When mild weather gives the sponge a "squeeze," acids concentrated on the surface of the snow are released with the first melt. Thus, the first meltwater can be five to ten times more acid than the remaining snowpack. This acid shock, acting in concert with mobilized aluminum, produces the drastic changes in water chemistry that destroy fish life.

With predaceous fish gone, aquatic insects can flourish, unless they too are sensitive to acidity. Acid-tolerant species, such as water boatmen, thrive. All other aquatic fauna decline in variety, as do the species of

phytoplankton. A reduction in the sheer numbers of these tiny plants may allow light to penetrate farther through the water. That's why acid-impacted lakes are often described as being unnaturally clear or bluish.

Larger plant life too is affected. Water lilies decline, while the sphagnum mosses and filamentous algae grow prodigiously. These can form impenetrable mats, sealing off oxygen and retarding decay of lake-floor litter. Looking into the crystal water of a lake in Sweden, I saw leaves on the lake bottom that had not rotted in three years.

No acid lake therefore is really dead. Instead its population structure reverts to fewer species, radically altering the food web.

Land Shows Mixed Effects

Unlike these dramatic effects on aquatic life, the influence of acid rain on crops and forests is difficult to measure. No conclusive evidence of actual crop damage by acid rain has yet been shown. This could stem in part from the fact that sulfur and nitrogen, even when administered in the form of mild acids, serve as plant nutrients.

Laboratory tests, in which crops are

Acid and

A GRIM FUTURE awaits spotted salamander embryos exposed to acid water in studies conducted at Cornell University. Experiencing acidity of pH 5.0, a few-days-old salamander embryo (left, upper) has failed to retract the nutrient-rich yolk plug, which appears as an oval knob at the bottom.

An embryo in pH 7.0 water (far left, upper) shows normal development, with the yolk plug retracted.

Contrasted with a healthy 2 1/2-week-old embryo (far left, lower), another at pH 5.0 exhibits a swelling near the heart and a stunted posterior (left,



grown in simulated acid rain conditions, produce a mixed bag of results. Some show a reduction in crop yield, others no effect, and yet others showed actual yield increases.

Yet many scientists fear that long-term exposure to acid rain inevitably must cause plant stress.

Is acid rain curtailing forest growth? The answer to this vital question too remains an ambiguous yes and no. It is complicated by the fact that forest systems are biologically more complex than croplands, and have a longer response time to acid stress.

"During six years of field experiments, growth of Scotch pine has actually been stimulated by acid rain, at least on poor soils," I heard from Dr. Folke Andersson of the Swedish University of Agricultural Sciences. "This change may be explained by the fertilization effect of the nitrogen that comes with polluted rain."

But Dr. Andersson was quick to add: "This fertilization probably cannot compensate for the delay in decomposition of forest-floor litter caused by acid rain, and the accumulation of heavy metals in soils over long time spans. And, in fact, another extended

study has shown decreases in growth rate on both poor and good soils.

"We need another 25 years," he said, "to determine if acid rain is seriously impairing tree growth, or causing other bad effects."

However, a West German study recently linked acid deposition with the death of trees' feeder roots and the subsequent decline in forest growth.

Does Wildlife Suffer Too?

Uncertainty also surrounds the effects of acid rain on wildlife. Unquestionably it is harmful to amphibians such as salamanders, spring peepers, and frogs—creatures that lay their eggs in acidified ponds and meltwater pools.

Dr. Erik Nyholm of the University of Lund in Sweden, studying the breeding biology of small songbirds along lakes in Lapland, found fewer eggs, less hatching success, and soft or missing shell material.

He theorizes that the birds were poisoned by aluminum from feeding on contaminated insects. "The aluminum probably was leached from the soil by the acid snow and rain," he said. "High aluminum content

the salamander

lower), deformities that are usually fatal. Of the salamanders that do survive, some are crippled. One shows a curved spine (right) as well as stunted gills.

Cornell's Dr. F. Harvey Pough also visited nearby ponds, the salamander's natural breeding spots, and found results corresponding to those in the laboratory.

In pools of nearly neutral acidity, egg mortality was less than one percent. But in waters more acid than pH 6.0, more than 60 percent of the amphibians died.

Dr. Pough explains that the salamander breeds early in the spring in temporary ponds formed by snowmelt and rain, where acidity is likely to be high, interfering with cell function and formation.

"The future of the spotted salamander appears bleak," he says. "In the food chain, it is as important as birds or small mammals. A drastic change in its population would be likely to have repercussions throughout the entire ecosystem."



ALL BY NATIONAL GEOGRAPHIC PHOTOGRAPHER ROBERT F. BISSON

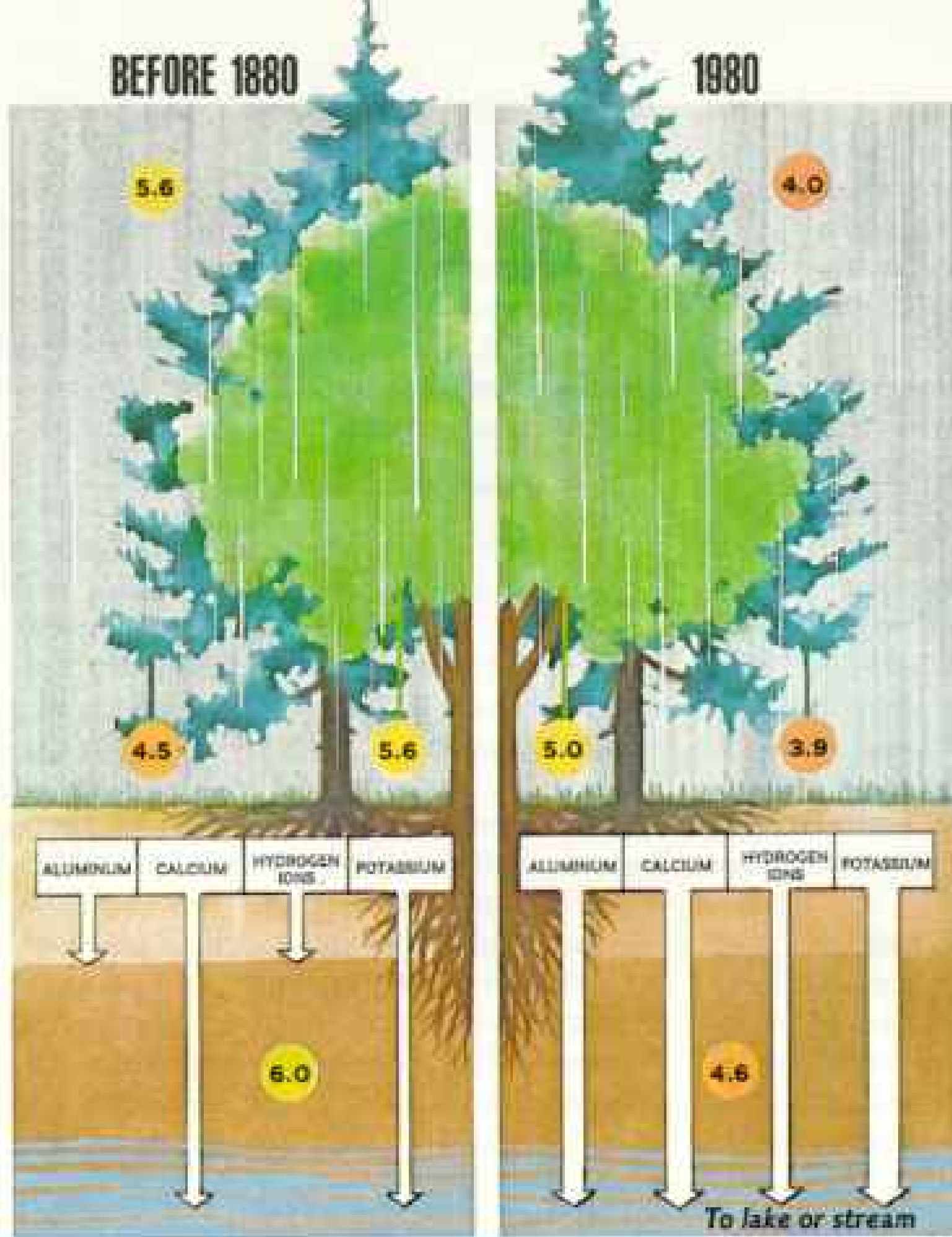


DIAGRAM BY WILLIAM H. BOYD

Twixt tree and ground, rain's acidity can change and may have long-range effects on soil, some scientists believe. Pattering through the foliage of a fir tree (near left), acid rain of pH 4.0 picks up organic and mineral acids that give it a pH of 3.9 at ground level.

Paradoxically, salts in the leaves of a hardwood dilute the rain to pH 5.0. But attempting to replace the salts, the hardwood releases acidifying hydrogen ions into the soil.

Both processes leach essential calcium and potassium from the soil and may ultimately deprive a tree's roots of these nutrients. Also leached are more hydrogen ions and aluminum, toxic to fish

found in the bone marrow of the birds counteracted calcium deposition, resulting in defective eggshells. Other birds, feeding deep in the forest or around buffered lakes, showed no such problems."

A few mammals also may be showing biological reaction to acid deposition. In Poland, a large group of roe deer living in a forest directly downwind from Krakow's steel mills demonstrates definite declines in antler size and trophy value during the past 25 years. Polish biologists believe that the deer's habitat has been contaminated by acid and heavy-metal deposition.

The reaction of soils to acid deposition understandably stirs wide concern, for these are critical ecosystems, supporting the plants and animals that give us food, fiber, and forest products. They represent our long-term bank account. Is acid rain starting to eat up the principal?

Naturally acidic soils, common to many regions of the U. S., possess little built-in

buffering capacity (pages 666-7). Laboratory and field experiments with simulated acid rain show that acidifying soils may undergo a host of undesirable changes: increased leaching of trace elements such as aluminum and manganese, a slowdown of the organisms that break down forest-floor litter, and reduced nitrogen.

How Dim the Future?

These laboratory results leave many scientists with a haunting fear. If acid deposition continues unabated, vast tracts of sensitive soils may slowly decline in fertility until their productivity fails. When, or if, this might occur, no one can calculate, but its effects could be difficult to reverse.

And what of corrosion—the eating away of man-made materials by acids? Engineers have despaired for decades as airborne pollutants have attacked structures ranging from steel bridges to tombstones. The list of the wounded includes many famous names:

and possibly to plants.

Diagram at far left, based on U. S. areas that do not receive acid rain, is believed to represent patterns of a century ago. Here nature's balance is retained. Aluminum and hydrogen ions are not released. Calcium and potassium remain in nourishing supply.

Cupped in an apple blossom petal (right), a raindrop turns red, indicating acidity, when a tell-tale chemical is dropped on it at the lower right portion of the picture.

The spring rain at an orchard in Geneva, New York, was measured at pH 4.1, about 30 times more acidic than average rain, but typical for the region. Apple yield was normal.



the caryatids of the Acropolis, Egypt's temples at Karnak, the U. S. Capitol. Even that glorious copper lady—the Statue of Liberty—is under the onslaught of acid rain and corrosive gases and particles.

If acid rain, with its associated gases and metals, can be detrimental to animals and structures, what might it be doing to people? No immediate, direct health problems, such as getting “burned” by acid rain, have been observed or reported. Indirect effects have been noted, however, both from dry and wet acid deposition.

Dry airborne pollutants—usually sulfates—are largely associated with respiratory diseases—chronic bronchitis, asthma, and emphysema. Dr. Leonard Hamilton, a Brookhaven National Laboratory epidemiologist, estimated in 1975 that “acid sulfates from fossil fuel . . . emissions are responsible for 7,500 to 120,000 deaths a year.” Few other scientists believe there is enough solid evidence to support such high figures.

Another health effect relates to acidified groundwater in Scandinavia. In western Sweden I drove through rural provinces with Dr. Hans Hultberg of the Swedish Water and Air Pollution Research Institute (page 656). We bounced over rough roads in farmland where severe groundwater acidification has begun, along with contamination by metals leached from the soil.

“See that farm over there?” Dr. Hultberg pointed. “The babies had diarrhea off and on for months until we found that high copper content in the drinking water was the cause. Their well was acid. The water leaches copper from the plumbing lines.”

A Hair-tinting Experience

We passed a small cottage. “The lady's hair there was tinted green,” exclaimed Dr. Hultberg. “Green as a birch in spring. She washed it in well water turned green by copper sulfate.”

Later I found an echo of this problem in

the western Adirondacks as I guided Dr. G. Wolfgang Fuhs, an environmental scientist with New York's Department of Health, to isolated springs, wells, and small municipal water supplies. Owners in the area had been complaining of corroding plumbing systems and suspicious-tasting tap water. Dr. Fuhs found several home systems and springs with elevated levels of lead and copper. For each family he had the same advice: Let faucets run a few minutes after nonuse overnight to lower metal concentrations before drinking or cooking.

Time Bombs for Tomorrow

Is it surprising, given this parcel of known and feared effects, that some scientists rank acid rain with toxic-chemical pollution and carbon dioxide buildup as the three worst "environmental time bombs?" They compare the connective evidence between fossil-fuel emissions and acid rain effects to that of cigarette smoking and lung cancer: Though in each case the cause-and-effect relationship is not proved, even doubters of acid rain must agree that the combustion of fossil fuels *has* increased in past decades, that lakes and streams *do* show a loss of life.

The dilemma of acid rain will ultimately be solved by politicians, economists, and the public, acting on the best information we scientists bring forth.

The principal tool we have to work with in this country is the Clean Air Act. This federal law, controlling adverse effects of air pollution on public health and welfare, requires that the emissions from fossil-fuel burning facilities and motor vehicles meet certain standards.

It does so essentially in two ways. One is through an EPA requirement making new pollution sources use the "best available" technology to control emissions.

The second approach relates to existing plants. Here, each state is expected to regulate itself. A result is that no state needs to heed another's standards. Thus the SO₂ emissions Ohio allows are nearly 30 times higher than permitted in Connecticut.

Robert F. Flacke, commissioner of New York State's Department of Environmental Conservation, says firmly, "The Clean Air Act is really one of the chief reasons for the increase in acid rain. Not only did its earlier

policy bring about the long-range transport of air pollution via tall stacks, it also permits New York and other clean-plant states to be dirtied by states with looser air standards."

Not surprisingly, these biases pit state against state, with at least half a dozen of them initiating legal actions. Another spate of litigation attacks EPA for allegedly failing to do its duty to provide protection under provisions of the Clean Air Act.

The act is up for reauthorization in Congress now, and swarms of lobbyists seek both to strengthen and to weaken it. Meanwhile, Congress allocated 12 million dollars under the Acid Precipitation Act of 1980 to spend on research in 1981, with more being recommended for 1982. A federal-level interagency task force directed by NOAA's Dr. Chris Bernabo is studying acid rain with a view toward developing a national strategy, and extensive research goes on at universities, national laboratories, and within the electric-power industry.

But the Reagan Administration is making no rush to judgment. In the words of A. Alan Hill, chairman of the Council on Environmental Quality: "Our scientific community is still unclear as to . . . what control methods should be used. In our opinion, we just don't know enough yet to impose control measures at great cost to the American people with questionable results."

Nations Fall Out Over Rain

On the international scene, too, acid precipitation emerges as a politically poisonous brew—one that embitters the valued friendship between the U. S. and Canada.

"We calculate that half the acid deposition striking Canada is imported from the U. S.," explained Dr. Hans Martin, Canada's coordinator for acid rain research. "Furthermore, it's falling on a million square miles of Ontario and Quebec that lack adequate buffering capacity. A million and a half lakes dot that region, and some are already giving way to acid deposition."

The meaning of this in terms of cold Canadian dollars came across in a statement by John Roberts, Canada's Minister of the Environment.

"Fifteen percent of our gross national product comes from forestry," he noted, "a higher percentage than the automobile



Acid rain hats, plastic cages provide a controlled environment (above) where crops are sprayed with simulated acid rain of varying pH levels to assess damage. Yet this first year of an Oregon State University study reaped more questions than answers. While two-thirds of the crops were unaffected, the remainder showed variable yields—some more, some less. The research continues.

In a similar study, somewhat sour grapes resulted when vines (right) were subjected to another man-made pollutant: ground-level ozone. In his left hand a Cornell University technician at Fredonia, New York, holds unprotected vine leaves showing lesions, attributed to ambient ozone, that reduced the sugar content of the grapes as well as the yield of the vine. Experiments indicate injury would have been even greater if the ozone had interacted with acid rain.







The costly sulfur purge



EXPENSIVE BURDEN of pollution control, sulfur-laden sludge spews into a huge containment dam of the Bruce Mansfield power plant in Shippingport, Pennsylvania (far left). Inside an octopuslike scrubbing system, beneath visiting Japanese engineers (above), jets of wet lime bombard combustion gases—a process that purges about 92 percent of the sulfur dioxide.

Dam and scrubbers made up about a third of the plant's 1.4-billion-dollar price tag, raising residential utility bills 7 percent. Ironically, though the plant meets federal emission standards, it occasionally violates tougher state regulations set for the heavily industrialized Beaver Valley and it currently operates under a temporary permit.

Sulfur dioxide output can also be curtailed by washing coal to remove sulfur before burning. At the R & F Coal Company's plant in Lamira, Ohio, a technician (left) prepares samples of newly mined coal to determine the wash formula. Such processes can reduce sulfur content by 10 to 40 percent.

industry contributes to the U. S. economy. Yet this resource is being threatened. The second largest industry in Canada is tourism. But how many tourists will want to spend their time at fishless lakes?

"Your country, the United States," he observed, "is dumping its garbage at the expense of our country."

U. S. spokesmen retort that American emission controls are more stringent than Canada's (although Canadian regulations are being rapidly tightened), and that Canadian pollution also drifts onto the United States (although not in nearly the volume that the U. S. exports to Canada).

Recognition of the problem led to the creation in 1980 of a massive binational program aimed at devising an agreement on transboundary air pollution.

Europeans Join Forces

An impressive team effort has arisen in Europe. In 1979, 31 of the 34 member governments in the UN's Economic Commission for Europe signed the Convention on Long-Range Transboundary Air Pollution. Though it does not enforce controls, it morally commits each nation to respect the environment of other countries.

Erik Lykke of Norway's Ministry of Environment told me, "I'm praying this convention will bring a cleaner landscape 10 to 15 years from now."

Few scientists are so optimistic. Many see the year 2000 as the earliest that emissions can be stabilized, and then slowly reduced. Experts at EPA, for example, predict that under current controls SO_2 in the United States will stay constant or increase modestly to 29 million tons per year by the end of the century. NO_x , on the other hand, will near 28 million tons a year and possibly outstrip SO_2 as a contributor to acid fallout.

