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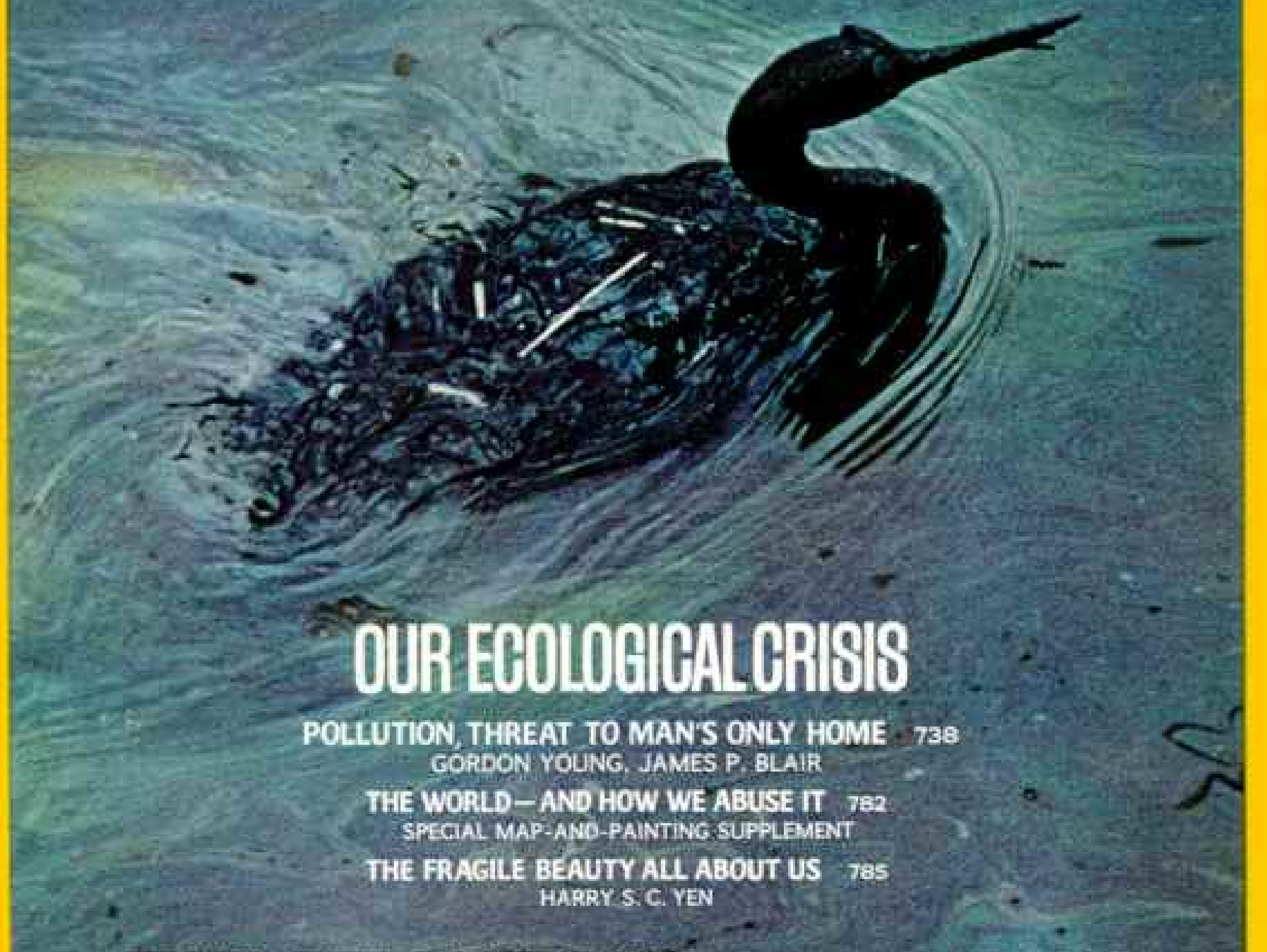

OUR ECOLOGICAL CRISIS

SEE "ETHIOPIA: THE HIDDEN EMPIRE" WEDNESDAY, DEC. 2, ON CBS TV (page 884A)

OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY WASHINGTON, D.C.

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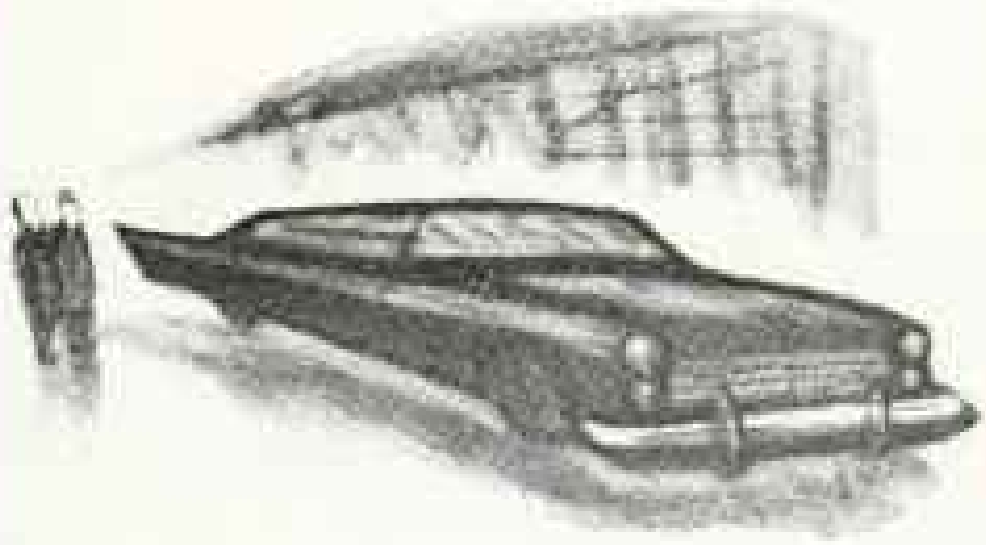

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Parker Duofold, it said on the side. This is positively Victorian, she thought. Modern pens are sleek and shiny. This is a plain and honest handful.

Her conclusion: Here was a find, a treasure from the good old days.

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Fish used to be scared when we looked

Not long ago, the oil industry usually looked for offshore oil with dynamite.

They exploded it underwater and recorded the telltale echoes on a seismograph.

When carefully done, this did little or no harm to aquatic life. But fish were sometimes scared and fled to quieter waters. Fishermen frowned.

Now, the Esso Production Research Company (a Jersey affiliate) has invented a substitute for dynamite. We have nicknamed it the popper and you can see one in our picture. It doesn't go bang like dynamite. It simply goes pop.

The device is beautifully simple. A mixture of propane and oxygen is ignited by a spark plug inside a rubber sleeve. The pop inflates the sleeve like an instant balloon.

This sudden expansion is strong enough to give a seismic echo, but not so strong that it hurts the fish.

But fishermen aren't the only people to cheer.