What can be done to lessen this impact, and how much will it cost? The most obvious step lies in conservation of energy—simply using less fuel. Another approach, more complicated and costly, is to apply new

technology to reduce emissions—the object of intensive research by the EPA, universities, and utility groups.

The cost of cleaning up is high; equipping older U. S. plants with scrubbers would require an investment of billions of dollars, and even then might reduce emissions by only a third. These costs might be mitigated by positive side effects—the generating of useful by-products such as commercial sulfuric acid and road-fill material, and the creation of new jobs.

Meanwhile, hidden costs of acid rain may already be surpassing the expense of controlling it. Metal corrosion by SO_2 may cost each American at least seven dollars a year, and possibly many times that.

Proof that a solution exists comes from Japan. The government issued stringent sulfur oxide controls in 1968 and encouraged use of low-sulfur fuels and desulfurization; by 1975 emissions had plunged by 50 percent even as energy consumption doubled. Since then, even stricter limits have been set, and nearly 1,200 scrubbers installed, compared to about 200 in the United States.

Scientists in several countries are experimenting with so-called curative approaches to acid rain. These include the breeding of acid-tolerant fish and crops, liming lakes to reduce acidity, and coating valuable structures and artwork against corrosion. Yet such solutions are only short term.

Will the 21st Century Be Silent?

What of the future? "It's only a matter of time before we are forcibly pressed to do something," says Norway's Dr. Lars Overrein, head of the Norwegian acid rain project. "Today's acid rain is just the beginning. We are already worried about heavy metals and organic pollutants that come with acid deposition."

When I stand looking out over my lake, what will I see and hear come the year 2000? Will peepers be trilling, fish jumping, trees leafing, deer drinking, baby birds chirping? Or will it be a silent spring? □

Twilight's last gleaming outlines a belt of polluted air looming above St. Louis, Missouri. The mixed bag of pollutants includes dust, soot, lead salts, and an acidic brew that amounts to about 40 percent of the total pall. Sorting out control measures promises to become a national preoccupation in the 1980s.



A Durable Scale of Values

By BOYD GIBBONS

NATIONAL GEOGRAPHIC SENIOR STAFF

Photographs by JIM BRANDENBURG

ALDO LEOPOLD has been referred to as a naturalist. He was an extraordinary one. But that's like describing Lincoln as a politician. You have only part of the man. Leopold was also a remarkable craftsman, a professional forester who saw more than the forest, one of the first professors of wildlife management, and an uncommon conservationist. These too are but arcs of his circumference.

Go to his essays and journals: *A Sand County Almanac* and *Round River*. There is the center of the man. Aldo Leopold elevated ecology to philosophy and literature. Were that his sole achievement, it would be enough. If the passenger pigeon had to pass into oblivion, God knows it went out on a dazzling requiem:

Men still live who, in their youth, remember pigeons. Trees still live who, in their youth, were shaken by a living wind. But a decade hence only the oldest oaks will remember, and at long last only the hills will know. . . . The pigeon was a biological storm. . . . he lived by the intensity of his desire for clustered grape and bursting

beechnut, and by his contempt of miles and seasons.

His former students at the University of Wisconsin still remember Leopold as "the professor," but he was ever the inquiring student, burrowing into histories of the West, and accounts of exploration—the narrative of the expedition of Coronado, the diaries of Lewis and Clark. He underlined facts—where the grizzly had been—filling his various journals that over the years included gleanings from Cicero—"It is doubted whether a man ever brings his faculties to bear with their full force on a subject until he writes upon it"—Thoreau, Lincoln, Edwin Arlington Robinson, Milton, Keats, Shakespeare, Epicurus, Xenophon, Tacitus, Plutarch, Isaiah. His tools, always sharp, were extensions of his mind: eye, pencil, ax, shovel, his dogs (well, not always his dogs—Gus once pointed "pheasants" and retrieved a piglet).

Leopold drew his strength from marsh, farm, prairie, rimrock, wilderness, his biases evident: "a completely industrialized United States is of no consequence to me." He helped found the Wilderness Society. He

There are some who can live without wild things, and some who cannot. These essays are the delights and dilemmas of one who cannot.



A white-tailed deer wades through duckweed in a Wisconsin pond.

defined wilderness, gave it meaning long before Congress gave it protection.

Leopold was a man of the camp fragrant with blue smoke of mesquite. He hunted, he fished, drawing from a farmer, from the scratchings of grouse, what was not found in books. One of his journals contains this note about quail: "One cock flew into elm and defecated on my face; could identify blackberry skins in dropping." Leopold spent a lifetime reading animal sign, reading the landscape, reading civilization—a lifetime, his son Luna would observe, developing perception. A perception that heard music from the wild goose, then supplied the lyrics:

In dire necessity somebody might write another Iliad, or paint an 'Angelus,' but fashion a goose? . . . If, then, we can live without goose music, we may as well do away with stars, or sunsets, or Iliads. But the point is that we would be fools to do away with any of them.

Of what economic value are geese or grizzlies? Next to nothing, said Leopold, so let us not "invent subterfuges to give [them] economic importance." Their continued existence must rest on other reasons. He did not disdain laws or other political means to achieve conservation, but he did have the sense to see their limitations, that if "there is as yet no social stigma in the possession of a gullied farm, a wrecked forest," all our controls and subsidies are but futile attempts at repairing damage—bad economics and bad land use.

Aldo Leopold tied the future of the natural world—what he called land, what we now call environment—to man's conscience. From someone with a less rigorous intellect, Leopold's "land ethic" might have fluttered into preciousness or preaching. But he was neither precious nor a preacher. His message—the keel of his thinking—was not a call to worship, but rather a gentle plea for self-inquiry:

There is as yet no ethic dealing with man's relation to land and to the animals and plants which grow upon it. . . . The land-relation is still strictly economic, entailing privileges but not obligations. . . . Obligations have no meaning without conscience, and the problem we face is the extension of the social conscience from people to land.

No important change in ethics was ever

accomplished without an internal change in our intellectual emphasis, loyalties, affections, and convictions. The proof that conservation has not yet touched these foundations of conduct lies in the fact that philosophy and religion have not yet heard of it. In our attempt to make conservation easy, we have made it trivial.

Times and environmental attitudes, we might say, have changed. Do we not now have environmental-impact statements to guide decisions? We do indeed—by the ton—but they seem to guide mostly the fortunes of the consultants who prepare them.

Look to the land. The wheat fields of the Palouse in Washington still erode as in Leopold's time. We have more places labeled wilderness (and more people to label them), but fewer that are wild. How falls the rain? By the pH.

There are disciples who deify Leopold, who refuse to see that he was mortal—of modest height, blue eyes, a balding brow, a prominent nose, full lips, and a flat stomach—that he went to bed early, leaving visitors to chat with his wife, and that before he learned to respect the role of predators he often shot hawks on sight. At a recent Sierra Club conference, after a former student of his had related Leopold's shift in attitude toward predators, a man took the stage and shouted, "You are sullyng the name of a great man!" Leopold dipped into the Bible, but he kept his distance from churches. He would have withdrawn from attempts to enshrine him.

Leopold died of a heart attack in 1948 at 61, while helping a neighbor fight a grass fire near his weekend shack in Wisconsin. *It is warm behind the driftwood now, for the wind has gone with the geese. So would I—if I were the wind.*

TO FIND THE MAN, start with the boy. He was born Rand Aldo Leopold in Burlington, Iowa, January 11, 1887. His grandfather, Charles Starker, a German architect from Stuttgart, owned the local bank, a company that made handsome hardwood desks, and an impressive home high on a bluff overlooking the Mississippi River—for young Aldo a satisfying aristocratic milieu.

"Aldo was the apple of his mother's eye,"

his brother Frederic told me. "We didn't hold it against him, but her preference for him embarrassed Father a bit, and sometimes even embarrassed Aldo."

Every Saturday the cook baked two cakes, but before they could be served, Aldo would help himself. His mother padlocked the cake boxes. Aldo filed off the locks.

"Mother never even considered chastising him," said his sister Marie, who still lives in the old house on the lip of the bluff, Frederic next door. "As a boy, Aldo didn't talk a lot, but he was a smart student. He liked a dance if pretty girls were there, but if he didn't want to go to a party, he would just say, 'No, I've got something else to do.' We all played golf, but Aldo wouldn't. He considered it foolishness. He would go for a walk."

With his mother's opera glasses and a canister for collecting plants, Aldo would ride the streetcar to the end of the line and disappear into the woods. Often as not he carried his shotgun and a notebook, the beginnings of his prolific and literate journals.

"Aldo read a great deal as a boy," said Frederic, "his preference being books on wood lore. Even then he was becoming skillful at reading sign, knowing what the animals were eating, what had been chasing them, who was eating whom. He seemed to have gotten this love of the outdoors from Dad."

On dark fall mornings young Aldo and his father pulled on hip boots by gaslight, then clumped down the hill to the railway station for a breakfast of pork and beans and a baked apple. The train took them across the Mississippi to a marsh where, crouched on a muskrat house, they awaited the whiffling of ducks. In the off-season they would explore the marsh, find a mink den, see what the mink had been eating.

Long before federal law prohibited hunting during the nesting season, Aldo's father concluded that it was wrong to do so and ended his shooting in winter, a lesson in sportsmanship not lost on his son.

"Aldo was tremendously sensitive," said Frederic, "and very anxious to be ethical—that was extremely important to him. He had no patience with bad intentions or bad ethics. He was a perfectionist."

In 1903, before Leopold arrived, the headmaster of the Lawrenceville School in



ROBERT A. MICALBI COLLECTION OF UNIVERSITY OF WISCONSIN-MADISON ARCHIVES

With his land ethic, Aldo Leopold gave conservation its philosophic roots. Here he holds a Norway pine, one of thousands of trees he and his family planted to restore the health of their weekend farm near Baraboo, Wisconsin.

New Jersey received this communication from the Burlington High School principal: "He is as earnest a boy as we have in school. . . . painstaking in his work. . . . Moral character above reproach."

At Lawrenceville, Aldo got the reputation of being bright and talented—a "shark." He was also something of a dude. Much to his father's distress, Aldo acquired a taste for Brooks Brothers suits, expensive shoes, and hand-tailored shirts, a taste that would accompany him to Yale's Sheffield Scientific School, and, with variations, well beyond.

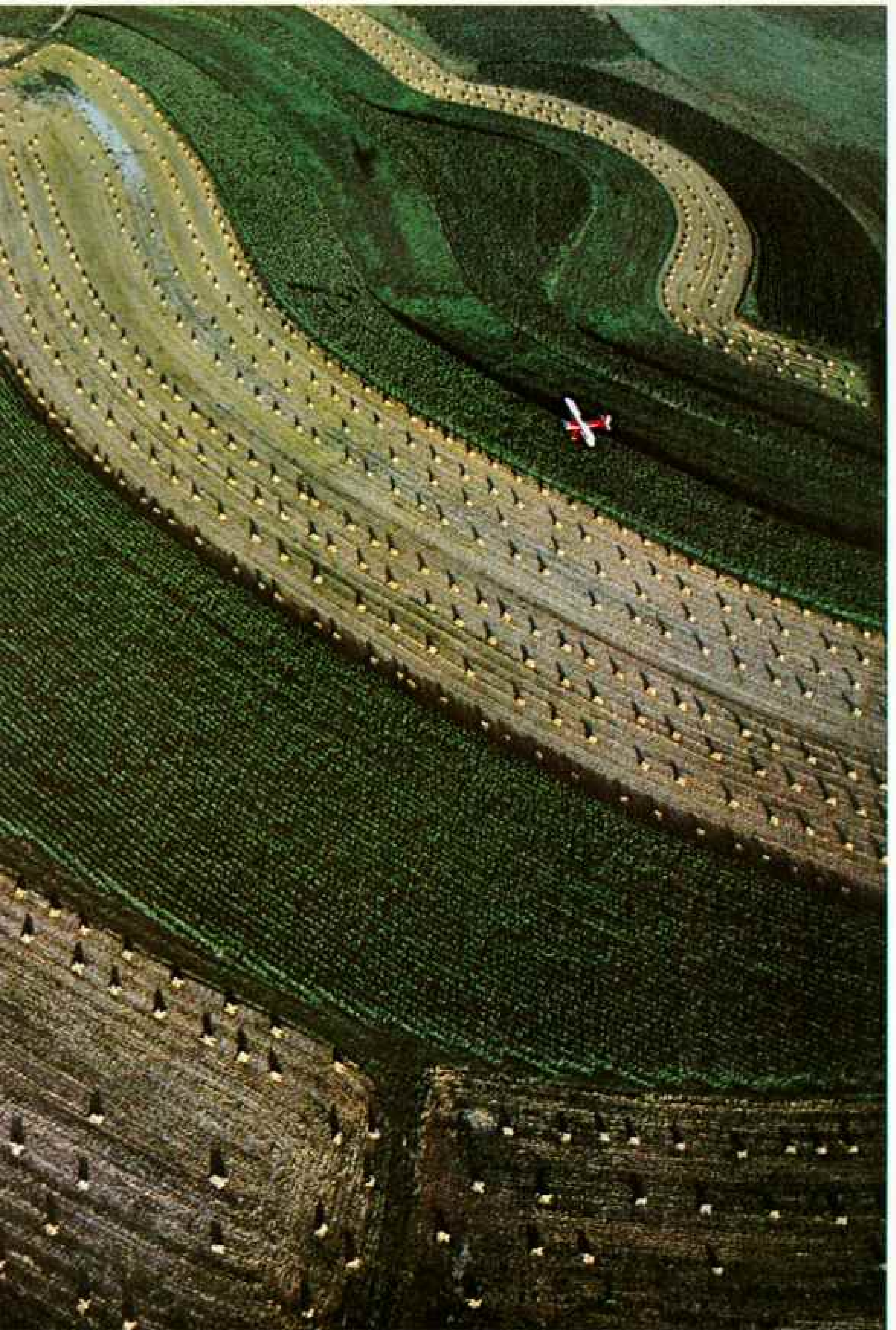
In early July (Continued on page 690)



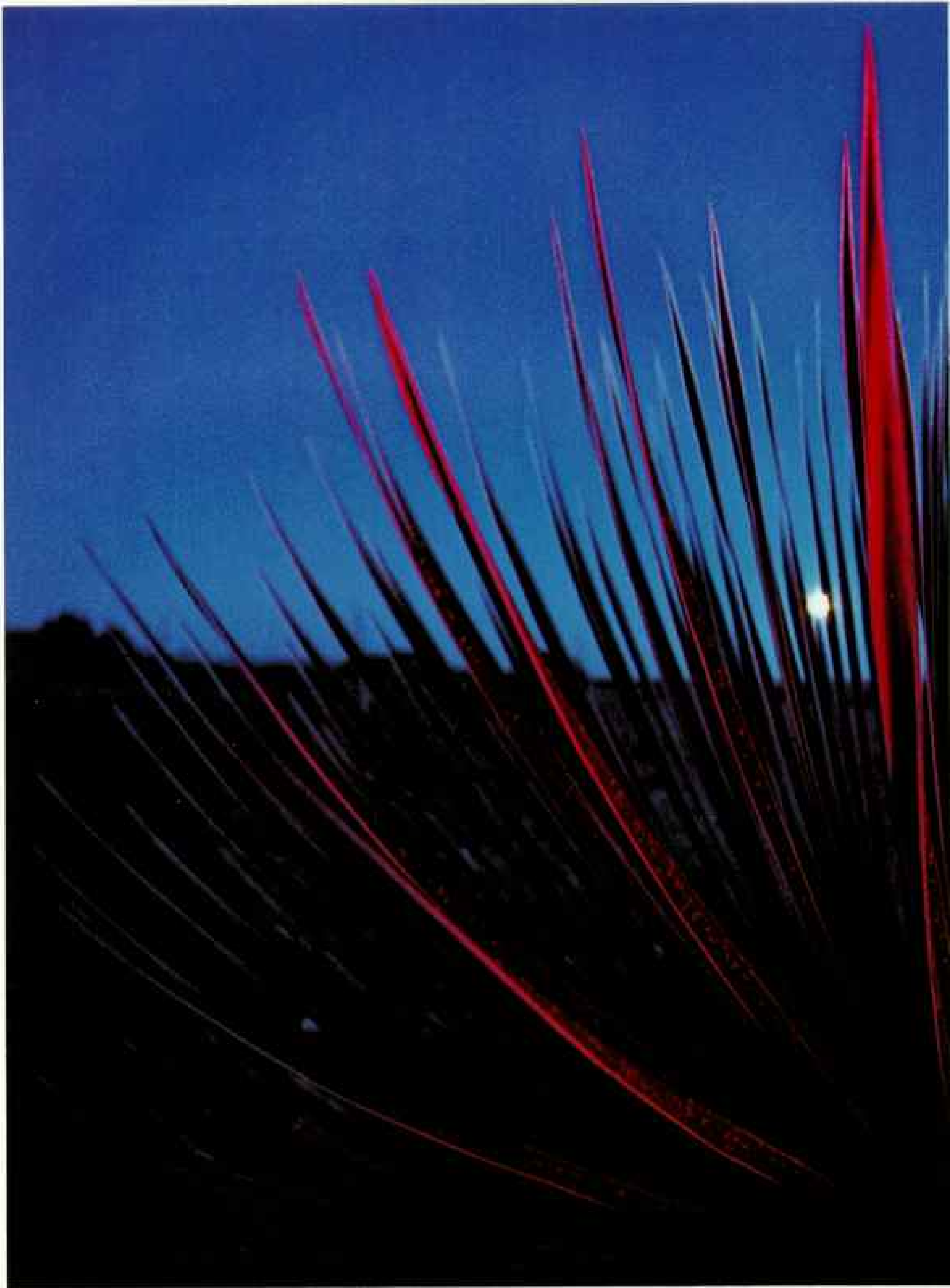
Dragonfly rests on a reed beside a pond at Leopold's Wisconsin farm.

That land is a community is the basic concept of ecology, but that land is to be loved and respected is an extension of ethics.





Contour plowing, endorsed by Leopold, swirls across the Coon Valley, Wisconsin, countryside.



I am glad I shall never be young



A yucca, reddened by the photographer's light, pricks the horizon at moonrise in Gila National Forest, New Mexico.

without wild country to be young in.

1909 with a Master of Forestry degree in his portmanteau, Aldo Leopold stepped off the train at Albuquerque. The United States Forest Service had recently been established, and to it came an elite cadre of foresters from Yale. The Forest Service promptly sent Leopold into the Blue Range of the Arizona Territory. His facility for cruising timber was quickly eclipsed by his awe for cowboys, their ability to travel light and cook well. He imagined bowlegs and sought something to put them around: "Bought a grey horse from F. E. Irwin . . . \$70 down . . . \$65 from bank." He soon reached the end of his salary. He picked up his pen: "My dear Papa. . . ." Father resisted, remembering the Brooks raids into his capital. Mother prevailed. Aldo bought a rope, a .30-30 carbine, a revolver, boots, batwing chaps, and a hat that practically shaded his horse. Off he rode.