Dynamite is often tricky stuff to handle.

for oil. Now they couldn't care less.

The popper is much safer. Exploration crews have less danger to contend with.

What's more, a crew using a popper can do an underwater survey six times faster than a crew using dynamite. They can work night and day in rough weather. Whereas a dynamite crew needs daylight and comparative calm. And our popper gives a better seismic picture in the bargain.

Esso Production Research has now made the popper available to the oil industry around the world.

Good news for oilmen. Great news for fish. Quite an invention.

Standard Oil Company (New Jersey)

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Jim was a chip off the old block. No job. No schooling. No hope.

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He came north right after World War II. But he just wasn't equipped to work in the industrial north. He had little schooling. No training. So all his working life most of the jobs he could get were menial and part-time. With little hope for anything better.

Jim, without knowing it, was on his way to becoming his father. He spurned school. Missed classes. Didn't study. Was thinking of dropping out. And the future was a big blank.

Then in his junior year, Jim started to do a slow but sure turnabout. He dropped the idea of dropping out. And started working hard to stay in. He went to all his classes. And really started digging the books.

What makes a young man like Jim change? A youngster who didn't believe in the future. One who saw the future as a lot of stupid little jobs. And never enough money.

No one knows. Not even Jim.

But one of the things Jim always mentions was a new course he took at his high school in New York City. A professional automotive course initiated by Shell Oil Company. With Shell providing the lesson plans, the sophisticated electronic tune-up equipment and various learning materials.

Jim says he sparked to the course immediately. He was intrigued by the fancy equipment. And liked the idea of diagnosing sick engines.

But more important than that, Jim started to see himself differently. He began to realize that he could become something . . . if he learned something. And the idea took hold.

Today Jim is well on his way. He's a sophomore in a New York City college, studying hard to be an engineer.

Jim is not the only success story in this course. So far, over 100 young men have graduated. Many have gone on to good paying jobs in automotive and aircraft repair.

But the real surprise: many of the youngsters have gone on to college.

Shell was delighted with the results. So they extended the course to 12 other high schools. With 25 more to follow.

There are a lot of young men out there just like Jim. Youngsters who can and want to be something.

All they need is a chance.

Shell wants to help even more of them get that chance.

(Jim is a real person. But his name is not Jim.)

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This one is our Model 350. It's under $160 and full of tricks.

Countdown Cameras from Polaroid

December 1970

NATIONAL GEOGRAPHIC

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Our Ecological Crisis

Pollution,

ENTACHROME, NASA

FACTORY CHIMNEYS belching black smoke—like those of a Birmingham, Alabama, steel mill on the preceding page—once were hailed as signs of prosperity, of recovery from the Great Depression of the 1930's, of a future with "two cars in every garage." Today, with eighty million more Americans and also eighty million more cars, trucks, and buses than 40 years ago, we see smoking stacks and acrid exhaust fumes as poisoners of the air we breathe, as examples and symbols of man's befoulment of the only home he has.

Full realization of this sober truth has come since Christmastime 1968, when—through the eyes and cameras of moon-orbiting Astronauts Frank Borman, James A. Lovell, Jr., and William A. Anders—we first saw our earth as a planet, and saw ourselves, in the words of poet Archibald MacLeish, "as riders on the earth together, brothers on that bright loveliness in the eternal cold—brothers who know now they are truly brothers."

Though worldwide and enormous, the problems of pollution surely are solvable by a human race capable of such a feat of science and technology as flight to another heavenly body—given the most precious ingredient of all: "Peace on earth, good-will toward men."

—THE EDITOR.

WE ARE ASTRONAUTS—all of us. We ride a spaceship called Earth on its endless journey around the sun. This ship of ours is blessed with life-support systems so ingenious that they are self-renewing, so massive that they can supply the needs of billions.

But for centuries we have taken them for granted, considering their capacity limitless. At last we have begun to monitor the systems, and the findings are deeply disturbing.

Scientists and government officials of the United States and other countries agree that we are in trouble. Unless we stop abusing our vital life-support systems, they will fail. We must maintain them, or pay the penalty. The penalty is death.

Nature Operates in Precarious Balance

Air, water, and land—those are the systems. How do they work?

Look into a pond. A fish feeds there on tiny plants and animals called plankton. In time, the fish dies. Micro-organisms in the water break the creature down into basic chemicals, consuming oxygen from the water in the process. Plant plankton, nourished by those chemicals, produce oxygen to replace it. Animal plankton feed on the plants, fish eat the tiny animals, and the cycle begins anew.*

On land, too, nature moves full circle. Living things are nourished there, grow old and die, then decompose to enrich the land again.

*See "Teeming Life of a Pond," by William H. Amos, NATIONAL GEOGRAPHIC, August 1970.

By GORDON YOUNG

Photographs by JAMES P. BLAIR

Both National Geographic Staff

Threat to Man's Only Home

A thin envelope of air surrounds the planet. We use its oxygen, exhaling carbon dioxide, which vegetation absorbs. Plants use the carbon for growth by the marvelous process called photosynthesis, and return oxygen to the atmosphere. Thus nature's delicate balance is maintained (see painting on the reverse side of **The World** map supplement).

Consider First Our Overloaded Air

For some "air pollution," let us give thanks. Dust and other particles in the atmosphere serve as nuclei about which raindrops form. But man has overloaded the sky. For centuries he has pumped particulate matter and gases into the atmosphere. As far back as 1661, a tract on air pollution was published in England: *Fumifugium: or the Inconvenience of the Aer and Smoake of London Dissipated.*

Today much of the world suffers from the eye-smarting, lung-scarring curse we call smog. In Los Angeles and other great cities it comes in large part from automobile engines.

Last March I braved the streets of Tokyo, in that careening, cacophonous time of day the Japanese call *rushawa*. I was there for the first International Symposium on Environmental Disruption, where scientists from 13 countries had gathered to exchange views.

"Environmental disruption" was easy enough to see from the window of my taxi. Where else in the world, I wondered, must traffic policemen pause regularly to breathe oxygen (page 747). Conditions became so bad last summer that all cars were banned from 122 Tokyo streets on Sundays—the busiest of Japan's shopping days.

In Essen, Germany, I saw disruption in another form—smog caused mainly by industries. The chief of air-pollution control and land protection for North Rhine-Westphalia, Dr. Heinrich Stratmann, showed me two small steel squares. The first was bright and new. The second, exposed to the Ruhr's smog for only two months, was chocolate brown and deeply corroded.

But the fight to clear the air was under way. In a laboratory I peered through electron microscopes, watched particle counters "talk" to computers, and visited special rooms where plants were being grown in scientifically polluted environments. Leaving, I ran into the laboratory's own rushawa. Forty Volkswagens flocked into the parking lot. Their drivers had spent the day taking air samples that would be analyzed and plotted on the daily air-pollution map.

The Ruhr's battle is far from won. Still, industry and power generation have doubled in the region during the past two decades, without an increase in air pollution; that is a victory, of sorts.