Leopold's trail eventually intersected the vast sheep lands of the Lunas, Spanish aristocrats of the New Mexico Territory. His eyes alighted on Estella Bergere (her mother was a Luna), whose dark eyes and traditional values lifted him out of the saddle and into marriage. Appointed to supervise the Carson National Forest in northern New Mexico, he reviewed his rangers' diaries, entering "Bully!" in the margins when talent struck his eye. At Tres Piedras, Aldo built a frame house, and he and Estella settled in.

But a storm caught Leopold in the backcountry, and acute nephritis—after a cold night in a wet bedroll—ended his days as a backcountry forester, and almost ended him. Sick for more than a year, he recuperated at home in Burlington.

Aldo Leopold returned to Albuquerque and the Forest Service a more reflective man. Gone was the cowboy bravado, the chinking of spurs. He administered grazing permits and was soon absorbed in his elemental affection: wildlife ("Arrested Arno Blueher for killing kingbird . . . fined \$50 and costs"). He stumped the region to form associations for the protection of game. On weekends, his shotgun and son Starker strapped behind, he bicycled down to the cottonwoods to hunt quail and dove, or try for ducks on the Rio Grande.

He showed Starker how cattle were destroying quail cover; they put up small

fences to detour cows. Aldo saw a hawk pin a quail in an *Atriplex* bush. Shot the hawk. Saw a roadrunner with a quail chick in its beak. Shot the roadrunner. Predators kill our game, he told Starker. Wolves, too—they eat our deer. Eradicate them. Leopold wounded a wolf in a boggy meadow, and when she charged, he had to jam the gunstock in her mouth to evade the teeth.

Years later, in his essay "Thinking Like a Mountain," Leopold admitted his error about predators.

We reached the old wolf in time to watch a fierce green fire dying in her eyes. I realized then, and have known ever since, that there was something new to me in those eyes—something known only to her and to the mountain. I was young then, and full of trigger itch; I thought that because fewer wolves meant more deer, that no wolves would mean hunters' paradise. But after seeing the green fire die, I sensed that neither the wolf nor the mountain agreed with such a view.

For some time he had been urging the Forest Service to set aside roadless areas as wilderness, particularly the Gila in New Mexico. In 1924, as Leopold was leaving the Southwest for Madison, Wisconsin, the Forest Service finally accepted his recommendation, and so designated the Gila—40 years before the Wilderness Act.

AFTER some disappointing years with the Forest Service's Forest Products Laboratory in Madison, Leopold set out across the upper Midwest to survey the condition of wildlife. With a wife, five children, and little means of support, Aldo might have returned to Burlington and the Leopold Desk Company, but he had neither interest in nor aptitude for business.

For the American Game Conference, he helped write this country's first game policy, and he was appointed to President Franklin D. Roosevelt's Committee on Wildlife Restoration. In 1933 Charles Scribner's Sons published Leopold's *Game Management*.

We of the industrial age boast of our control over nature. . . . there is no force in earth or sky which we will not shortly harness to build "the good life" for ourselves. But what is the good life? . . . We stand guard over works of art, but species

representing the work of aeons are stolen from under our noses. . . . game can be restored by the creative use of the same tools which have heretofore destroyed it—axe, plow, cow, fire, and gun.

Leopold had now defined a profession and written a classic, the foundation of the literature and still widely used today.

So impressed was the University of Wisconsin that it established for Leopold the country's first chair of game management. He taught an undergraduate course in wildlife ecology, but devoted most of his time to the few graduate students that he gathered around himself.

"A Ph.D. didn't impress him. His only concern was the quality of the individual."

"His concentration was intense. He'd get so wrapped up in what he was discussing that he'd forget to shift—kept his Chevrolet in second gear. Drove us crazy."

"He was always well dressed in the field, and around his neck hung that dog whistle and the Zeiss binoculars."

"He was a gentleman to the core."

"There was always a certain awe toward him, a distance between us. But there was a great feeling of respect."

"He was a man of enthusiasms, and in the field he really came alive. He was always growing intellectually."

"He was constantly pressing us to sharpen our powers of observation, of perception, always a gentle probing: 'I wonder why this field is abandoned?'"

In his essay "Natural History," Leopold held a typical zoology student up to the light:

Instead of being taught to see his native countryside with appreciation and intelligence, he is taught to carve cats.

A classroom exercise might be a deceptively simple landscape puzzle: a road

flanked on one side by a subsiding telephone pole, then a pink granitic boulder, bluestem, oat stubble bearing ragweed, some young pine, poorer oat stubble; on the other side a *Silphium*, double-forked sumac, another pink rock, a fence post, and a bit of corn stubble. A rabbit lay dead on the road.

"How long ago was the last hard winter?" (Two years—the sumac's double fork.) "What sex is the rabbit?" (Male—females stay close to home in spring.) A final exam in wildlife management: "Select one plant or



COLLECTION OF UNIVERSITY OF WISCONSIN-MADISON ARCHIVES

Enamored of cowboys, the young forester in the Arizona Territory dressed the part. Leopold's affection for wild country led the U. S. Forest Service to set aside the country's first wilderness area—the Gila in New Mexico.

animal which you saw on the campus today and discuss its role in Wisconsin history."

"Dad could look at a piece of landscape and read its history from what he saw," his son Luna told me. "It's something he did better than anyone I know."

The Leopold home—modest, gray stucco—was only a mile from Aldo's office on campus. He walked to his office in early morning, strolled home for lunch and a short nap, returned and was back home around 5 p.m. He rarely brought work home; evenings were for the family.

"At dinner," (Continued on page 696)



Juvenile great blue herons stand alert in Gila National Forest.

That wildlife is merely something to shoot at or look at is the grossest of fallacies. It often represents the difference between rich country and mere land.



Drillings of a yellow-bellied sapsucker pattern a tree in Minnesota.



A black-tailed jackrabbit keeps ears tuned for predators in Gila National Forest.

Harmony with land is like harmony with a friend; you cannot cherish his right hand and chop off his left. . . . you cannot love game and hate predators. . . . The land is one organism.





Dusted with Minnesota snow, a gray wolf goes on the prowl.

Starker recalls, "Dad would pick one of us out and ask, 'What did you learn today?' Not what had you *done* that day but what you had *learned*—a big difference." There were three Leopold sons—Starker, Luna, and Carl—and two daughters, Nina and young Estella. "He was a wonderful father," Estella told me, "who had a brusque way about him. Whenever he came home, he'd get in his chair and be lost in his thoughts. But you felt comfortable."

"Mother followed the Spanish tradition of

became except for Estella. "She was completely selfless, though never made a show of it. She spoiled him—kept candy in his desk drawer—just as his mother had." To Estella fell the disciplining of the children.

In New Mexico, Aldo had carved and painted his own duck decoys from pine. Presents were not important to him unless handmade, so each Christmas the family made and exchanged gifts—a split-bamboo fly rod, a leather quiver. When the fireplace needed tools one Christmas, Luna and Starker bought a set from the store. Their father was unimpressed.

Soon after moving to Madison, Aldo was given a stave of yew. He carried it to the basement, and over the winter fashioned a bow. To make arrows, he sent off to Oregon for wands of Port Orford cedar. He used cow horn and deer antler for the nocks, shoemaker's thread for the bowstrings. "You do not annex a hobby," he wrote, "the hobby annexes you." The family entered archery tournaments shooting Leopold bows. Estella, much to her husband's delight, was the state woman's champion for five years running.

But Leopold was to the core a hunter, and the kind of range that animated his nerve endings did not hold straw targets. With his brothers and sons, he returned for long hunting trips to the Gila and the Gavilán in Mexico. It was not the kill that mattered, but the hunt.

Golf is a delightful accomplishment, but the love of hunting is almost a physiological characteristic. A man may not care for golf and still be human, but the man who does not like to see, hunt, photograph, or otherwise outwit birds or animals is hardly normal. He is supercivilized, and I for one do not know how to deal with him. Babes do not tremble



In tiny notebooks, Leopold recorded the comings and goings of the natural world—and some of his own. Here, along with a provisions list for the shack on the Wisconsin farm, are the birds of one August dawn.

staying in the background," said Carl. "She absolutely adored Dad and never questioned him—ever. She viewed her place in life to keep a comfortable and happy home for him and us. She loved the shack, the plantings, the blooming of the wild flowers. These were all Dad's ideas, and she was really reveling in the things of Dad."

After dinner Aldo and Estella would sit together in the living room, often holding hands, listening to classical music or reading aloud from novels and plays.

His brother Frederic is convinced that Aldo could not have become what he

when they are shown a golf ball, but I should not like to own the boy whose hair does not lift his hat when he sees his first deer.

Hunting had always been Aldo's deep love, his excuse to be in the field and enjoy its subtle pleasures: handmade boots from Cutter's in Seattle, the balance of an Ansley-Fox double-barrel, Gus freezing on point, a ruffed grouse exploding through the tamaracks, and at noon a pause to light a fire and sizzle a pork chop on a stick.

In Leopold's mind the virtue of hunting lay in the exercise of ethical restraints, dictated by the hunter's conscience, not by "a mob of onlookers."

For years Aldo had been looking for land near Madison to use as a weekend retreat. On a bend of the Wisconsin River, he found an abandoned farm of marsh, a "corned-out" field, and a naked hill of drifting sand. The only standing structure was a chicken shed, its floor deep in manure. Leopold bought it.

THERE ARE TWO spiritual dangers in not owning a farm. One is the danger of supposing that breakfast comes from the grocery, and the other that heat comes from the furnace. To avoid the first danger, one should plant a garden, preferably where there is no grocer to confuse the issue. To avoid the second, he should lay a split of good oak on the andirons, preferably where there is no furnace, and let it warm his shins while a February blizzard tosses the trees outside. If one has cut, split, hauled, and piled his own good oak, and let his mind work the while, he will remember much about where the heat comes from, and with a wealth of detail denied to those who spend the week end in town astride a radiator.

The oak died one summer at the end of a bolt of lightning. After letting it "season for a year in the sun it could no longer use," the Leopolds laid a sharp saw to its trunk, while Estella, the "chief sawyer," cautioned against exhaustion. Years later Aldo reassembled "Good Oak" into rich metaphor.

Fragrant little chips of history spewed from the saw cut . . . We sensed that these two piles of sawdust were something more than wood . . . that our saw was biting its way, stroke by stroke, decade by decade, into the chronology of a lifetime, written in

concentric annual rings of good oak. . . .

Abruptly we began to cut the years of our predecessor the bootlegger, who hated this farm, skinned it of residual fertility, burned its farmhouse, threw it back into the lap of the County (with delinquent taxes to boot), and then disappeared among the landless anonymities of the Great Depression. . . . Rest! cries the chief sawyer, and we pause for breath.

Aldo had always wanted to own land, to study and enrich it. Almost immediately after buying the shack, the Leopolds planted Sudan grass, sorghum, and millet for wintering bobwhites and pheasants. They shoveled the manure out of the shack, laid a clay floor, and built a fireplace.

Now our saw bites into the 1920's, the Babbittian decade when everything grew bigger and better in heedlessness and arrogance—until 1929, when stock markets crumbled. If the oak heard them fall, its wood gives no sign. . . . Rest! cries the chief sawyer, and we pause for breath.

The following April, 2,000 red and white pine seedlings arrived on a truck. The Leopolds planted them all by hand.

Now the saw bites into 1910-20, the decade of the drainage dream, when steam shovels sucked dry the marshes of central Wisconsin to make farms, and made ash-heaps instead. . . . Rest! cries the chief sawyer, and we pause for breath.

Summer drought killed almost all the seedlings. In the cold mud of spring, the family planted more pine, and tamarack, wahoo, dogwood, hazel, white birch, hard maple. Another summer, another drought. They sharpened the shovels. More pine.

"Dad loved his tools," Carl Leopold recalls. "He had great scorn for anyone who had a dull shovel. He sharpened everything." Over the years, on their knees, the Leopolds would anchor their farm with some 36,000 pines.

We cut 1905 when a great flight of goshawks came out of the North and ate up the local grouse (they no doubt perched in this tree to eat some of mine). . . . Rest! cries the chief sawyer, and we pause for breath.

On Friday afternoons in Madison, while Estella collected the children and packed food for the shack, Aldo would sit quietly in the car with (Continued on page 702)



April writes its name across snowmelt on the Leopold farm.



Crevice'd bark and sinuous needle mark a Norway pine on the farm.

There are woods that are plain to look at, but not to look into. . . . The taste for country displays the same diversity in aesthetic competence among individuals as the taste for opera, or oils.

*Tell me of what
plant-birthday a
man takes notice,
and I shall tell you
a good deal about
his vocation, his
hobbies, his hay
fever, and the
general level of his
ecological education.*



Glories of a northern prairie: purple coneflowers (top) and fragile pasqueflowers (above).



Wisconsin prairie blooms with spikes of gayfeather.

the engine running, itching to get going.

Aldo insisted that life at the shack remain simple, but bowing to Estella he bought lumber for a floor. Everything else was made by hand, or scrounged. The river cast up bridge timbers. Made fine benches. They plucked a small table from the Madison dump. The bunk springs were snow fences, the mattresses of canvas and hay. In summer Aldo cooked outside over an open fire, in winter in the fireplace; he was an artist with the Dutch oven.

asked.") From these remnants of prairie, he collected seeds of *Silphium*, coneflower, bluestem, wild rye, prairie dropseed. Near the shack he stripped away the sod and dropped them in.

The saw now severs 1865, the pith-year of our oak. In that year John Muir offered to buy from his brother, who then owned the home farm thirty miles east of my oak, a sanctuary for the wildflowers that had gladdened his youth. His brother declined to part with the land, but he could not suppress the idea: 1865 still stands in Wisconsin history as the birth-year of mercy for things natural, wild, and free.

Recently, I visited the shack with Nina. Her mother had died a few years before, and her brothers and sister had long since scattered: Starker, once the prodigal, now retired as professor of wildlife and forestry at Berkeley; Luna, the hydrologist, who lives up the hill from Starker and who helped establish why rivers meander; Estella, a palynologist, now director of the Quaternary Research Center in Seattle (all three are members of the National Academy of Sciences); Carl, at Cornell, a noted plant physiologist, polished, private, a fine classical guitarist. And

Nina, who did not pursue a Ph.D. but is steeped in natural science. Aldo was careful not to push his children in any particular direction, but if they did something that pleased him, he showed it. "Isn't it interesting," said Carl, "how each of us may have gone into science partly to please Dad."

Nina and her husband live on what is now the Leopold Memorial Reserve: the family farm, bordered by a thousand acres that the neighboring farmers have covenanted to protect as wildlife habitat. The pines are now so thick they must be thinned; Nina's



Taking Leopold's conservation advice literally—that we should shift "attention from the symbol to the music"—a group joins in song following the conclusion of a soil seminar at the Leopold shack.

Now our saw bites the 1870's, the decade of Wisconsin's carousel in wheat. . . . I suspect that . . . the sand blow just north of my oak had its origin in over-wheating. . . . Rest! cries the chief sawyer, and we pause for breath.

If history and the plow had denied him prairie, Aldo would build his own. He made forays to unmowed cemeteries and railroad embankments that still held the yellow splash of *Silphium*. ("What a thousand acres of *Silphiums* looked like when they tickled the bellies of the buffalo is a question never again to be answered, and perhaps not even

log home was built with Leopold pine.

Nina and I entered the shack. In a corner sat the canvas chair Aldo had made. Above the window hung Carl's toasting-fork spear (he used it to pluck carp from the flooded fields and plant them among the potatoes). I noticed deep cuts in the cedar log that Luna had emplaced as a mantel. In 1939 boys vandalized the shack, taking an ax to the mantel, puncturing pots and smashing plates. They poured kerosene in Estella's tins of homemade blackberry jam and wild honey. They stole Aldo's tools, and reduced his liquor supply.

"When we came in," Nina said, "all of us just went to a corner and began to cry. All, that is, but Dad. He just looked around, saw our state, and burst into a big smile. 'I didn't know how much this place meant to you,' he said. 'Let's get busy.' At night we would end up around the fireplace with guitars, singing. But Dad always went to bed early. We would ask what he wanted to hear. He would raise his head and say 'How about Brahms's "Lullaby"?'"

Getting up too early is a vice habitual in horned owls, stars, geese, and freight trains. Some hunters acquire it from geese, and some coffee pots from hunters. It is strange that of all the multitude of creatures who must rise in the morning at some time, only these few should have discovered the most pleasant and least useful time for doing it.

Aldo Leopold was up well in advance of the birds. Around 3:30 or 4 a.m. the door of the shack would swing open, and Aldo would step out, a cup in his shirt, coffeepot in one hand, tiny notebook in the other. He would sit on the bench, have a sip, and listen. He also carried a light meter, and with each call would jot down bird, time, and footcandle: Song Sparrow, 4:32, -0.012.

One hundred and twenty acres, according to the County Clerk, is the extent of my worldly domain. But the County Clerk is a sleepy fellow . . . at daybreak I am the sole owner of all the acres I can walk over. It is not only the boundaries that disappear, but also the thought of being bounded.

Leopold believed that the future of American wildlife lay largely on private land, in the attitudes and decisions—wise or otherwise—of American farmers, not in the tape of bureaucracy. "At what point," he

asked, "will governmental conservation, like the mastodon, become handicapped by its own dimensions?"

He likened his fellow conservationists to his bird dog Gus, who, when he couldn't find pheasants, pointed meadowlarks.

This whipped-up zeal for unsatisfactory substitutes masked his failure to find the real thing. . . . We conservationists are like that. . . . we have found us a meadowlark. . . . the idea that if the private landowner won't practice conservation, let's build a bureau to do it for him.

Leopold had always been somewhat of a loner, and he paid a price. At wildlife conferences, in articles, by force of his intellect, Aldo Leopold commanded the stage, but some in the wings were chilled in his shadow. He was not one of the boys.

In the 1940s Leopold saw that Wisconsin's irrupting deer herd was destroying the forests. Leopold was a member of the Conservation Commission. Trim the entire herd, not just bucks, he argued, or we will lose the deer and the woods for decades to come. He was called a Bambi killer.