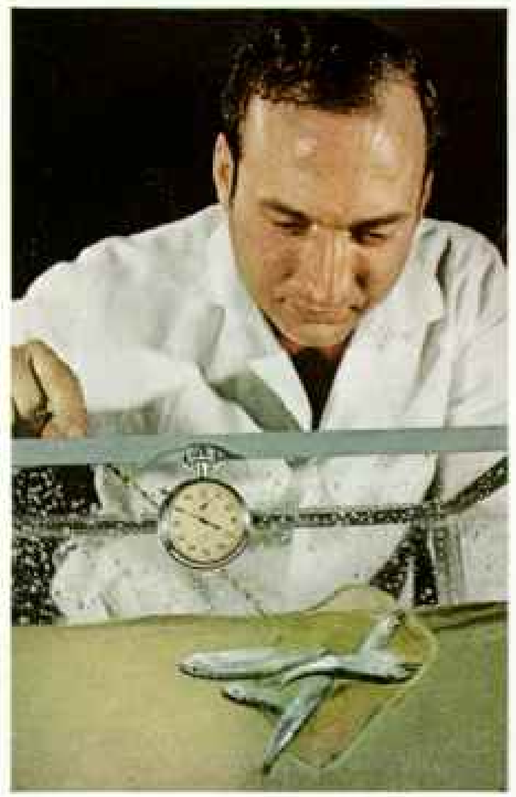
Polluted Air Circles the Earth

We can clean up land before we use it, and purify water before we drink it, but—except in air-conditioned rooms—we must breathe air as it comes to us. Scientists have tracked one type of air pollution—radioactive fallout—twice around the globe. The hazy air I am

FEDERAL WATER QUALITY ADMINISTRATION (UPPER RIGHT); BIOMICHROMES (INCLUDING FOLDOUT) BY JAMES P. BLAIR © N.G.S.

Microscopic view of a degraded river: Round *vorticellae* feed on bacteria teeming in sewage. Here, attached by slender stalks, they ride a dead micro-crustacean. To biologists the protozoa, common in the Cuyahoga, point to grossly polluted water.

Water can kill—when it carries cyanide away from a steel mill. These minnows died in less than seven minutes when placed in Cuyahoga River water. Thomas Braidech, aquatic biologist with the Federal Water Quality Administration, conducts the test.



Sad, soiled waters: the Cuyahoga River and Lake Erie

ONE of the Nation's most polluted streams, Ohio's Cuyahoga (foldout, left) became so covered with oil and debris that in July 1969 the river caught fire here in Cleveland's factory area, damaging two railroad bridges. Along this six-mile stretch, before emptying into Lake Erie, the river receives the wastes of steel mills, chemical and meat-rendering plants, and other industries. Just upstream, Cleveland and Akron discharge inadequately treated sewage. And from hinterland farms drain phosphate- and nitrate-rich fertilizers and poisonous pesticides.

The Cuyahoga flows into Lake Erie (above), mixing with effluent from the Detroit and Maumee Rivers. The flow, rich in nutrients, stimulates the growth of *Cladophora* algae, here brought up by the handful from shallow waters off South Bass Island. As the overfertilized algae die and decompose, oxygen essential to fish life is depleted. This successive enrichment and suffocation of the lake is called "eutrophication"—a process threatening many American waters.

Thus man disrupts the ecology, the delicate interrelationship of organisms—including himself—and their environment.

Mounting public concern and increasingly stringent laws offer some hope. The Federal Water Quality Administration coordinates enforcement of federal laws regulating municipal and industrial polluters. Five states whose waters drain into Lake Erie—Michigan, Ohio, New York, Pennsylvania, and Indiana—have embarked on a 1½-billion-dollar municipal sewage-treatment program for the Erie Basin, the largest such project yet launched.

(Continued from page 739)

breathing now in Washington, D.C., may contain sulphur from a Pittsburgh steel mill and carbon monoxide from a Chicago taxi, for this continent's weather patterns often send a river of polluted air flowing southeastward. Someone in Norfolk, Virginia, will be using this air again when I am finished with it.

Automobiles, factories, heating furnaces, power plants, trash incinerators—each adds to the problem, so control is difficult. Compounding that difficulty has been the diversity of agencies responsible for control. Until the President this year established a new Environmental Protection Agency, air-pollution control came chiefly under the Department of Health, Education, and Welfare, water pollution under the Department of the Interior, and land pollution under the Departments of Agriculture, HEW, and Interior.

Now virtually all pollution control is to be directed by one federal agency. But it will still be a complex problem, with much responsibility devolving upon state, county, and municipal governments.

The National Air Pollution Control Administration is in the process of dividing most of the country into air-quality control regions. When such a region is designated, states falling within it have about 15 months (450 days) to set air-quality standards that meet federal requirements, and to begin putting them into effect. National standards have already been established to control automotive pollution.

Hard Choice Faces Many Communities

Most states today are ill equipped to monitor the thousands of air-pollution sources within their borders. And, because corrective measures can be tremendously expensive, years may pass before a factory stops spouting black smoke. If a plant has polluted the air for fifty years, and is operating on a close budget—can we, in good conscience, make demands that will drive it into bankruptcy? On the other hand, can we afford to risk our health by continuing to breathe the smoke?

Valley towns, especially, can be smog traps. Missoula, Montana, is such a town. When a layer of stable lifeless air hovers overhead, it holds industrial haze and dust in the valley and gives Missoula an air-pollution intensity that rivals New York City's (pages 756-7).

And, of course, there is Los Angeles. "Smog City, U.S.A.," some call it (following pages). But the Angelenos have tackled their problem head on. Air-pollution regulations there are broader than those the Federal Government has formulated, and the regulations grow tougher year by year. Still, new residents pour into the city, bringing their automobiles. Los Angeles, like the Ruhr, is just managing to keep its smog density from rising.

If Los Angeles can't live without its automobiles and can't live with them, what is the solution? Electric cars?

I asked the question of Ralph K. Longaker, regional air-pollution control director.

"The electric companies would love that," he replied. "Their lowest demand for power is at night—and that, of course, would be the time when people would be recharging all those electric-car batteries. But there would be such a tremendous increase in electric-power requirements that many more generating plants would have to be built. Would all those power plants be less harmful to the environment than automobiles? At this point, we just don't know."