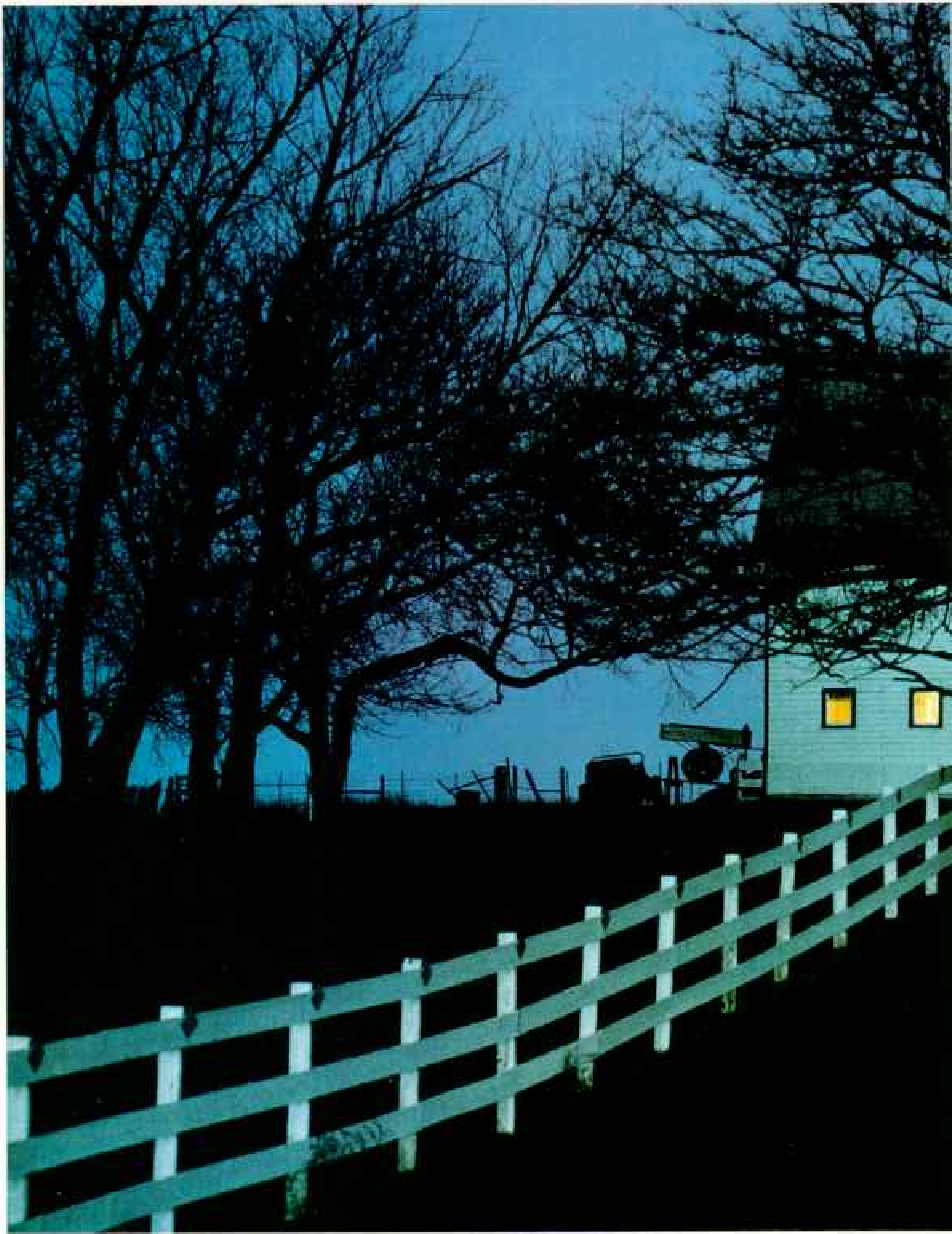
"He wasn't naive," Starker told me, "but he believed in an honest, straightforward presentation of the facts and debate. He was not a subtle politician. He became increasingly discouraged by the inability of the public to accept facts and by their propensity to get emotional."

Aldo's family saw a change come over him. At the shack he was still full of enthusiasm, but in Madison he withdrew more into troubled thought. He developed tic douloureux, a painful inflammation of the facial nerves that eventually required surgery at the Mayo Clinic. Sleep became more difficult, and he rose even earlier. Dawn would find him at his walnut desk at the office, well into another essay.

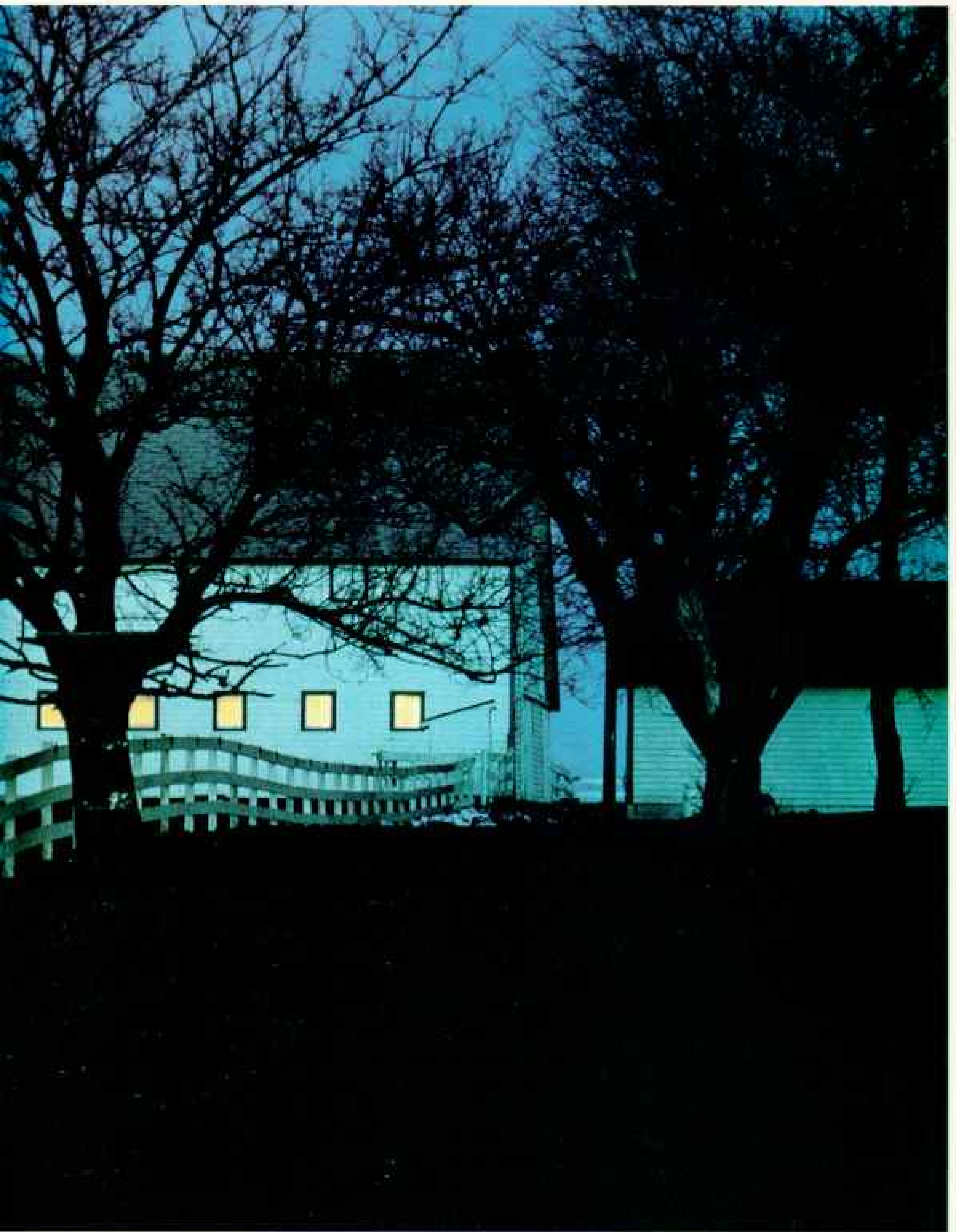
ON EXAMS, Leopold wrote: "Please boil down your writing; it will be graded for conciseness of expression."

A student's paper on deer browse stated:

"The scope of this paper has been purposely limited to woody species common to the bear-oak type as it seemed desirable to lay particular emphasis upon the winter season when woody species were not only heavily
(Continued on page 708)

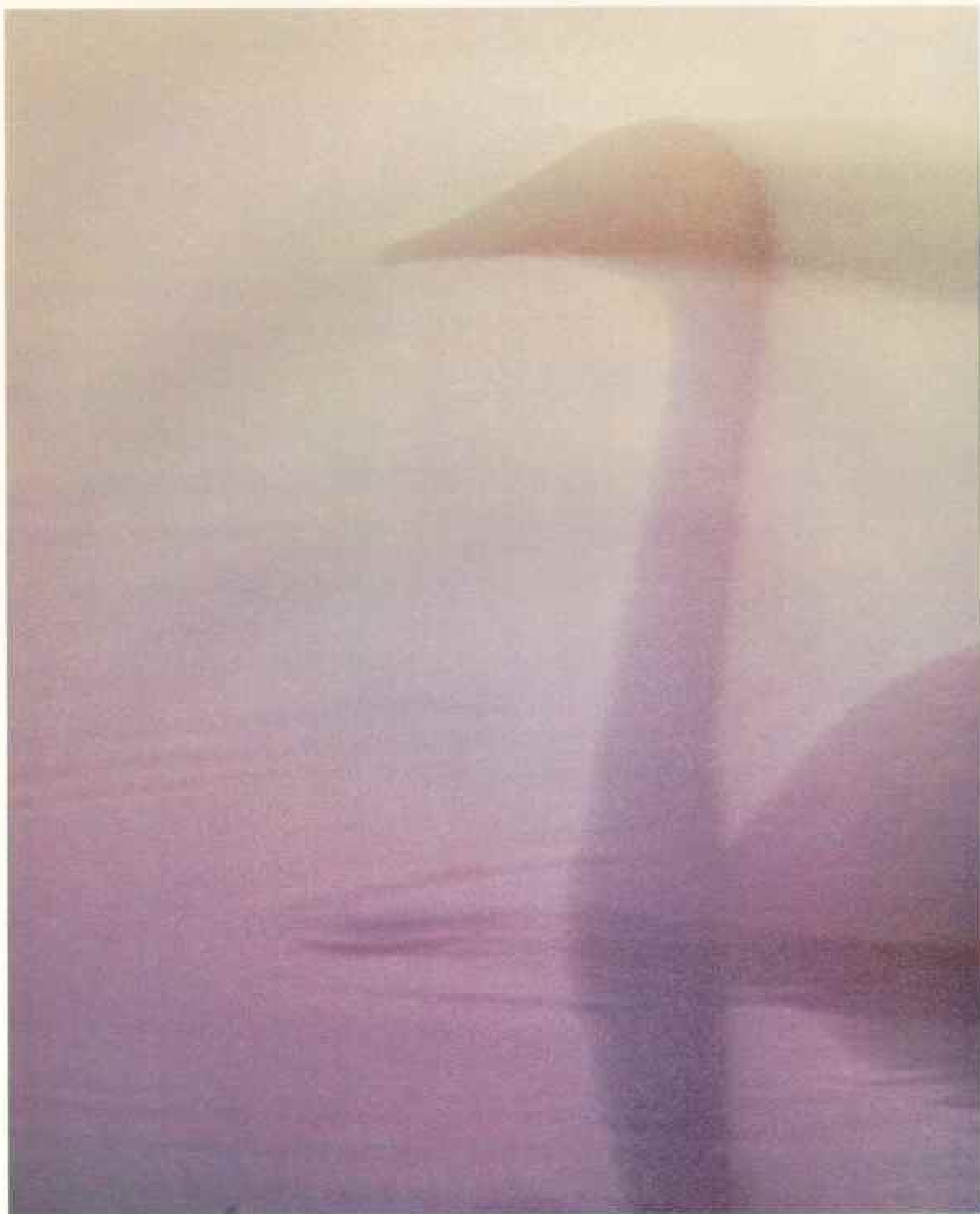


We can be ethical only in relation to something we can



Barn lights signal dusk on a Minnesota farm.

see, feel, understand, love, or otherwise have faith in.



*Like winds and sunsets, wild things
were taken for granted until progress
began to do away with them. Now*



Whistling swan ghosts across a mist-shrouded pond.

*we face the question whether a still
higher 'standard of living' is worth its
cost in things natural, wild, and free.*

utilized in general as browse but were even the sole food of deer following heavy snows."

Leopold concluded that meant: "We studied woody plants because deer depend on them in winter, and during snow, may eat nothing else."

Other great minds have died unexpressed. Leopold's ideas have survived because he was determined to master the craft of good writing, to wring of himself only the essence. He labored over his writing in pursuit of the fit word. He wrote on a yellow pad with a sharp pencil, his handwriting tiny and orderly, disguising the ferment in his mind. He would complete a paragraph, strike a vagueness, move a sentence around, light his pipe, pause in thought, then yelp as the flame reached his fingers.

The sun came up, his secretary came in. He kept writing, cutting, simplifying. Still unsatisfied, he would put the piece away in the desk, his "cooler." A week, maybe months, later, after it had properly aged, he would pull it out and rework it more.

He was his own severest critic. After his death in 1948, the essay "Blue River" was found in his desk. It was but 14 sentences, a vivid, understated reflection on life and death—a cow, some green flies, the sudden arrival and departure of an ecstatic vermilion flycatcher: *the old cow was dead. . . . She had craned her neck—the mark was there in the sand—as if for one last look up into the cruel cliffs of Blue River.* Aldo had written a note on it to his wife: "Stella—do you think this is any good? It happened last year on the Blue. I've been thinking for a year how to write it. Afraid it can't be done." The note was dated June 11, 1922.

THERE ARE NO MONUMENTS to Aldo Leopold, save for a bronze plaque in the Gila. Just as well. Monuments were not his style. What mattered was that his ideas receive wider currency, but he died still in the minority and known only to a small audience. *A Sand County Almanac* was published posthumously and had only modest sales, until two decades later when the environmental movement discovered him.

What Leopold said of American conservation could be said of it today: We are too

enamored of "show pieces. We have not yet learned to think in terms of small cogs and wheels" that determine healthy land. Only knowledge of its cogs and wheels can build a lasting affection for the land—and affection underpins ethics.

We shall never achieve harmony with land, any more than we shall achieve justice or liberty for people. In these higher aspirations the important thing is not to achieve, but to strive. . . .

In the past ten years we have created numerous environmental laws and institutions of government and cleaned up some polluted lakes and streams. But our striving suggests that as in Leopold's time we seem to be good for a few years of righteous flexing, yet lack endurance. Our patience is short and our self-interest deep. Lately our attention has drifted to the price of fuel, the shrinking dollar, the rumble of thunder from that part of the world on which we increasingly depend for a drive in the country. So we bend to digging up the West and probing the continental shelf for solutions. Confused and angered, we may look upon environmental laws, rather than our appetites, as the source of our current discontent. What was gained by one alarm may be lost by another.

Minds addicted to economics dismiss Leopold's land ethic as hopelessly idealistic. It is an ideal, but is it hopeless? Ethics guide, admittedly imperfectly, our relationships with one another. Can we not apply human values to the land? Leopold admitted that economic feasibility limits "the tether of what can and cannot be done for land. . . . The fallacy . . . is the belief that economics determines *all* land-use." Something more profound is at work. The farmer who refuses to plow to the road edge or drain the marsh because he will miss the quail and the crane knows this. And so, in his own way, does the city boy, who one evening sees the crane in flight, and feels his neck prickle.

Aldo Leopold observed that *recreational development is a job not of building roads into lovely country, but of building receptivity into the still unlovely human mind.*

. . . all history consists of successive excursions from a single starting-point, to which man returns again and again to organize yet another search for a durable scale of values. □

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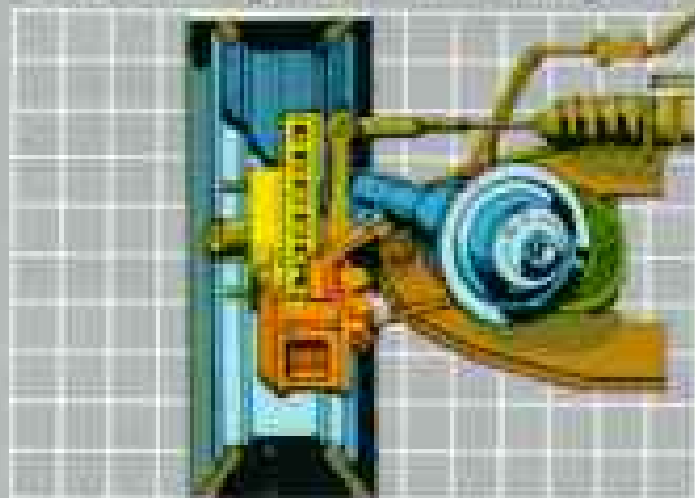
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The French Connection¹



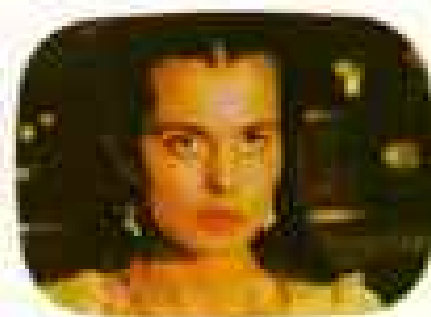
The China Syndrome¹



Alien¹



Butch Cassidy and the Sundance Kid¹



Tess¹

¹—Paramount Home Video ²—MCA/Universal Video ³—Columbia Pictures Home Entertainment
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The Royal Horticultural Society
presents an original work of art
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Sculpture shown smaller than actual size. Sculpture is approximately 8" x 4 1/4"

The Queen Elizabeth Rose

by Ronald Van Ruyckevelt

The first issue in the Society's first collection of flower sculptures in porcelain.

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one of the world's leading porcelain sculptors.

In limited edition. At the very attractive price of \$95.

For the first time in its history, the Royal Horticultural Society has undertaken the creation of a collection of flower sculptures in fine, hand-painted porcelain.

Since Queen Elizabeth the Queen Mother is a Patron of the Society, it is appropriate that the first issue in the Society's first collection of porcelain flower sculpture will be *The Queen Elizabeth Rose* by Van Ruyckevelt.

One of the world's most beautiful roses, sculptured by one of the world's leading artists in porcelain, *The Queen Elizabeth Rose* is an impressive work and a triumph of realism. And it is being issued at the attractive price of \$95, payable in four monthly installments.

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In the tradition of major works of art in porcelain *The Queen Elizabeth Rose* will be issued in a limited edition, which will be permanently closed in the United States at the end of 1981. There is also a further limit of *one* per person.

To acquire *The Queen Elizabeth Rose*, please be sure to return the Reservation Application at right by December 31, 1981.

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Members Forum

SOLAR SYSTEM

I am confused about Saturn's moons. The most recently discovered moon (before Voyager 1), Janus, was not shown in your article.

Todd McComb
Fort Wayne, Indiana

Because of many recent discoveries, the number and names of Saturn's moons are indeed confusing. Once a moon has been confirmed by more than one observation and its precise orbit determined, it is given a permanent number and name. Janus was an unofficial name given to the moon observed by A. Dollfus in 1966. Observations from Voyager now show two moons in that location orbiting together; one of these is the moon known as Janus.

How anything as flagrant as the one-tenth ratio of Jupiter to ol' Sol got by is hard to comprehend—more like one-thousandth.

John Wensinger
Santa Rosa, California

NATIONAL GEOGRAPHIC was using diameter, not volume, in comparing sizes of planets or moons, as do most scientists. The diameter of Jupiter is 142,800 km and that of the sun is 1,400,000 km.

If you want to know more about Voyager's accomplishments on its journey past Saturn and into the solar system, NATIONAL GEOGRAPHIC is the bible.

Lee A. DuBridge
President Emeritus
California Institute of Technology, Pasadena

UNITED STATES ARTICLES

The Society is not national any more, it is international. Most of the time you only have one story on the Good Old U.S.A.

Roy Losh
Utica, Ohio

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Robin Watts
Wahroonga, Australia

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Put Some
Youth in
YOUR LIFE.



THE FUNGUS THAT WALKS

Please, no more. That is gross!!!!

Novella Ohara
San Francisco, California

I am a biology teacher. The article is an added asset to my classroom. Thank you.

Deborah Wagner
Houston, Texas

MAN BITES SHARK

Your statement, "shark meat, one of the most common ingredients of England's beloved fish-and-chips," would come as a shock and surprise to most British people. I have never in all my life eaten shark meat. The fish used is halibut, whiting, cod, or haddock, and as far as I know there have been no sharks caught in the North Sea.

Annette El-Hayek
Youngstown, Ohio

Shark is marketed in Great Britain under the names nursehound, flake, rock salmon, and huss, and thus finds its way onto the fish-and-chips plate, along with the traditional fishes mentioned. Norwegians are second only to Japanese in shark fishing; the British and the Irish are their best customers.

HELSINKI

I have just returned from Helsinki after a year-long visit, and am pleased to find that someone has taken time to clear up some grave misconceptions people have about Finland.

Saara Kuure
Anacortes, Washington

BUFFALO BILL

You certainly make Bill out to be a very human being, and I hope your work goes a long way in counteracting recent efforts to portray him as something of an old phony.

John C. Ewers
Ethnologist Emeritus
Smithsonian Institution
Washington, D.C.

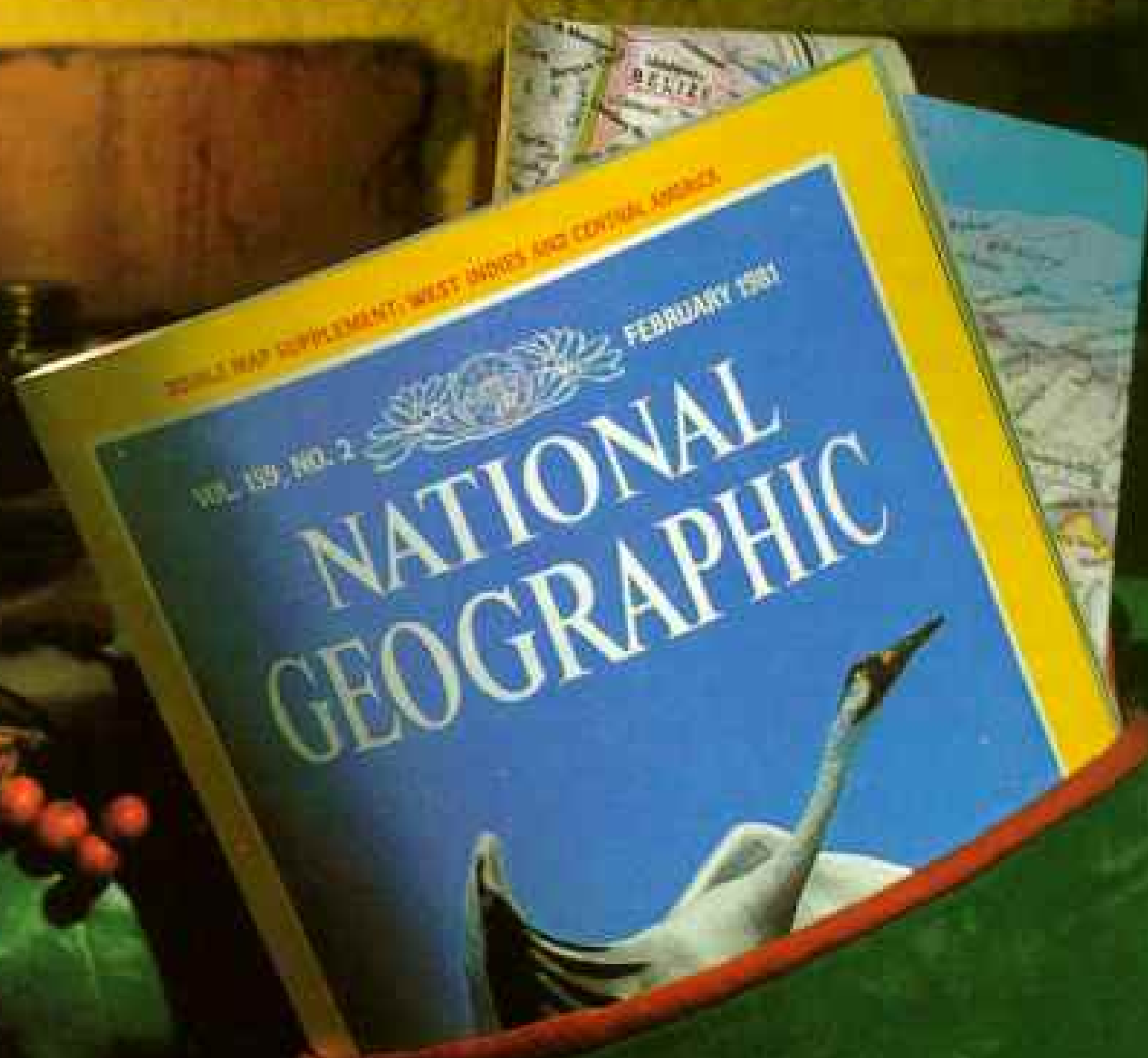
I enjoyed your article on Granddad. You did a wonderful job.

Fred H. Garlow
Cody, Wyoming

I've been near to "kicking the bucket" ever since NATIONAL GEOGRAPHIC came out. Friends near and far haven't left me alone day or night, with a few rattlebrain women hounding me with phone calls—long distance—telling me their troubles. Letters from all over began pouring in, telling me they saw my picture. They requested everything

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from a lock of my hair to six-shooters. I told them I couldn't spare my hair.

Brisbane, Australia, asked for a pair of leather cuffs "like the cowboys all wore." I never knew a real cowboy who wore cuffs, only some town show-off. Wellington, New Zealand, just a nice letter asking for my autograph, and the same from a lady in Hobart, Tasmania.

It wore me out, and I was so run down the flu got me. I'm not as "enduring as the West" by a long shot.

Harry E. Webb
Tujunga, California

MOLOKAI—FORGOTTEN HAWAII

The best and most honest account of the state of Hawaii I have had the pleasure of reading in years. It stressed what I, as a transplanted but born-and-bred Honolulu, always believed to be the primary beauty of the island—her people, and their unity with the little land they possess.

Wendell C. M. Lee
Mill Valley, California

FREE PRESS

Having lived for 18 years in a developing nation, I perhaps overly sympathize with the Third World when, in your words, it "may justifiably feel that some articles distort its problems, may be insensitive or even inaccurate."

You comment on a "less-than-perfect" free press. It is certainly that, and some of that imperfection seems to stem from a sad lack of responsibility. If there were only a near-equal effort publicly to improve upon the free press as there is the strong drive to maintain its freedom at any cost, then perhaps those of us who have seen the picture from both sides would feel more at ease about the future.

Dick C. Tymeson
Fort Lauderdale, Florida

COSTA RICA

I find a classic U. S. citizen-style evaluation of the situation prevailing in Costa Rica and the rest of the countries: simplistic, romantic, frivolous.

I don't consider that "unequal distribution of wealth is the only reason at the root of the unrest." There is a foreign movement also, promoting these upheavals. The objective is clear—not wealth for the people, but making these republics spin into the socialist orbit.

Julio Andrade
Mazatenango, Guatemala

I was a Peace Corps volunteer in Costa Rica. What I enjoyed most about your work was the truth, the honesty, and the way you captured what the country and its people are all about.

Mary Ellen Garrity
Milton, Massachusetts

TROUBLED TIMES FOR CENTRAL AMERICA

Isn't wealth unequally distributed all over the world, including the U. S. and Russia?

It is through threats and deaths that the Indians are being coerced into participation in civil strife, a thing they had not done before, and you do not mention the death squads of the left, who, incidentally, began the kidnappings and murders, including the one of U. S. Ambassador John Gordon Mein, long before the government was forced into taking defensive action.

Olga de Sánchez
Guatemala City, Guatemala

You have fallen for the propaganda of the liberal lobby that has been orchestrated to attack Guatemala at all costs. You are wrong: Indians are not being drawn into civil strife. Unequal distribution of wealth is not at the root of any unrest. Two percent of the people do not control two-thirds of the farmland. The undeclared war between guerrillas and security forces here in Guatemala is the cause of death of many persons, moderates and extremists.

(The writer, a former official, asked for anonymity out of concern for his personal safety.)

Almost 20 years ago, the official agricultural census of Guatemala reported that two-thirds of the farmland was owned by 2 percent of the farmers. In 1978 the World Bank cited 1970 data that 10 percent of landowners held 81.4 percent of the land. Scholar Richard Millett reported in 1981 that a fourth of the rural population owns no land at all, and almost all—90 percent—live on plots too small to provide a minimal standard of living. He also notes that the Indian population has been providing members to the leftist guerrilla forces, especially since the killing of a number of Indian women in the village of Nebaj in March 1980.

Amnesty International maintains that more than 25,000 people have been killed since 1965.

.....
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A cake so moist,
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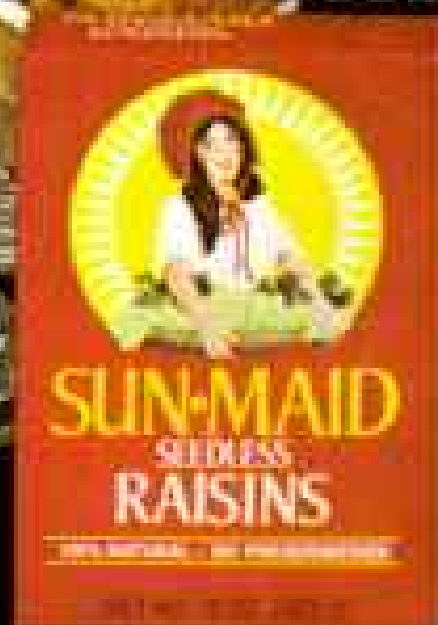
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Hellmann's bakes it better!

Amazin' Raisin Cake

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|--------------------------------------|----------------------------------|
| 3 cups unsifted flour | 1 1/2 tsp ground cinnamon |
| 2 cups sugar | 1/2 tsp ground nutmeg |
| 1 cup HELLMANN'S®
Real Mayonnaise | 1/2 tsp salt |
| 1/3 cup milk | 1/4 tsp ground cloves |
| 2 eggs | 3 cups chopped peeled apples |
| 2 tsp baking soda | 1 cup SUN-MAID® Seedless Raisins |
| | 1/2 cup coarsely chopped walnuts |

Grease and flour 2 (9") round baking pans. In large bowl with mixer at low speed beat first 10 ingredients 2 min, scraping bowl frequently, or beat vigorously 300 strokes by hand. (Batter will be very thick.) With spoon stir in apples, raisins and nuts. Spoon batter into pans. Bake in 350° F oven 45 min or until tester inserted in center comes out clean. Cool in pans 10 min. Remove; cool. Fill and frost with 2 cups whipped cream.



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Use estimated MPG for comparison. Your mileage may differ depending on speed, distance,

weather. Actual highway mileage lower. Estimates lower in California. Some Buicks are equipped with engines produced by other GM Divisions, subsidiaries, or affiliated companies worldwide. See your Buick dealer for details.



Wouldn't you really rather have a Buick?

WE'RE EXXON

We're Bob Payne, turning solid coal into a new source of liquid fuel for America.



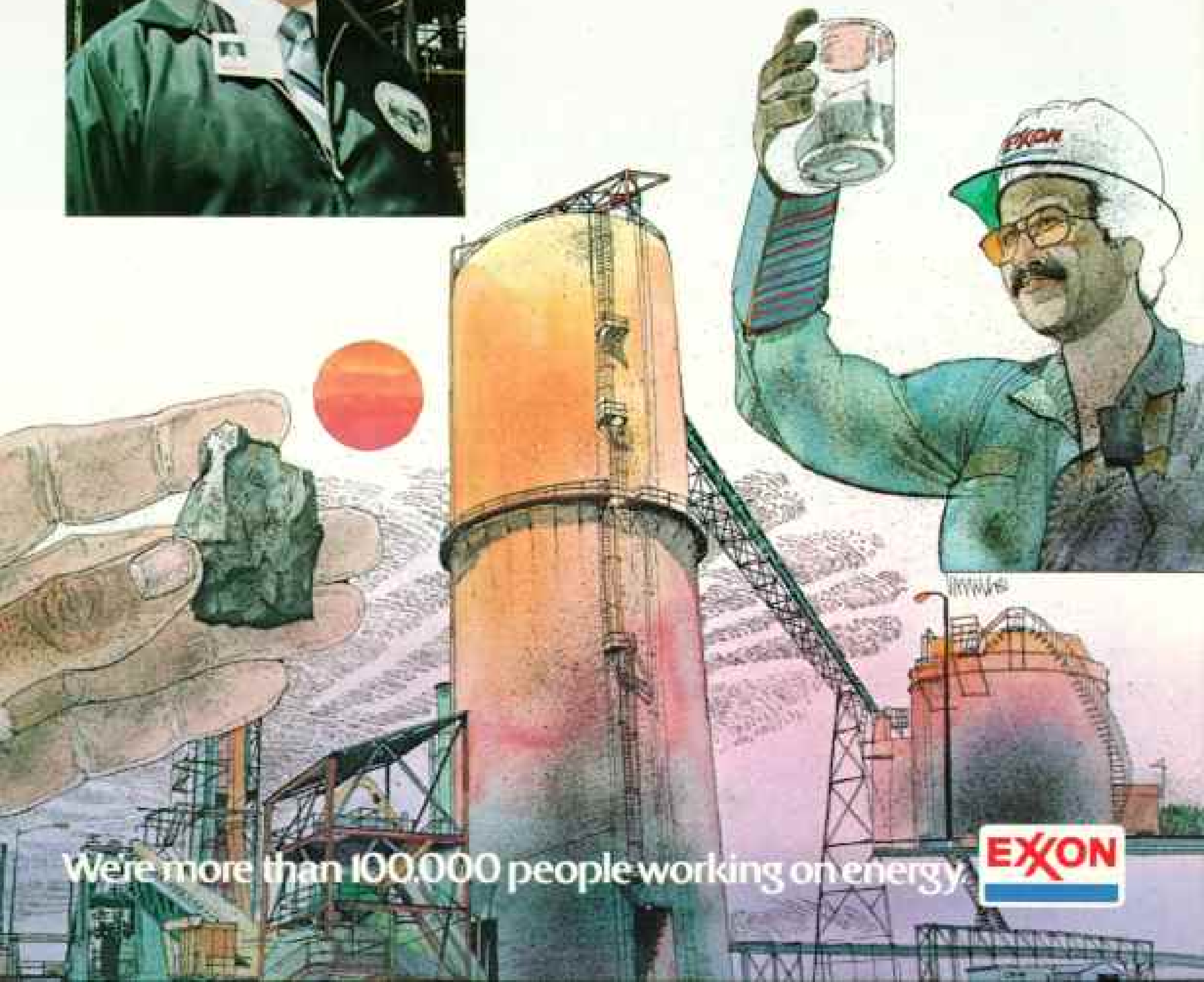
America has more energy in coal than the Middle East has in oil. For many uses, however, the coal must be turned into a liquid. Bob Payne is using his 30 years of experience in petroleum refining to do something about that. He manages a test plant that's finding better ways to turn American coal into liquid products we can use in industry, homes and transportation.

The test program will cost \$350 million. In addition to Exxon, it's funded by the U.S. Department of Energy, the Electric Power Research Institute, two

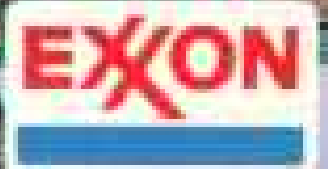
other U.S. oil companies and companies from Japan, Germany and Italy.

The test plant uses the Exxon Donor Solvent Process which works on many different kinds of coal. It turns 250 tons of coal a day into a liquid that's a substitute for products made from natural crude oil.

Bob Payne and the scores of Exxon people at the test plant know their work is important, because coal is an alternative to foreign oil. It's one more way to produce energy in America, for America.



We're more than 100,000 people working on energy.





ONE OF OUR BIGGEST IDEAS.

At Sony, our biggest ideas include everything from the world's tiniest color television (a little masterpiece that measures 3.7" diagonally) to a giant console measuring 30" diagonally. In fact, Sony's Trinitron comes in 11 screen sizes—more than any other television. Because only Trinitron has the patented one-gun, one-lens technology to produce an extraordinary picture on any size screen.

TRINITRON'S EMMY AWARD-WINNING SYSTEM

This exclusive one-gun, one-lens system is your assurance that no matter which Trinitron you choose, you'll be getting a super-sharp image from corner to corner. Along with color so vibrant it actually earned us an Emmy.

And those are just a couple of the features that make Trinitron so special it could only be a Sony.

THAT REMARKABLE TRINITRON TOUCH
Every Trinitron includes electronic tuning. Most are also equipped with another Sony innovation: Express Tuning. One touch and you go directly to the channel you'd like, skipping the channels in between. It's not only faster, it means less wear on your set.

We offer remote control on more models than anyone else, too. And with many of our Express Commander remote control units, you can do almost everything by simply lifting your finger—select your channel, raise and lower the sound level, refine the picture. Our new cable adaptable sets even let you switch from VHF to UHF to cable without leaving your chair.

TRINITRON TAKES A GOOD LOOK AT LARGE SCREENS

And if you've always wanted a larger screen—but haven't wanted to give up small-screen picture quality—here are



DITTO.

some other Trinitron exclusives you should know about.

Sony invented something called Velocity Modulation Scanning that brought small-screen color and clarity to larger televisions.

But we weren't satisfied with providing the best in wide-screen viewing. This year, we made it even better with further electronic improvements. Like Dynamic Picture, which allows for greater contrast range in both bright and dark areas by continually adjusting the picture contrast level. And Dynamic Color, for lifelike flesh tones and pure, clean whites.