Killer Fogs Led to London's Air Cleanup

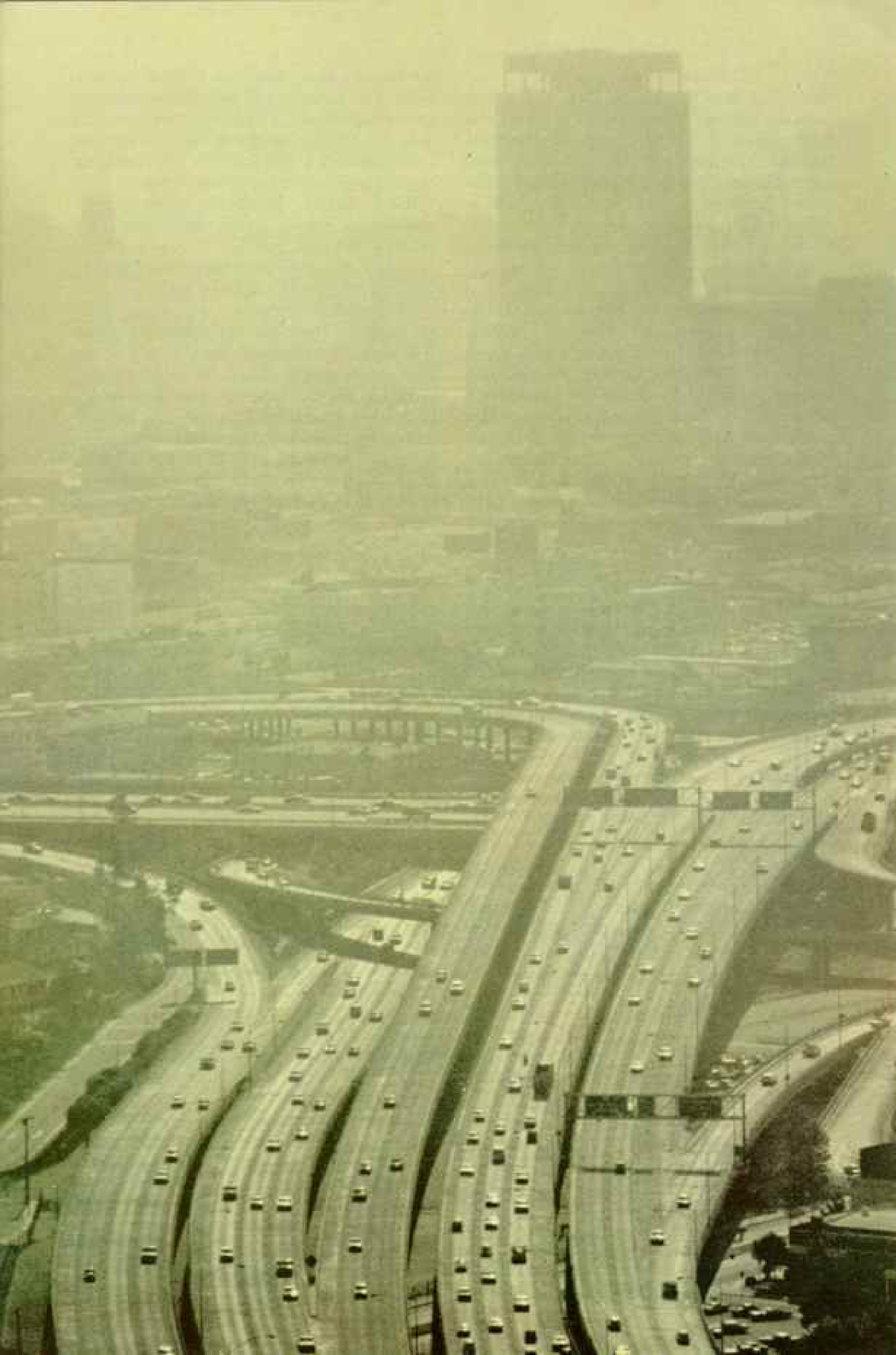
Twenty years ago London could have claimed the title "Smog City, Europe." Three-fourths of its smoke is gone now—a remarkable change triggered by a series of killer fogs in the late 1940's and early 1950's (page 778).

The worst of these settled over London on December 5, 1952. For four consecutive days the city's normal daily death rate of 300 more than tripled; in all, some 4,000 extra deaths that winter were blamed on the incident. More such fogs came in the winters that followed. Each took its toll.

In 1956 Parliament passed the Clean Air Act, decreeing that factories and homes in critical areas of the city must switch from soft high-sulphur coal to less smoky fuels: hard coal, gas, electricity, or oil. Inevitably there were economic repercussions, both to householders and to industries. But, with each passing year, London's air grew clearer.

I visited the city last spring and found it a spirit-lifting experience after passing through so many smog-blanketed cities. In St. James's Park, deck chairs were filled with tanning Londoners (pages 778-9).

London has proved that the veil of smog can be cast off, but its success story stands almost alone. In sunny Spain, Madrid has joined the ranks of shrouded cities. In Italy, acid from smog eats into centuries-old sculpture (page 752). And each rain here in Washington washes more acid onto our marble buildings and monuments.



Smog shrouds Los Angeles; Tokyo fights for breath

It's 9:30 on a June morning in Los Angeles (left), and the air hangs heavy with carbon monoxide, hydrocarbons, oxides of nitrogen, plus such particulate matter as soot, pollen, and dust. By noon the pall will be even thicker.

This witches' brew of pollutants, spewed primarily by automobiles, interacts with sunshine to produce still other noxious compounds. The product of this photochemical reaction is popularly termed smog. When an overlying layer of warm air—temperature inversion—traps the smog in the Los Angeles basin, eyes and throats become irritated; for those with respiratory diseases, the haze may menace life itself.

Paradoxically, Los Angeles has led the Nation in enforcing strict standards for industrial and residential emissions. But automobile exhausts have yet to be effectively regulated.

Whiffs of oxygen, dispensed in a streetside station, refresh a traffic policeman in smog-choked Tokyo. Pedestrians seek the same relief at vending machines. A blanket of smog last July sent more than 8,000 people to hospitals. Air pollution now afflicts almost every major city in the world, and many small ones.

EKTACHROME (ABOVE) BY EIJI MIYAZAWA, BLACK STAR;
KODACHROME BY JULIAN WASSER © N.G.S.

The massive struggle to clean our air began so recently that victory seems far off. But we have taken an important step—we realize we must do something. In the frequently quoted words of Pogo, Walt Kelly's cartoon possum, "We have met the enemy, and he is us."

One by one, the factory smokestacks stop gushing noxious smoke and gases—for it is easier to regulate one factory than it is to depollute ten thousand automobiles. But here in the United States, motor vehicles contribute nearly half our air pollution. A hundred and nine million exhausts spout carbon monoxide, oxides of nitrogen, lead, and a variety of hydrocarbons.

Tetraethyl lead, an additive to most gasolines, is an acknowledged poison, although experts disagree on the long-term effects of small amounts of lead in the human body. Primitive man carried about two milligrams of lead in his bones. Today's city dweller carries 50 to 100 times that amount—up to one-third of what many doctors consider dangerous.

While legislators frame stringent new laws, manufacturers redouble their efforts to develop more efficient emission-control devices and less harmful fuels.

What else can be done to reduce automobile pollution? Increased use of car pools and mass transit would help, say environmentalists. So, perhaps, would engines of more modest horsepower. Others feel such talk is defeatist, except as a short-term measure, and look to new technological advances for the answer.