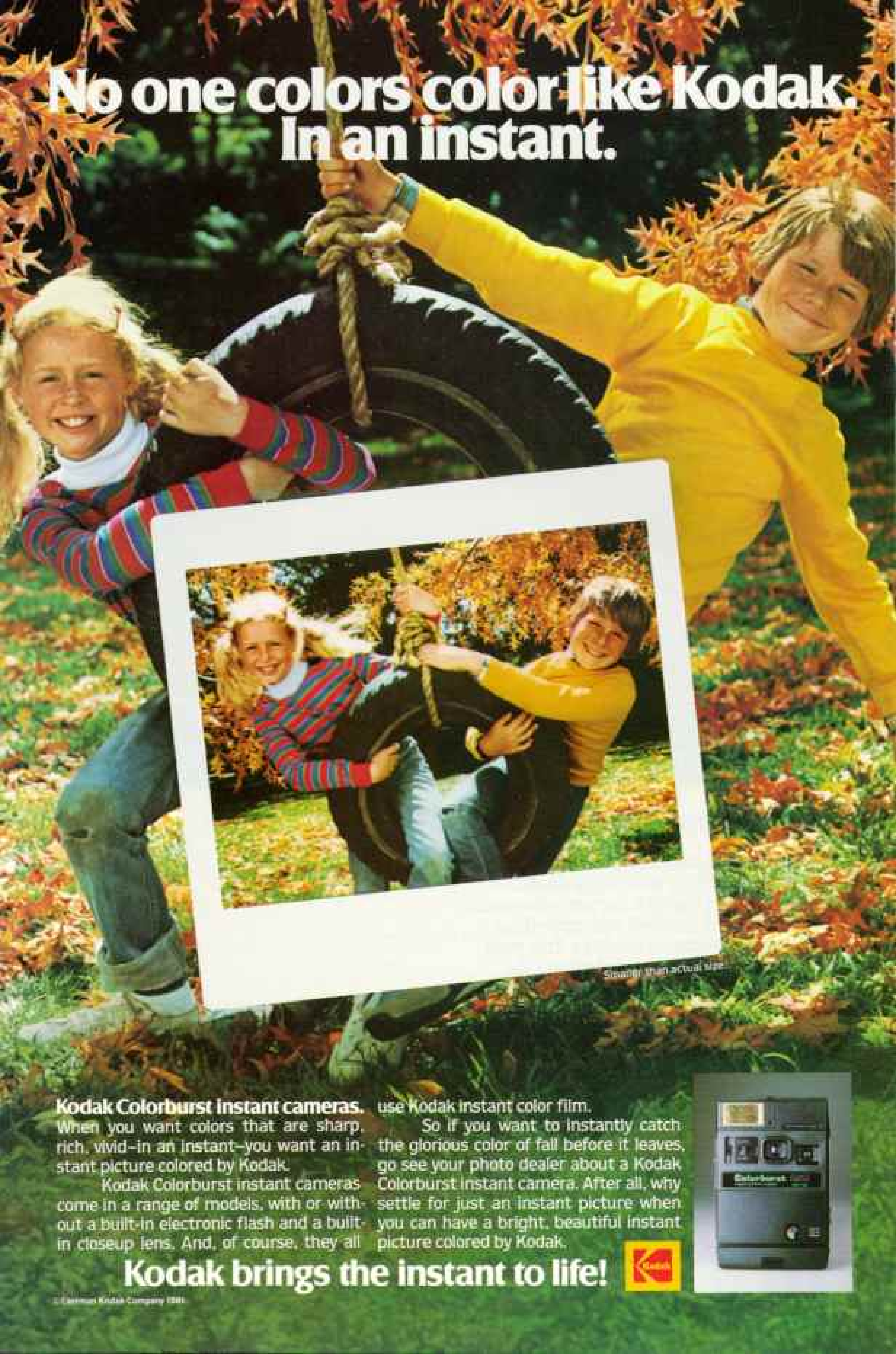
YOU'LL LOVE TRINITRON'S STYLE

Naturally, our engineers wouldn't put all these big ideas into anything less than the most handsomely styled cabinets. Because whether your Trinitron is on or off, we think it should be truly beautiful to see.

THE TRINITRON

SONY®
THE ONE AND ONLY

No one colors color like Kodak. In an instant.



Slower than actual size

Kodak Colorburst instant cameras.

When you want colors that are sharp, rich, vivid—in an instant—you want an instant picture colored by Kodak.

Kodak Colorburst instant cameras come in a range of models, with or without a built-in electronic flash and a built-in closeup lens. And, of course, they all

use Kodak instant color film.

So if you want to instantly catch the glorious color of fall before it leaves, go see your photo dealer about a Kodak Colorburst instant camera. After all, why settle for just an instant picture when you can have a bright, beautiful instant picture colored by Kodak.

Kodak brings the instant to life!

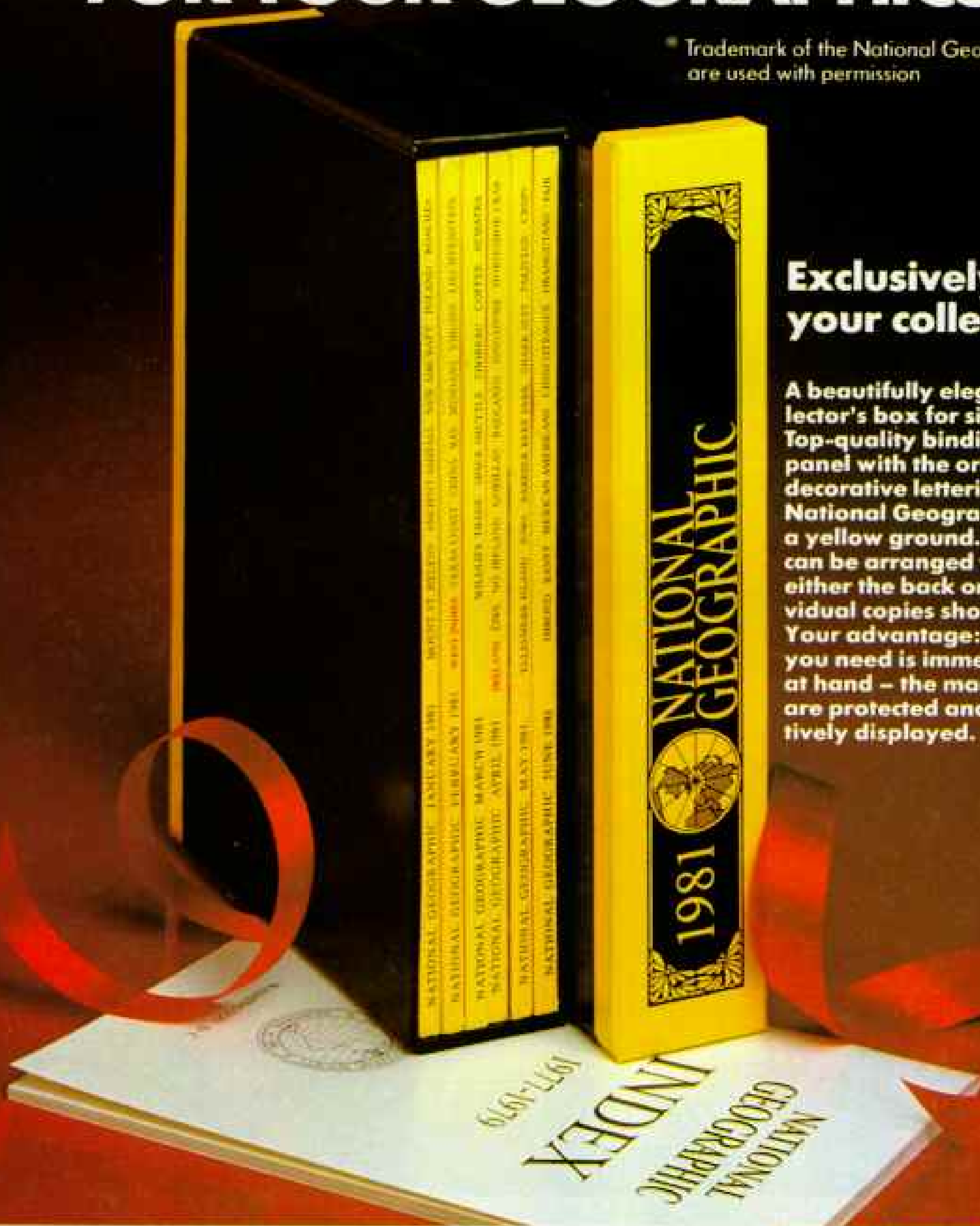


NOW: THE COLLECTOR'S BOX FOR YOUR GEOGRAPHICS

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A beautifully elegant collector's box for six issues. Top-quality binding. Back panel with the original decorative lettering of the National Geographic on a yellow ground. The box can be arranged with either the back or the individual copies showing. Your advantage: the issue you need is immediately at hand - the magazines are protected and attractively displayed.



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**We'd like to
show you more
of our true colors.**

New Jersey's true colors become vividly clear to those who really know us. In the brilliance of an Autumn day. The panorama of seashore, mountains, forests and lakes. The vibrant climate for investment. And a lifestyle that comes with hundreds of attractive communities. To learn more about America's most eye-opening surprise, write Governor Brendan Byrne, CN 110, Department NA, Trenton, N.J. 08625



**New
Jersey's got it!**

Helping to speed America's offshore search for energy.



That's a Bethlehem commitment. And we're succeeding.

Exploration for oil and gas beneath U.S. coastal waters is intensifying. And so is demand for the offshore mobile drilling rigs used to find them.

To help satisfy that demand, we recently started to build these rigs in our shipyard at Sparrows Point, Maryland—in addition to expanding rig production at our shipyard in Beaumont, Texas.

At Beaumont, Bethlehem pioneered in the design and construction of facilities used to find oil and gas

offshore. More than 60 rigs built at this yard have proved themselves on drilling sites around the world.

Now the expertise we've gained at Beaumont over the past 35 years is being shared with our rigbuilders at Sparrows Point.

The SABINE III, shown here, is the first drill rig to be completed at Sparrows Point. But...with orders for five more rigs on the books...it won't be the last.

Bethlehem 

Bethlehem Steel Corp., Bethlehem, PA 18016

**COULD
THE INDIVIDUAL
HOLD THE KEY
TO AN ENTIRE
COMPANY'S
PRODUCTIVITY?**

Many factors contribute to productivity: producible designs, superior tools, clever processes, minimal regulations.

But, heading the list is people. Most of us are aware of the impressive productivity improvements Japanese companies have realized with their people by using teams of cooperating workers called Quality Circles.

Wisely, hundreds of American companies now are duplicating these efforts in their factories.

At Motorola, over a decade ago, we initiated a plan of our own. Today we call it the Participative Management Program (PMP), and it reaches beyond the factory floor. We believe it has helped us achieve the same, and often better, quality and productivity results for which Japanese companies get credit.

PMP is an effective way to get the individual worker more involved, responsible, informed, and therefore, more productive.

Any individual worker can suggest things about any job he or she does that a supervisor may not know as well. As management listens and acts, quality and output rise.

In PMP, teams of employees meet frequently, sometimes daily, among themselves and with support groups to tackle the basics. Everyone is encouraged to define problems and suggest solutions. The management listens, contributes, acts. Each team operates to high, published standards which it participates in setting. The teams measure their improving performance to these standards daily, weekly, monthly. And everyone benefits.

Employees who want to can communicate additionally by submitting written recommendations. These are posted on prominent bulletin boards and must be answered in 72 hours. Not just with words, but with changes in tools, procedures or policies when humanly possible.

The results have been dramatic. Quality, output, and customer service are way up. Costs are down. Our jobs are more satisfying.

One-third of our 45,000 U.S. employees are operating under PMP today. Building on our years of experience, the balance of our U.S. operations will be fully managed through employee participation in 1983.

If we are succeeding well now, and we are, imagine how much better we will be soon.

There is much more to PMP that we'll be talking about in ads to come. You see, we believe what we've learned about productivity and the American worker can help other companies as well.

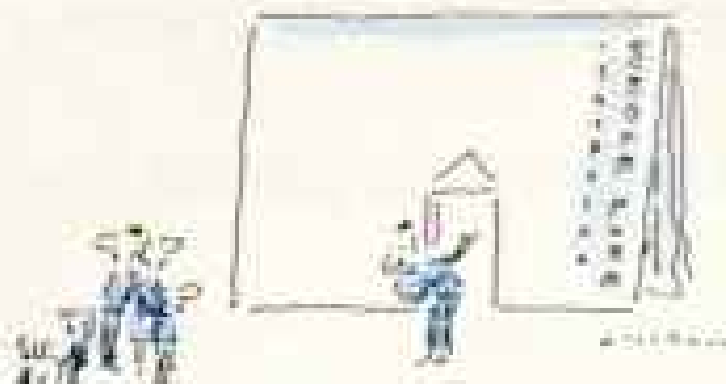


MOTOROLA A World Leader In Electronics

Quality and productivity through employee participation in management.



Life Insurance...



Should you
'rent' it
or own it?

Deciding what type of life insurance you need can be compared to deciding whether to rent an apartment or own a home. This comparison can help you understand the different benefits the two basic types of insurance can provide and how Metropolitan's new **Whole Life *Plus*** policy may be the answer for you.

Term Insurance Is Like Renting

Both an apartment lease and a term policy last for a set period. Renting an apartment is often the only affordable choice for some. So too, term insurance can initially provide much more coverage per premium dollar than whole life. Like most rents, however, the premiums on term increase with each renewal. Also, as an apartment renter doesn't build up equity, a term policy doesn't build up cash value.

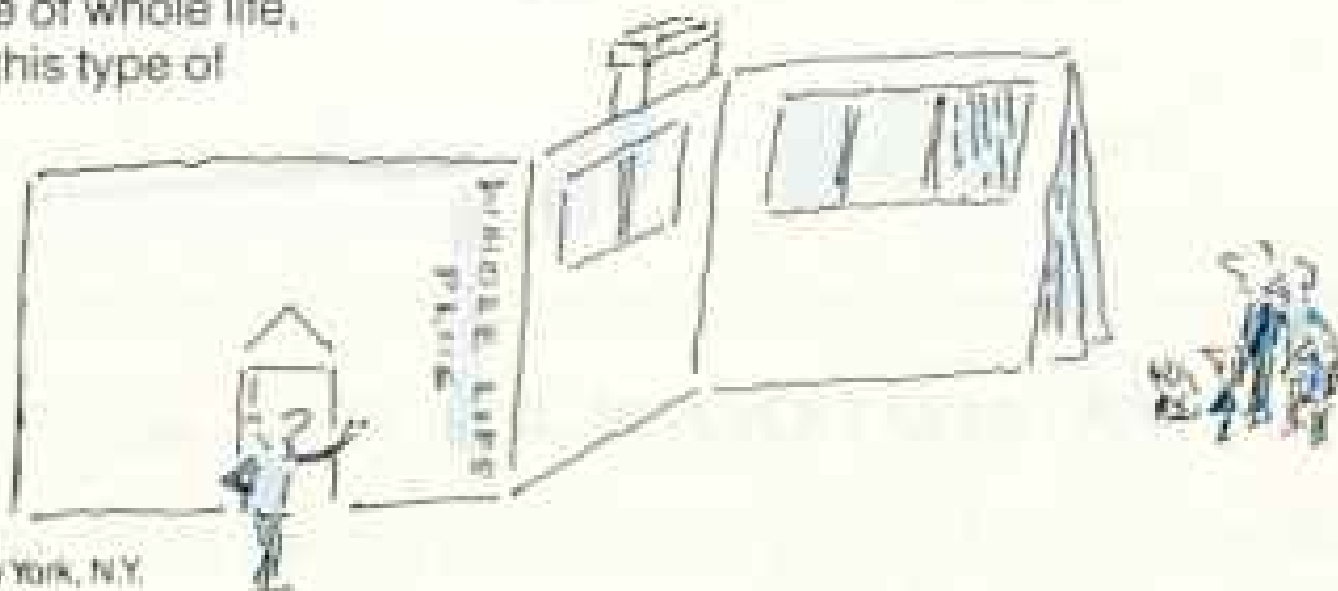
Whole Life Insurance Is Like Owning

Both a home you own and a whole life policy can protect you for your entire life if you want. And just as a home-owner makes equal payments with a conventional mortgage, the owner of a whole life policy pays the same premium each year. Further, the cash value builds up in a whole life policy in much the same way as equity in the home does from making mortgage payments.

Which Type of Life Insurance Is For You?

The answer depends on your needs and preferences. If your needs are high, but your budget is limited, term insurance may be the answer. Or, you may prefer the permanence, fixed premiums and cash value of whole life, but feel you really can't afford this type of protection.

Now there's an answer to this dilemma—**Metropolitan's new Whole Life *Plus* Policy**. It's like putting an addition on your house at no extra cost.



Metropolitan's new Whole Life *Plus* Policy can give you the whole life benefits you need—at a surprisingly low premium.

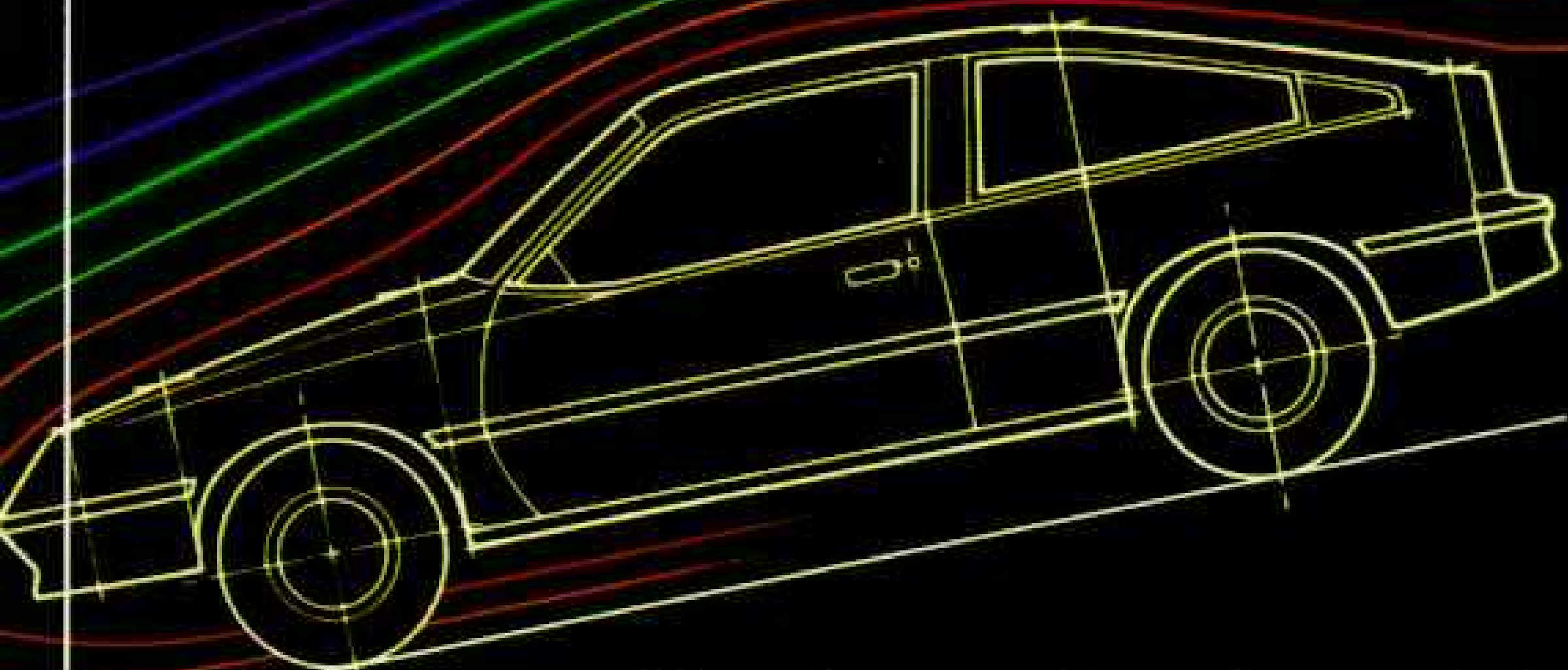
Depending on your age, Metropolitan's new Whole Life *Plus* Policy lets you buy **up to one-third more** whole life coverage than we offered before for the same premium payment. It's like building a sizeable addition on the cozy traditional whole life house—with no extra payment! Metropolitan is offering the Whole Life *Plus* Policy for coverage amounts of \$25,000 or more and you'll probably be surprised at how much coverage you can now afford.

Is Whole Life *Plus* The Answer?

Your local Metropolitan representative is a trained professional, prepared to help you answer this question and meet all of your insurance needs—life, health, auto, home and retirement.

Metropolitan 

Metropolitan really stands by you.
LIFE/HEALTH/AUTO/HOME/RETIREMENT



***After the aerodynamics are right,
go to the wind tunnel again.***

The original goal had been achieved. It took less aerodynamic energy per pound to move our new car than any other in its size category. But GM engineers sought even better results.

By going into the wind tunnel for yet another test, we found that we could reduce the drag coefficient even more by moving the car's nameplate back less than an inch. It was a small detail, but we made the change. And it was worth it. No American company had ever built a more aerodynamically efficient family car.

General Motors is one of the few automobile manufacturers in the world, and the only one in the United States, with its own full-scale aerodynamic wind tunnel. That means we can run aerodynamic tests round-the-clock, whenever necessary. After the test, we can make improvements right at the site, and test the cars again.

That's our idea of how to use technology to build cars. Attention to details where you don't see them, as well as where you do. Appearance and comfort may sometimes sell a car, but today's customers demand real value.

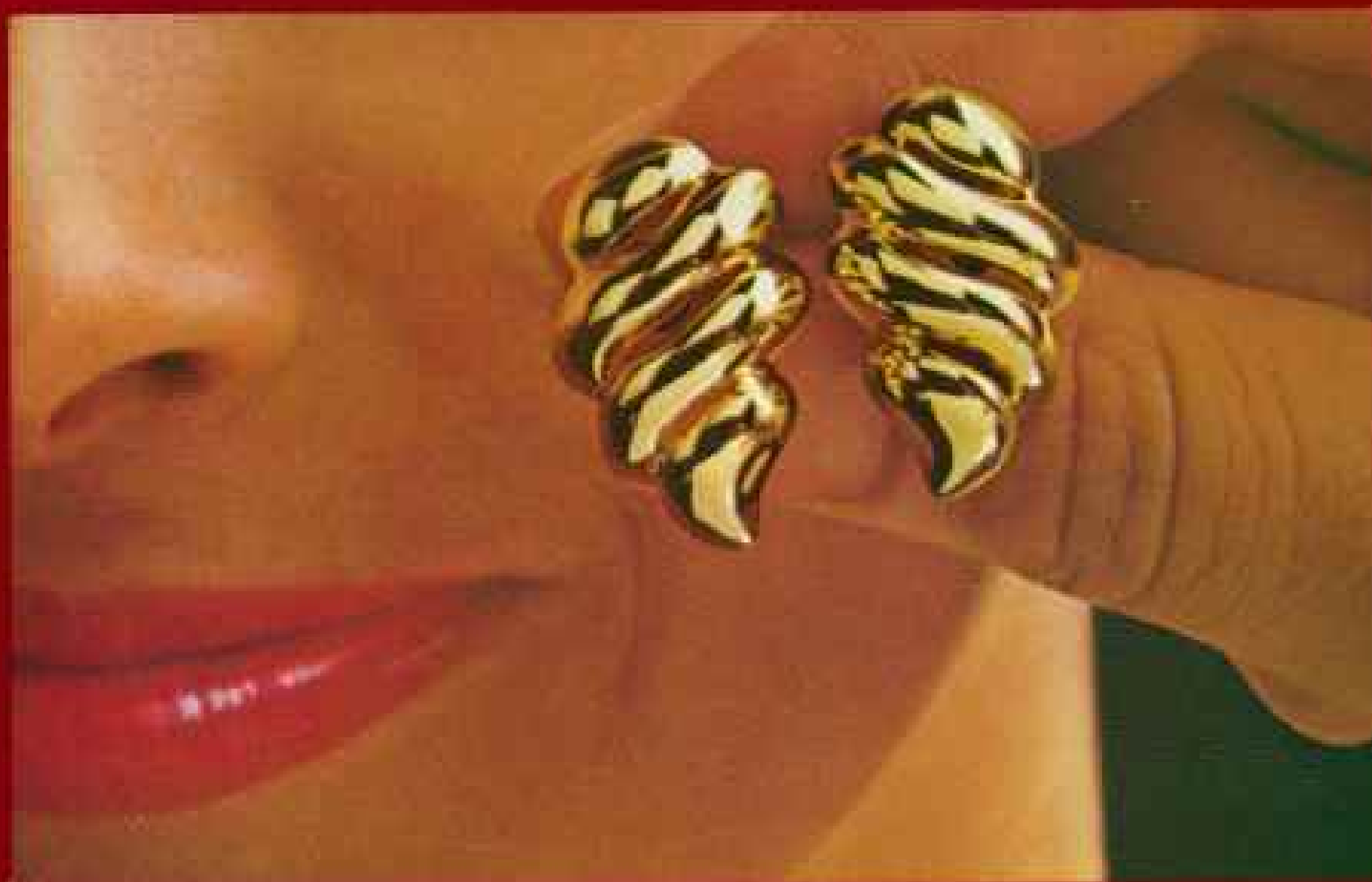
Our goal, as the company that sells more cars than any other manufacturer in the world, is to maintain our lead by using new technology to build cars that run better and last longer, with lower maintenance costs, than those built by any competitor.

General Motors

The future of transportation is here.



**"Remember
all those years
of last-minute gifts?"**



Nothing else feels like real gold.
Nothing else makes any moment so precious.

Give her the gleaming, elegant, enduring gift she will treasure all of her life.
KARAT GOLD JEWELRY

For more information about Karat Gold Jewelry or the specific jewelry pictured here,
write to Jewelry Information, International Gold Corp., Ltd., 645 Fifth Avenue, New York, N.Y. 10022.

Germany, now only \$3.15

It's the new low rate, \$3.15 for a 3-minute call to Germany. Just dial the call yourself during the lower rate periods, any night 5 p.m. to 5 a.m.

No International Dialing in your area? You still get the same low rate as long as it's a simple Station call.

(Person-to-person, credit card and collect calls, for example, cost more because they require special operator assistance.) Just tell the local Operator the country, city, and telephone number you want.

Here's how easy it is to dial Munich:

INTERNATIONAL NUMBER CITY ACCESS CODE

011 + 49 + 89 + LOCAL NUMBER

(If you are calling from a Touch-Tone® telephone, press the "#" button after dialing the entire number. This will speed your call along.)

\$3.15! What a nice surprise! Or... as they say in Germany, "Ach Du lieber!"

*Trademark of AT&T Co.
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INITIAL 3-MINUTE DIAL RATES

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Austria	\$4.05	— A
Belgium	4.05	\$3.15 B
Denmark	4.05	3.15 B
Finland	4.05	3.15 B
France	4.05	— A
Germany	4.05	3.15 C
Greece	4.05	— A
Ireland	3.00	2.40 B
Italy	4.05	3.15 B
Luxembourg	4.05	3.15 B
Monaco	4.05	— A
Netherlands	4.05	3.15 B
Norway	4.05	3.15 B
Portugal	4.05	3.15 B
San Marino	4.05	3.15 B
Spain	4.05	3.15 B
Sweden	4.05	3.15 B
Switzerland	4.05	— A
United Kingdom	3.00	2.40 B
Vatican City	4.05	3.15 B

A) No lower rate period
B) Nights 5pm-5am & Sunday
C) Nights 5pm-5am only

The charge for each additional minute is 1/3 the initial 3-min. dial rate. Federal excise tax of 2% is added on all calls billed in the United States.

 Bell System

*ACH
DU
LIEBER!*



Model 7-4001

THE GE COMPUTER RADIO. AT 6 A.M. IT'S SMARTER THAN YOU ARE.

TIME. For starters, The Great Awakening from General Electric is smart enough to let you set the time directly... there's no flipping around the clock.

6:00

WAKE-UP 1. You can program it to change stations for you. So it will rock you to sleep with Strauss, switch to your news station, and wake you at 6:15.

6:15

WAKE-UP 2. Then it comes back on to wake up your better half to a Beethoven symphony at 7:53. And on the Great Awakening, it's all done with push-button ease.

7:53

SNOOZ-ALARM! For a little extra sleep, press the Snooz-Alarm. It lets you sleep an extra minute or an extra hour. You tell the memory how long.

15

RADIO FM. You can also program up to six of your favorite stations into the Computer Radio's memory. And recall any one of them with the touch of a finger.

102.7

RADIO AM. You can scan all the AM or FM stations by pressing a button or, to tune in one station, just punch in the frequency of your choice on the keyboard.

1410

ERROR. The Great Awakening Computer Radio is so smart it even tells you when you've made an error. But it's no problem to correct... just press a button.

E

ALARM OFF. When you forget to set the alarm... The Great Awakening remembers to remind you. WE BRING GOOD THINGS TO LIFE.

OFF

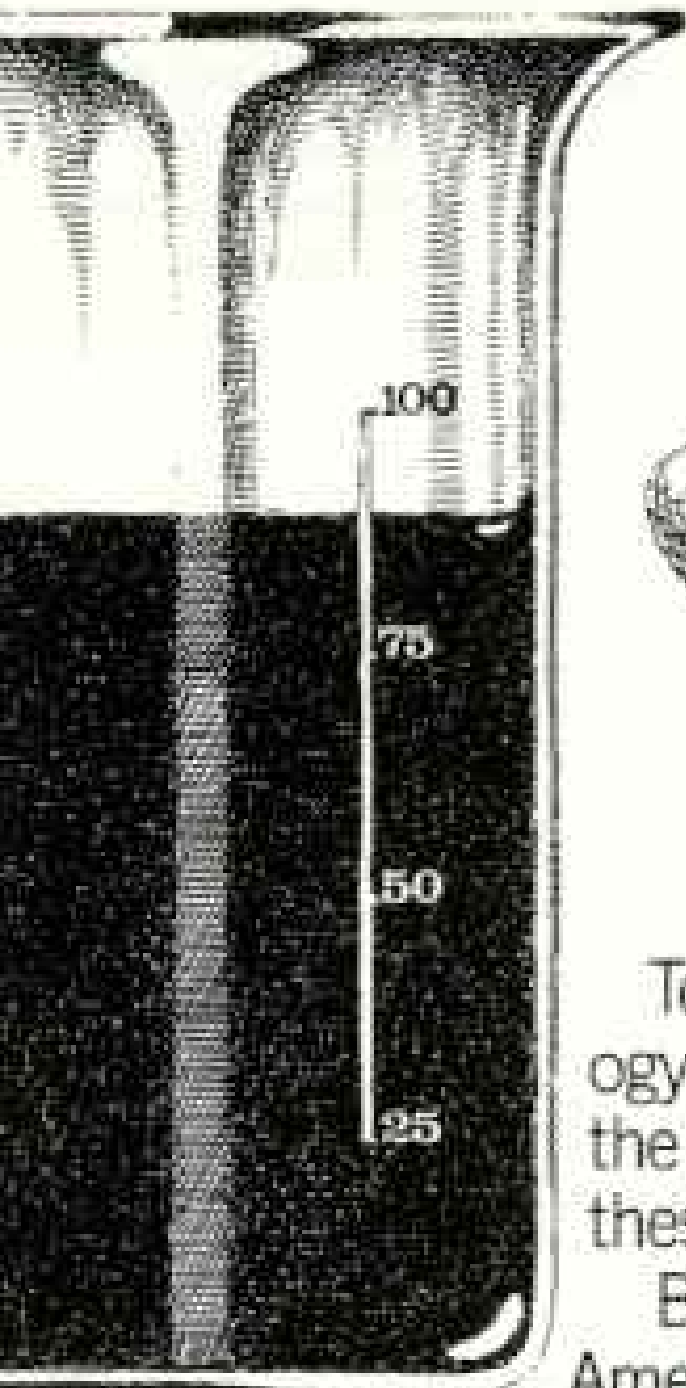
For more information, write to: General Electric Co., E.P. Bldg. 5, Rm. DR Syracuse, NY 13221.

GENERAL  ELECTRIC

The promise of oil lies just beyond our shore.

Some say the risk puts it beyond our reach.

There may be more than 20 billion barrels of oil still to be discovered beneath our offshore waters. And, along with it, possibly 100 trillion cubic feet of natural gas.



Today, technology gives America the potential of tapping these vast reserves.

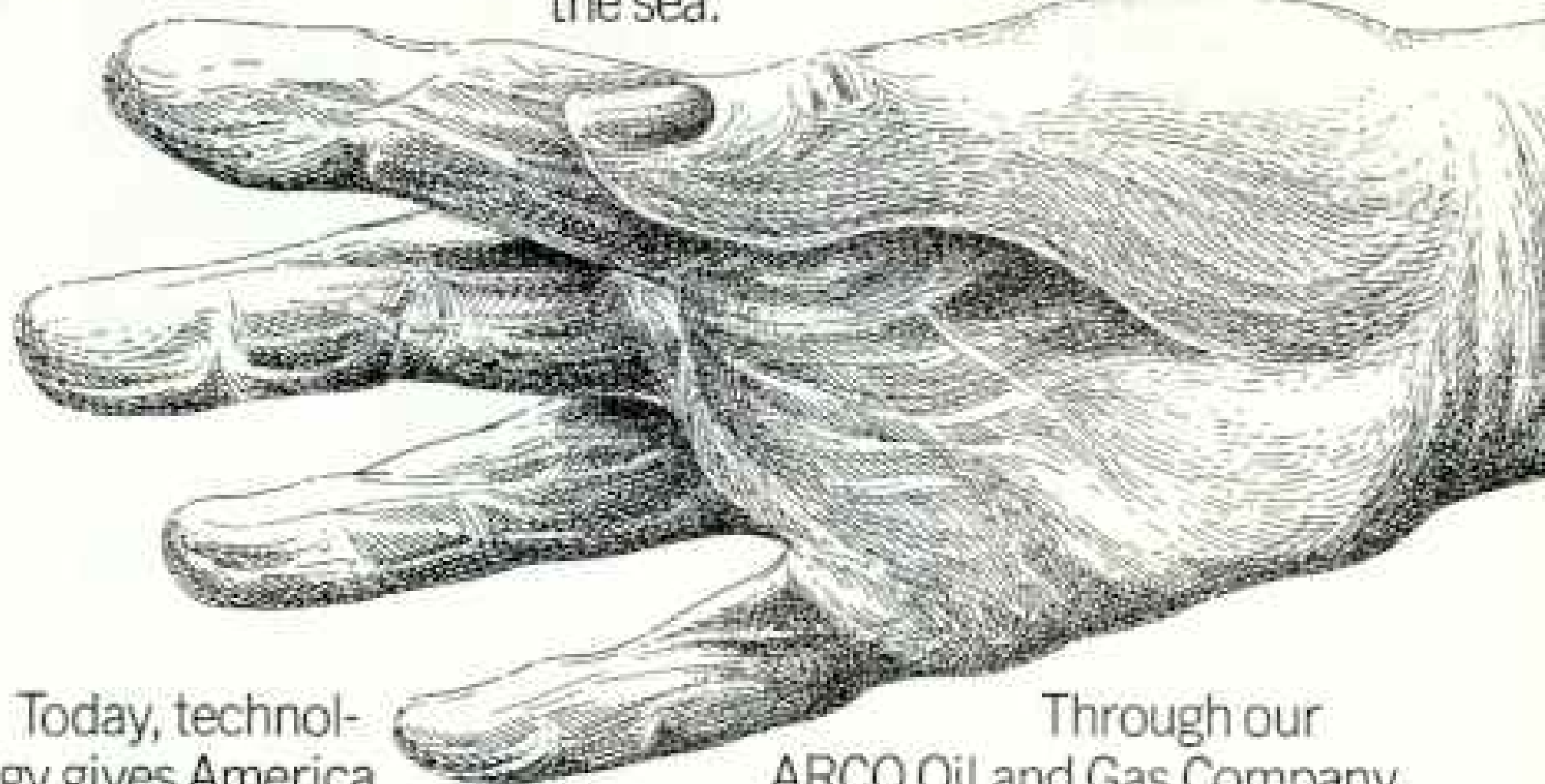
But every concerned American must demand thoughtful answers to questions about environmental safety.

The facts are these: Few of the 21,000 current offshore wells have caused environmental problems. And technology is further reducing the risk.

This includes pumping techniques and blowout preventers that automatically shut down wells at the first sign of an emergency, sealing the well against fluid leakage.

What's more, commercial and sport fishing actually improves around oil platforms. They provide underwater areas where many varieties of marine life can flourish.

Offshore oil and gas now provide about 10 percent of our daily energy needs. With only 2 percent of the country's one billion acres of potential offshore oil now leased, there is clearly much oil to be explored for under the sea.



Through our ARCO Oil and Gas Company, we're working to develop the safest, most dependable way of getting the most out of the oil America has to offer.

Atlantic Richfield and thousands of Americans who have invested with us believe that exploring undersea is important in reducing our dependence on foreign oil.

And that's something we can't afford to ignore.

There are no easy answers.