Gasoline isn't the only fuel available. In San Francisco, I rode in an unusual car. Its engine burned propane, which gives off few pollutants. At least thirty colleges and a number of industrial firms are trying to develop low-pollution engines powered by steam, electricity, or natural gas (page 762).*

Jet Planes Spew Tons of Water

No type of air pollution is more evident than the dark streaks trailing jet airliners. By 1973 this jet smoke will virtually be gone, for airlines are modifying their engines. But jets also spew less visible pollutants. And another contribution to environmental change is, strangely, water vapor. Burn a ton of jet fuel, and you produce 1¼ tons of water; the hydrogen in the fuel combines with oxygen from the atmosphere.

Some meteorologists think this has resulted in an increase in cloud cover—and a corresponding reduction in the amount of solar energy reaching the earth—since jet aircraft began to fly in the 1940's. The increase thus far has been estimated at as high as 10 percent, but no one yet knows whether it will prove harmful, nor has the effect on the world's rainfall been determined.

The much-discussed supersonic transport raises further important questions. Public controversy has focused on two points—economics and broken windows. But

(Continued on page 753)

*See "The Coming Revolution in Transportation," by Fredric C. Appel, in the September 1969 GEOGRAPHIC.

Like a canary in a coal mine, vegetation reacts with greater sensitivity to bad air than does man. Ozone, a toxic component of photochemical smog, severely damages half the ponderosa pines in the San Bernardino National Forest, 60 miles east of Los Angeles, according to Dr. Paul R. Miller (far right), U. S. Forest Service pathologist. Ozone-injured needles turn a mottled yellow, then brown (right). The weakened pines fall prey to pine-bark beetles, whose tunnels girdle the inner surface of the bark, killing the tree.

Close-up of polluted air: Particles spewed from factories and automobiles, enlarged 20,000 times, speckle this photomicrograph of Los Angeles smog. The average—one billion particles per cubic foot of air—is ten times the concentration on clear days. Engineers designing control devices use such samples to understand their problem. Average particle density has not increased appreciably in 15 years, but the area afflicted by smog has spread.

DEPARTMENT OF ENGINEERING AND APPLIED SCIENCES, UNIVERSITY OF CALIFORNIA, LOS ANGELES (BELOW); ASSEMBLED BY JAMES P. BLAIR © N.G.S.

DETACHROME (ABOVE) AND KODACHROME BY JAMES P. BLAIR © N.G.S.

Culprit and victim—man himself. The growing world population makes increasing demands on the planet's fixed supply of air, water, and land, especially when people concentrate in cities. On New York City's Nassau Street (opposite) in the financial district, the press of lunch-hour crowds prompted the city to ban auto traffic for three hours a day. Crowded tenements near 143rd Street fill an alley with trash (above). Although the population in the United States has increased only 1 to 1½ percent annually in recent years, low by world standards, its citizens demand more and more electricity, water, and goods, and consume a third of the minerals the world uses. Thus they produce more waste—an average of six pounds per person per day.


STREET
CLOSED
HAIRCUT

scientists point to the fact that the stratosphere—cruising level of the SST—has little vertical interchange of air. Pollutants there tend to remain in suspension longer, and water vapor might have even greater cloud-making capabilities.

What will be the total effect of the SST on our environment? We can't be sure. Military supersonic aircraft have not been numerous enough to give us answers. There is still so much that we don't know!

Rivers Overwhelmed by Man's Wastes

Each morning in Washington, I drive to work across the Francis Scott Key Bridge, high above the Potomac River. Traffic often stops me there—Key Bridge has justly been called "the car-strangled spanner"—so I have time to look around.

Seemingly I'm poised between past and present. Upstream the river is tree lined and peaceful, looking much as it must have looked two hundred years ago. But the downstream view is more modern. Industry lines the northern bank, squatting low beneath the Whitehurst Freeway. Farther down, Washington's skyline is veiled in the mists of morning traffic fumes. A jetliner sweeps down to land at National Airport.

I prefer the upstream view, but even there the Potomac's beauty is only surface deep. The river lost its purity many years ago. In December 1897 an article titled "Pollution of the Potomac River" appeared in THE NATIONAL GEOGRAPHIC MAGAZINE. Its author's conclusion was this: "Until state or national legislation can be secured to regulate such matters, the Potomac . . . must serve as a sort of sewer into which towns and manufacturing establishments empty their refuse."

Why have so many of America's rivers become casualties as the country grew? Shortsightedness? Not at first. When only a few settlements dotted a river's banks, the sewage that poured in caused little harm. The organic wastes were recycled into nutrients that nourished the tiny forms of life that fed the fish. The river purified itself before it reached the next settlement.

What village could resist using such a convenient disposal system? Pour sewage in, and it disappeared downstream.

Then villages grew into towns. The river reeked a bit on hot summer days, but townspeople knew that the tainted water soon would be disappearing into the "boundless" sea. The answer to pollution was dilution.

Most towns today remove at least some of the sewage before pouring the wastes into the rivers. Primary plants settle out about a third of the solid matter. More-sophisticated treatment plants add a second step, using bacteria to convert the remaining organic material into inorganic nitrates and phosphates.

But even this disrupts the river's cycle. The "purified" water is too rich in these nutrients. Detergent wastes add more, and so do the fertilizers that wash in from farmland.

Nitrates and phosphates are food for the water plants such as algae. In the overnourished river, too many algae grow (pages 743-4). But algae need sunlight to live. When the algae layer becomes too thick for light to penetrate, the deeper-lying algae die and sink to the river bottom in a thick brown soup. Oxygen is consumed by the decaying algae, making the water uninhabitable by fish.

Thermal pollution, too, afflicts our rivers. When power plants gulp water to cool their steam generators, they return it warmer than before. A temperature rise of just a few degrees can disrupt the breeding habits of fish, "cook" some of the oxygen out of the water, and increase algal growth.

Industrial chemicals pour into rivers. Pesticides wash in from farm fields. Petroleum products from marine engines and industrial spillage coat the surface, inhibiting the river's oxygen intake. Ohio's oily Cuyahoga River (pages 740–42) actually caught fire last year and burned two railroad bridges.

(Continued on page 758)

Stone cancer spreads across a marble Madonna carved about 1650 beneath a buttress of the Cathedral of Milan. Here in Italy's industrial center, as in many world cities, the burning of high-sulphur coal and oil generates sulphur oxides. Deposited on stone, they combine with rain water to form sulphuric acid. The highly reactive fluid produces a chemical change in the stone, eventually disintegrating it under prolonged exposure. The acid has not remained long enough on the lighter areas to damage them severely. Such destruction threatens many of man's noblest monuments, from the gargoyles of Notre Dame de Paris to the Lincoln Memorial.

PHOTOGRAPHED BY JAMES P. BLAIR © N.G.S.

Oil fouls troubled waters

"THE BIRD WAS DOOMED," said noted ornithologist Dr. Alexander Wetmore of this western grebe, swimming through an oil slick caused by an offshore well blowout near Santa Barbara, California, in early 1969. "The oil so damaged his feathers that human help would be of no avail."