Atlantic Richfield Company

AALOHA

Say hello to gentle trade winds and warm, friendly smiles. Hawaii. Where lush islands, blue ocean and remarkable people come together to create paradise. An American Airlines 747 is ready to introduce you to Hawaii any day you choose. And our special vacation packages let you



discover the islands any way you choose. It's all part of the special service you've come to expect from American. So call your Travel Agent or us and say hello to Hawaii. Once you do, you'll never say goodbye. Just Aloha. We're American Airlines. Doing what we do best.



SLIDE SHOW.

This Christmas get an entirely new view in slide projection. Our exclusive Slide-Scan™ built-in screen puts viewing slides right at your fingertips. Just remove the standard lens, pull out the Slide-Scan screen, and you're ready to preview, review, or just plain view your slides ... anywhere ... without putting up a projection screen!

Other new features include a conveniently located, illuminated control panel. Much longer lamp life (70 hours). And, on some models, a variable-speed auto-timer.

These new Carousel projectors make a terrific gift for anyone who



has a 35 mm camera. Because they give you a more uniform corner-to-center illumination. A manual select control, which lets you remove the tray when the power is off. And a rapid, reliable, automatic focus system on the top four models.

Add all this to regular features like dependable gravity feed, an Ektanar C projection lens, and a dark-screen shutter latch. Plus accessories such as a dissolve control and a sound-slide synchronizer. Then you'll know why the new Kodak Carousel projector makes such a great gift.

**KODAK CAROUSEL® PROJECTORS.
THE NEW BREED.**

SIDE SHOW.



**THIS CHRISTMAS KODAK INTRODUCES
THE NEW BREED OF PROJECTORS
THAT GIVES YOU BOTH.**



GO TO THE POST OFFICE AND DRIVE OFF WITH A CELEBRITY.

Bobby Jones, one of the most famous golfers of all time, is waiting for you on the newest U.S. Commemorative stamp.

Over 50 years ago, Jones won the Grand Slam. No one since has equalled that feat. And now you can bring that accomplishment home, with this handsome stamp.

But that's just one small part of the America you can explore through U.S. Com-

memoratives. Every few weeks another new issue honors this country's heroes. History. And natural beauty.

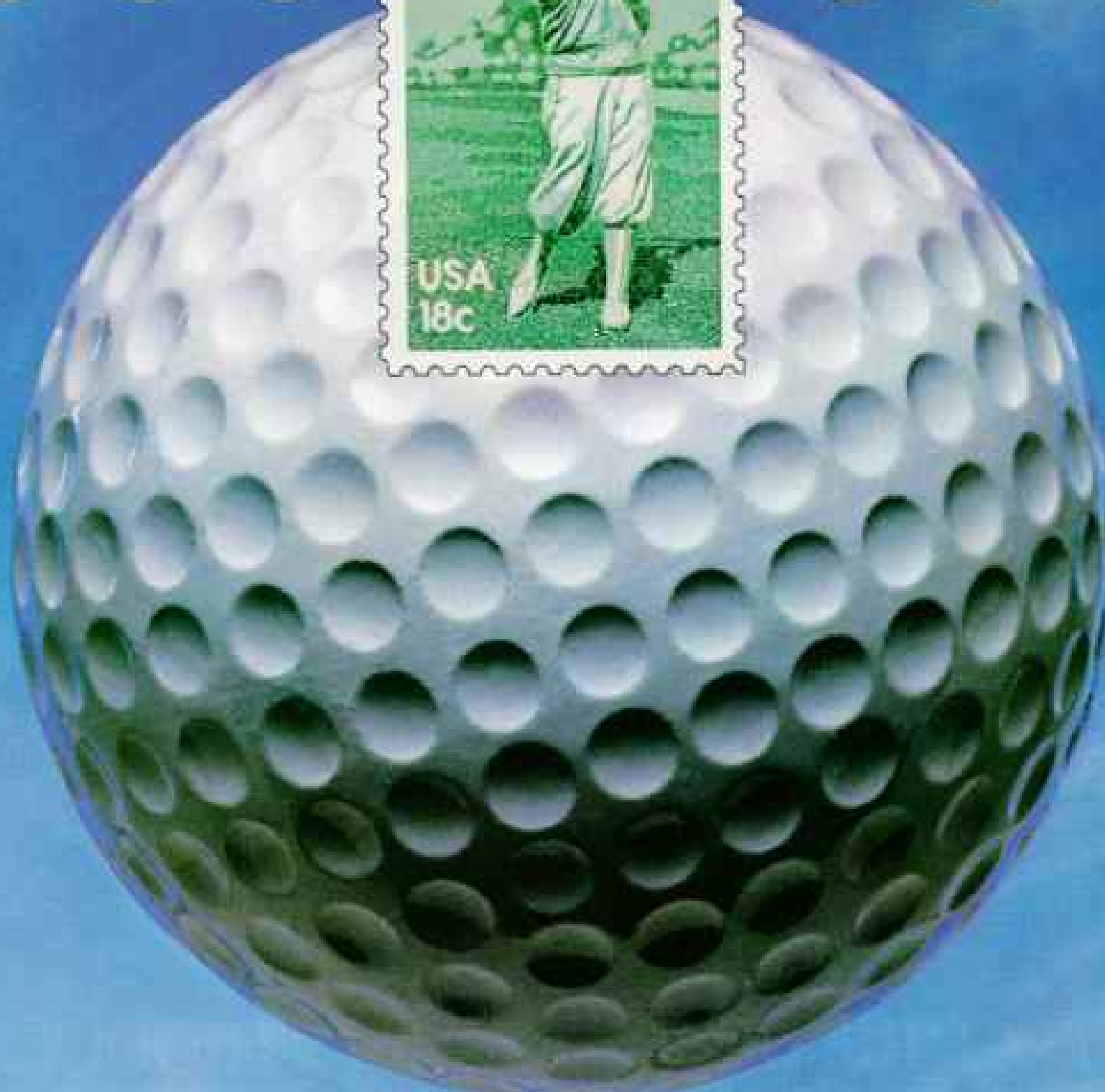
There's no better time than right now to get started on this intriguing hobby.

So come to the Post Office and discover stamp collecting. When you drive off with the Bobby Jones stamp, you'll feel like a pro.



U.S. Postal Service

©USPS 1981



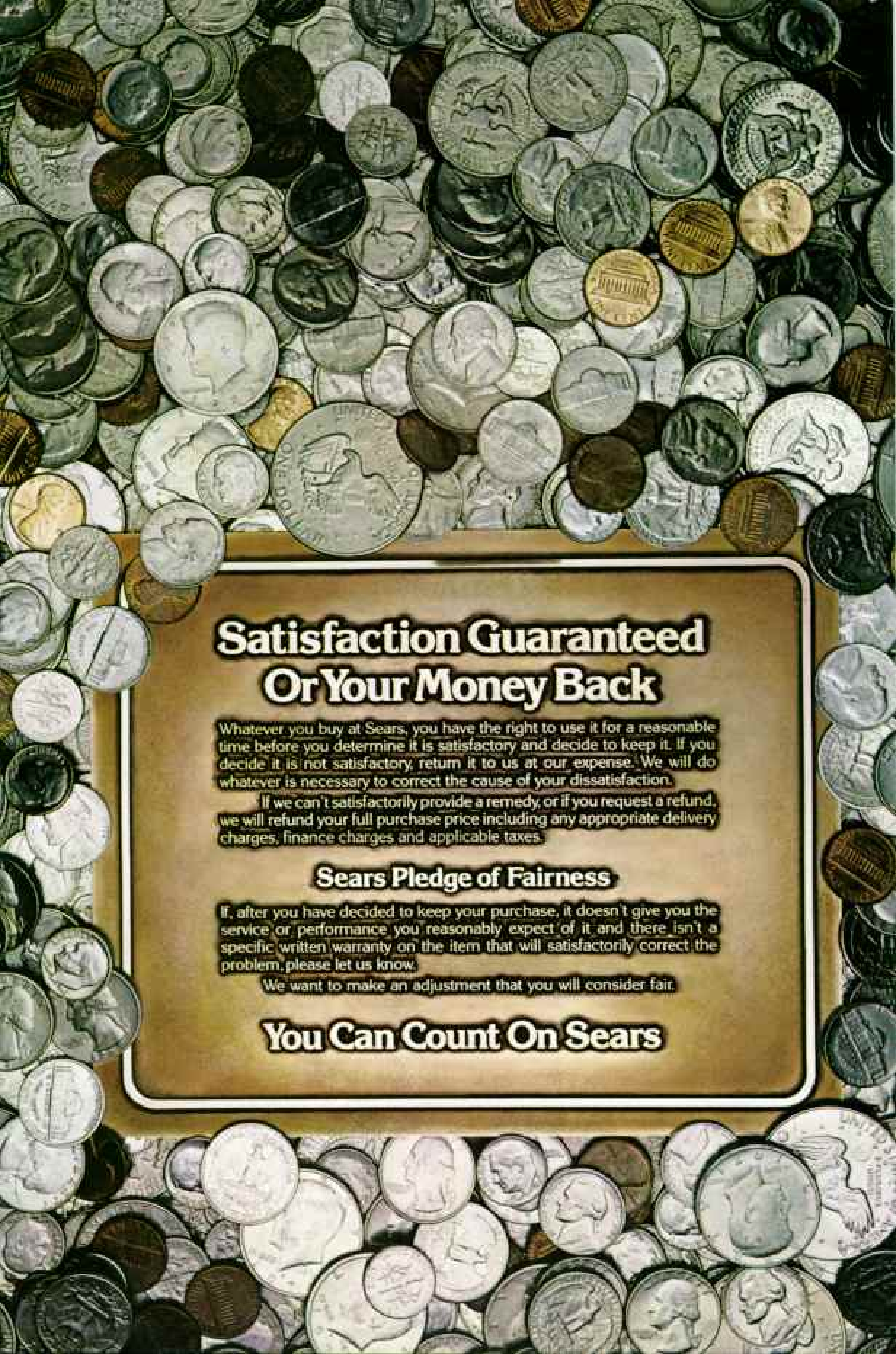
Your hand should look as contemporary as the rest of you.

You can't really put your best foot forward if your hand is behind the times. Which is why we've created our stylish new line of TRZ ballpoints and pencils.

TRZ™ pens have fashionably sleek lines and come in the year's most chic colors and materials. Yet they go for the most unfashionably low prices (\$5–\$15).

This not only makes them a perfect gift. It proves that you don't have to be well-heeled to keep your hand well-dressed.


SHEAFFER.



Satisfaction Guaranteed Or Your Money Back

Whatever you buy at Sears, you have the right to use it for a reasonable time before you determine it is satisfactory and decide to keep it. If you decide it is not satisfactory, return it to us at our expense. We will do whatever is necessary to correct the cause of your dissatisfaction.

If we can't satisfactorily provide a remedy, or if you request a refund, we will refund your full purchase price including any appropriate delivery charges, finance charges and applicable taxes.

Sears Pledge of Fairness

If, after you have decided to keep your purchase, it doesn't give you the service or performance you reasonably expect of it and there isn't a specific written warranty on the item that will satisfactorily correct the problem, please let us know.

We want to make an adjustment that you will consider fair.

You Can Count On Sears

You can count on Sears for satisfaction

Satisfaction guaranteed or your money back is a promise Sears has lived by for half a century. Other things you can still count on at Sears: fair prices, good workmanship, wide selection, competent service.

Sears believes that you should be completely satisfied—with performance, workmanship, fit, styling, even *color*.

Suppose you buy a blue sweater through the catalog and the blue looks different, however slightly, from the blue on the printed page. Says Sears catalog: "In such a case, as with everything we sell, we guarantee your satisfaction or your money back." Among the steps Sears takes:

1. *Sears people spend thousands of hours a year at factories that make Sears products.*

They study the needs and desires of Sears customers—and work personally with manufacturers to make certain that Sears products perform as expected.

2. *The Sears Laboratory tests over 10,000 products a year. Sears*

maintains one of the world's largest private laboratories for testing consumer goods. It tests for strength, durability, handling, and performance.

3. *Sears employs engineers to help manufacturers improve their efficiency.*

This is one of many steps Sears takes to help hold down costs. Others include an almost fanatically efficient distribution system. Dozens of small efficiencies explain why Sears regular prices are so reasonable, and Sears sale prices such bargains.

So it's first to Sears for millions of shoppers. They have found again and again that they are likely to spot exactly what they're looking for at Sears, to pay a fair price for it—and to be completely satisfied with it once they get it home.

Sears

© Sears, Roebuck and Co. 1989

Satisfaction Guaranteed or Your Money Back has been firm Sears policy for over half a century. The words on this plaque stand behind every purchase by every Sears customer.

When curiosity flourishes, worlds can be changed.

Why? How? What if? Young people question. Taking joy in the search for solutions. Their worlds abound with endless possibilities. So, too, it is with scientists. Whose laboratories are as limitless as the universe. Whose ideas shape worlds. To interest young minds in the wonders of science, Phillips Petroleum has made possible a film series called "The Search for Solutions."

Stimulating films aired on PBS and seen by over two million students per month. They



capture the excitement of discovery.

And the discoverer.

To teach. To encourage.

But most of all, to interest.

Because childlike curiosity in the right

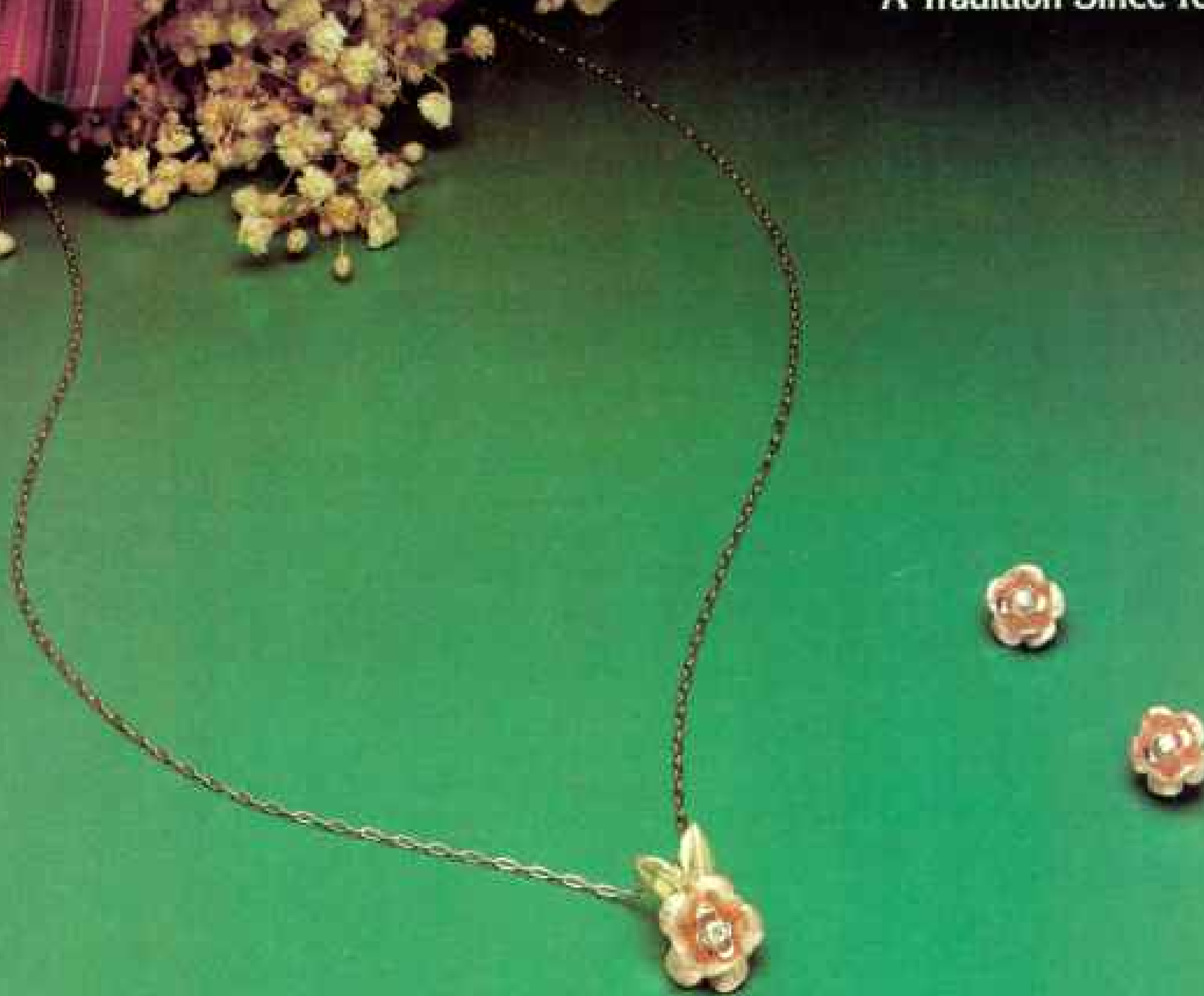
hands can help turn darkness into light.





Krementz[®]

A Tradition Since 1866



Add elegance to your holiday season with this stunning pendant and earrings by Krementz. Handcrafted in 14Kt. Gold Overlay and accented with sparkling diamonds, this jewelry is perfect for holiday gift-giving and wearing. When you buy jewelry, ask for Krementz... Its style and quality will last a lifetime.

Write Krementz & Co., 73 Chestnut St., Newark, N.J. 07101 for free copy of "Unique—The Story of Krementz Gold Overlay Jewelry." Suggested retail prices: Pendant \$60, Earrings \$90.

JEWELRY ENLARGED TO SHOW DETAIL

NOW WE KNOW WHAT IT'S LIKE TO BE ALONE.

It wasn't always this way. It used to be hard to decide among all the 35mm SLR's. Then we created the new Minolta XG-M. A camera so extraordinary it stands alone in its class. With an unrivaled combination of creative features.

First, it's automatic. So it's easy to get sharp, clear pictures. You just point, focus, and shoot. It even has electronic features that keep you from making mistakes.

As your skills advance, you'll appreciate advanced features like metered manual and exposure override for full creative control.

To further separate ourselves from the competition, we built in the option of professional motor-drive. Something normally found only on more expensive cameras.

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Photographed by J.P. Ferrero *Siberian Crane: Genus: Grus Species: leucogeranus Adult weight: 5.4-8kg Adult height: 1.37m Habitat: Breeding grounds are vast expanses of tundra in Siberia. Wintering range includes islands by the Caspian Sea in Iran, the Keoladeo Ghana Bird Sanctuary in India and wetlands in the basin of the Yangtze River in China. Surviving number: Approximately 150 in the wild.*



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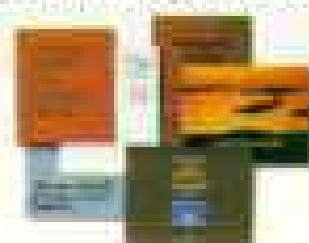
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