Raw petroleum gushes like a geyser from a drilling platform off Louisiana (above). The spill occurred last March after a fire that raged out of control for a month.

The oil companies responsible spent millions to clean beaches, birds, and water. But the disasters dramatize man's increasing abuse of the sea. Harbor spills and bilge cleaning at sea release millions of gallons of oil. Power plants discharge hot water, and cities dump sewage. Such alien agents disrupt life cycles along the continental shelf, spawning ground of most ocean life. Secretary of the Interior Walter Hickel warns, "The future of our environment is at stake in these offshore areas."

KODACHROMES BY NATIONAL GEOGRAPHIC PHOTOGRAPHERS BRUCE DALE (ABOVE) AND JAMES P. BLAIR © N.G.S.

KODACHROMES BY DR. CLARENCE C. GORDON (ABOVE) AND JAMES P. BLAIR © N.G.S.

Clearing up Big Sky country

TEMPERATURE INVERSION holds down odorous particle-laden vapor billowing from a large Montana paper mill on July 20, 1969; prevailing winds fan the haze through the valley toward Missoula, ten miles to the east, where it mingles with smoke from smaller industries and dust from fields.

Upset about pollution from all sources, Missoulians supported the state's Clean Air Act of 1967. To see that it was enforced, local women organized GASP—Gals Against Smog and Pollution. Their picket line at the paper plant (right) was only one pressure technique. They wrote to their representatives, sponsored lectures, and questioned public officials at open forums. Editorial-page editor of the *Missoulian*, Sam Reynolds (left), campaigned "for results."

Industries cooperated. Incorporating new technology, the paper company is spending $13,500,000 on modifications to meet state standards by 1972.

"**The public has great power,** but because of apathy or fear of economic pressure, all too often it doesn't speak out," says Mrs. Marilyn Templeton. A co-chairman of GASP, she encourages the forming of antipollution groups elsewhere.

PHOTOGRAPHS BY DR. CHRIS FIELD AND JAMES P. BLAIR (ABOVE) © N.G.S.

Lakes can be even more vulnerable than rivers. Witness Lake Erie, second smallest (after Ontario) and shallowest of the five Great Lakes. No body of fresh water in the country has received more attention than Erie, a lake dying of too much nourishment.

"Lake Erie is suffering from eutrophication," I was told by Francis T. Mayo, Great Lakes Regional Director of the Federal Water Quality Administration. "That word comes from the Greek *eutrophos*, meaning 'well nourished.' A lake becomes overnourished as part of its normal aging process, but man accelerates the process tremendously by pouring in nutrients and industrial chemicals."

When I asked if Lake Erie could be saved, he nodded. "It *has* to be saved. Nobody can afford to write it off."

But salvation comes hard, I learned. Many industrial plants and municipalities around the lake must change their ways. The tributaries that flow into the lake must be cleaned up—including the inflammable Cuyahoga River. Sewage plants must be upgraded, and agricultural runoff must be controlled.

"Nitrates are very difficult to remove from sewage water," Mr. Mayo said. "About 80 percent of the phosphorus can be taken out chemically, though, and that should hold down algae. Once the pollution stops, Erie should begin to clean itself. Its flushing time is only three to five years—that's the time it takes to replace all its water."

If three to five years seems long, consider Lake Michigan's flushing time: one century! The lake's only outlets are the slow-moving Chicago River and the Straits of Mackinac. Thus Michigan rates special concern from Mr. Mayo and his associates. The lake's pollution load is light—by Erie standards, at least—but any pollution is bound to be there for a long, long time.

Tahoe's Sewage Water Fit to Drink

At an environmental conference in Washington last spring, I was given a glass of water to drink. I sipped with some misgiving, for it was the end product of a sewage plant.

There was an amused glint in the eyes of Frank Sebastian (page 774) as he watched how slowly I tilted the glass. Mr. Sebastian is Senior Vice President of Envirotech, a California corporation that makes, among other things, tertiary sewage-plant equipment.

"It's purer than the water that comes from your faucets at home," he said comfortingly.

The water—which tasted like any other

RESEARCHERS BY JAMES P. BLAIR © N.G.S.

Sexual trickery may lead to the downfall of the cabbage looper, a major farm pest. Entomologists at the University of California, Riverside, have learned that when the odor of the female moth is spread over whole fields, males become too confused to mate. Oscilloscope (above) records this male moth's response to the female aroma. Federal and state governments are pushing development of biological controls as alternatives to pesticides that threaten wildlife.

How DDT can affect birds: Mallards at the U. S. Government's Patuxent Wildlife Research Center in Maryland were fed DDE, a breakdown product of DDT, in concentrations now common in the wild. They laid thin-shelled eggs, subject to hairline cracks (below). On an average, as this exhibit dramatizes, three eggs in a clutch of 12 were cracked or crushed by the mother. Eight others failed to develop, and only one hatchling, rather than the usual 9 to 11, emerged alive.

Household pesticides provide the theme for a conservation lecture at Pioneer High School, Ann Arbor, Michigan; the state enacted the first general ban on DDT. Some bug killers contain "hard," or long-lasting, poisons such as DDT, dieldrin, heptachlor, aldrin, and endrin, which build up in the fatty tissues of animals and persist in the environment for years. Instructor John Russell, displaying a random selection, recommends checking contents by reading the labels to avoid the more dangerous products.

water—came from the sewage plant at South Lake Tahoe, California (pages 774-5).

Beautiful Lake Tahoe has long been known as one of the purest lakes in the world, but the number of tourists and residents on its shores has skyrocketed in the past two decades. Increasingly, Lake Tahoe was losing the purity that made it so attractive. But for once something was done in time.

"Even secondary sewage treatment wasn't enough," Mr. Sebastian said, "so more modern tertiary equipment was installed."

Although the nutrient content of the output water is low, it is not discharged into Lake Tahoe; instead, it is pumped 27 miles into another drainage basin. Dr. Charles R. Goldman, of the University of California, explained why. He is one of the Nation's leading limnologists—lake experts.

"Lake Tahoe has very little flushing action," he told me. "Its 37½ cubic miles of water are nearly permanent. We just can't add any nitrates and phosphates unnecessarily—even that sewage water. It would aggravate the lake's algal problem."

Algal problem? To me, Lake Tahoe looked as clear as blue crystal. Where were the algae getting their nutrient?

Dr. Goldman reminded me of construction I had seen around the lake. "If all that bulldozing isn't done very carefully—and often it isn't—topsoil washes into the lake during rains. Nutrients wash in with the soil."

We walked down to the shore. Dr. Goldman felt down between underwater rocks and came up with a handful of green strands.

"There is a lot more of this than there used to be," he said. "The lake is still clear enough for sunlight to penetrate about 300 feet and sustain plants down there. If it clouds over with algae or silt, its life-sustaining ability will be greatly reduced."

When residents of Seattle, Washington, head for the water—and most of them do at every opportunity—they have a choice. Puget Sound stretches along the city's western edge, 20-mile-long Lake Washington on the east.

That lake is important to the people. Ten years ago it was on its way to Lake Erie's fate. Inadequately treated sewage gushed in. A green scum could be seen on the lake's cloudy surface, and the unpleasant stench of dead lake life was hard to ignore on a hot summer day.

Puget Sound was in trouble, too, for seventy million gallons of raw sewage from the Seattle area poured in daily.

In September 1958 the citizens voted Metro into existence—the Municipality of Metropolitan Seattle—to solve the problem. Four up-to-date sewage plants were built, replacing 28 old ones. It was expensive but worthwhile. Discharge of treated wastes into Lake Washington has ended entirely. Output

EXCHROME BY JAMES P. BLAIR © NATIONAL GEOGRAPHIC SOCIETY

of raw sewage into Puget Sound has virtually stopped.

I asked Charles V. Gibbs, Metro's director, whether the lake had recovered.

"Salmon and steelhead trout are coming in from Puget Sound in increasing numbers, and crossing Lake Washington on their way to spawn upriver," he said. "Where else in this country can you catch salmon and trout in the middle of a city?"

"Boundless" Seas Are Polluted, Too

A lake, with its clearly defined boundaries, fits comfortably into the human mind. We have no trouble thinking of it as a "thing." And if a thing is damaged, we feel that it can be fixed.

But now we realize that our oceans—those "boundless" seas that cover nearly three-quarters of the planet—are in trouble, too.

"Man puts at least three million tons of oil a year into the oceans," Dr. Max Blumer, of Woods Hole Oceanographic Institution, told me. "The yearly total may run as high as ten million tons, which doesn't include tanker wrecks, such as the *Torrey Canyon* disaster, or production accidents like those off Santa Barbara and Louisiana, either" (pages 754-5).

Astounding statements, I thought. But Dr. Blumer is not a man to make extravagant claims for the sake of sensation. He is a senior chemist at Woods Hole.

"Unfortunately, most of the spillage happens in just the wrong places," Dr. Blumer said. "Spills occur in the coastal waters, where marine productivity is concentrated."

Like most laymen, I had thought of oil spills in terms of blackened beaches and dying sea birds. Dr. Blumer assured me that the effects were much more far reaching.

Car of the future may be driven by a turbine, according to George Huebner, Chrysler Corporation's Director of Research, here holding an engine's vaned compressor. The turbine engine burns hydrocarbons more completely and produces less carbon monoxide than a piston engine. Neither as yet effectively controls nitrogen-oxide emissions. Also undergoing tests are cars powered by liquefied natural gas, electricity, and steam. For the present, manufacturers are developing pollution controls on conventional engines to meet increasingly rigorous federal emission standards.

"We know more about oil's toxic properties now, because a spill near here—160,000 to 175,000 gallons of number 2 fuel oil—has turned out to be something of a lab experiment in oil pollution and its aftermath."

The spill occurred September 16, 1969, off West Falmouth, Massachusetts. Three days later oceanographers trawled the area. Ninety-five percent of their catch was dead, and the rest was dying.

"Now, a year later, bottom life is still being poisoned," Dr. Blumer said. "Toxic substances in the oil have entered the sediment. They seep out and spread with the current. Even after the poison has been diluted a thousand times, it kills shellfish. Where it doesn't kill, it gets into their meat—and it will persist there as long as they live."

More than two million tons of oil a year, Dr. Blumer estimates, come from tankers that flush out their tanks at sea (local laws prevent their doing so in port) and from vessels that pump out oily bilge water. All too often, their wastes drift ashore to foul beaches.

But Dr. Blumer and others are perfecting techniques that "fingerprint" oil—tell exactly where the oil came from. The day may come when the careless voiding of oil at sea can be traced to a specific ship, and the captain or owners charged with negligence.

In March 1967, when the tanker *Torrey Canyon* went aground off the British coast, 110,000 tons of oil spilled out. I asked Dr. Blumer what measures could be taken to clean up a huge oil slick of that kind.

"Speed is essential," he said, "since the most toxic elements dissolve quickly into the sea water. If the oil can be pumped into air-dropped bladders or into another ship . . . fine. If not, burning is probably the best answer, though that causes air pollution, of course. Containing booms haven't worked out well. Detergents or dispersants may get the problem out of sight, but they do it by sinking the oil down into the marine environment, where it can do more damage."

We talked of the oilman's new frontier, the Arctic.* "A spill up there would be very bad," Dr. Blumer warned. "Degradation of the oil would be slow in that cold climate, so toxic effects would last longer. Another factor worries me even more, though. Most organisms in the Arctic ice areas are dependent on the top few inches of ocean under the ice—it's the only region where solar energy penetrates to an appreciable degree. If an oil tanker ripped its bottom open, the oil would float in that top few inches of sunlit water."

DDT—Boon and Hazard

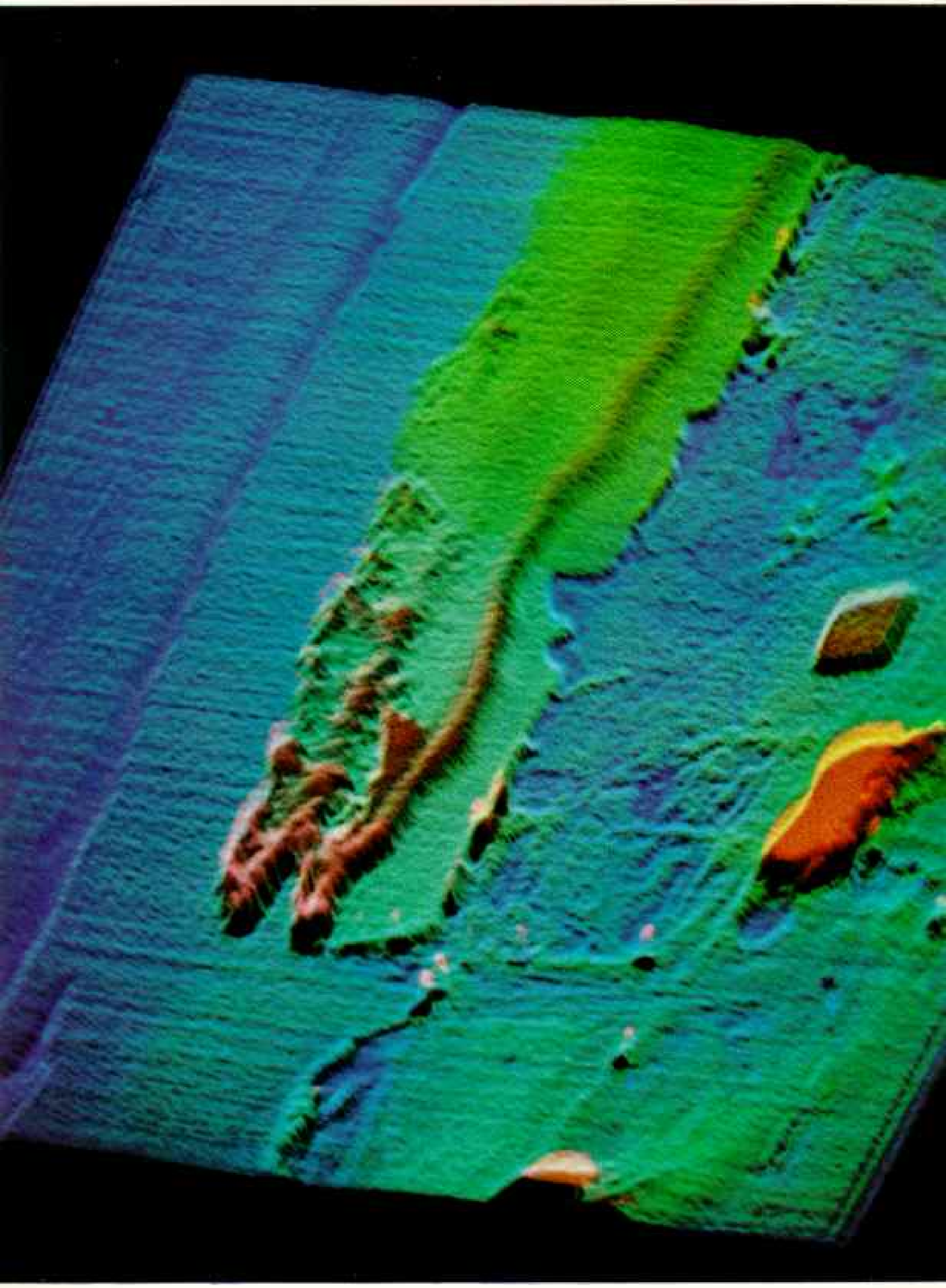
In 1874 a German chemist named Othmar Zeidler created a new compound. Its jaw-breaking name was dichloro-diphenyl-trichloroethane. We know it as DDT.

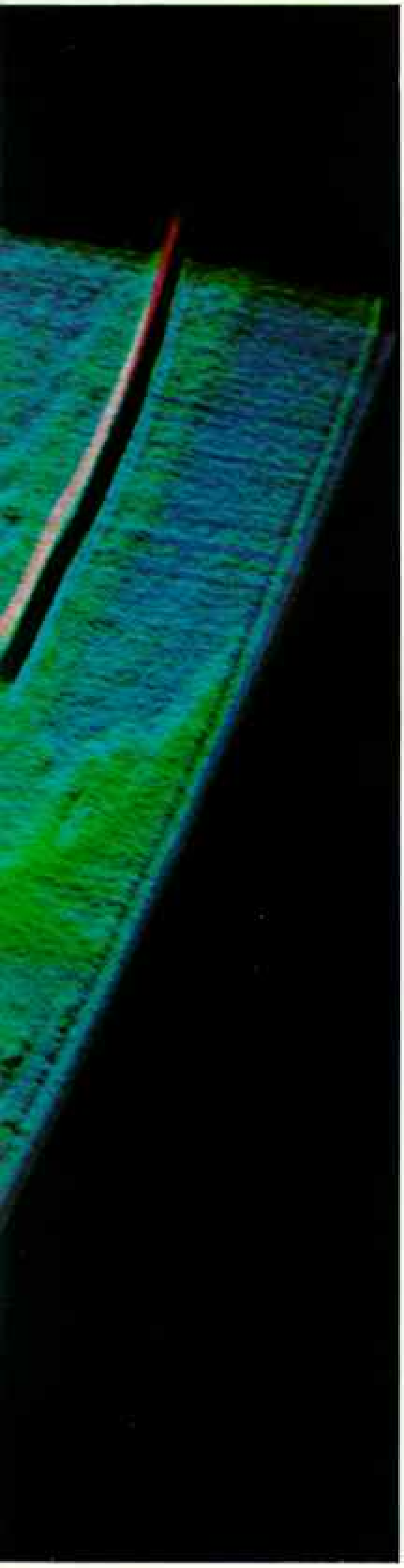
Dr. Zeidler was unaware that he had found a potential insecticide. Sixty-five years passed before the insecticidal properties were recognized—just before World War II.

*See "North for Oil," by Bern Keating, NATIONAL GEOGRAPHIC, March 1970.

KODACHROME BY JAMES P. BLAIR © N.G.S.

Eyes smarting from smog, a volunteer responds to various mixtures of polluted air. Tests conducted by the National Air Pollution Control Administration's laboratories in Cincinnati, Ohio, show that aromatic hydrocarbons, olefins, and aldehydes—all products of gasoline combustion and evaporation—form eye irritants in the atmosphere. Miner's mask protects nose and lungs.





DDT was used extensively during the war, against mosquitoes and body lice, with great success. And thousands upon thousands of tons have been used since then, on forests, on farms, and to control household pests. Many an area has been freed at last from malaria.

But one of the compound's most attractive features—the fact that it remains active long after application—has had unpleasant ramifications, too. In the past decade it has become increasingly evident that creatures in water, in air, and on land—including man himself—have built up concentrations within their bodies. Sharp reductions in numbers of ospreys and other birds are attributed to DDT and its derivatives (pages 758-9).*

The pesticide has traveled through the ocean chain. Even penguins in the Antarctic, where DDT has never been used, have accumulated traces of the compound.

Another senior scientist at Woods Hole Oceanographic Institution, biologist Dr. H. L. Sanders, told me more about the problem.

"It has become apparent that DDT and the other chlorinated hydrocarbon insecticides aren't selective. They are toxic to many forms of animal and marine life. When a fish eats food organisms contaminated with the insecticides, the compound builds up in its fatty tissues. When a larger fish eats him, that predator will end up with the insecticide."

*See "The Osprey, Endangered World Citizen," by Roger Tory Peterson, NATIONAL GEOGRAPHIC, July 1969.

ACKNOWLEDGMENTS © N.G.S.

Red means hot! A color-coded three-dimensional heat picture (left) shows how heated water from the Atomic Energy Commission's Hanford plutonium-producing plant flows into the Columbia River near Richland, Washington. The AEC uses such remote sensing as part of its long-range studies of the effects of hot water on river ecology.

In the heat image, which covers much of the area shown above, steaming tanks of water that cooled a reactor glow orange. Square pond and long trench also receive the coolant. Submerged pipes discharge in midriver, where warmest surface temperatures show as red mountains that flatten into a green plateau amid the blue and purple of cooler water.

Dr. Sanders is also concerned about another group of toxic chemical compounds—the polychlorinated biphenyls, called PCB's.

"The PCB's have been around for 25 years or so," he told me. "But, until recently, we weren't too conscious of them. They are used in the manufacture of plastics, paints, and a great many other things—so they're present in a lot of the industrial waste that ends up in our rivers and oceans. When scientists began analyzing fish samples in a chromatograph to track DDT through the food chain, PCB's kept showing up.

"We've found that they act on marine life much as DDT does, traveling through the food chain. Their toxic effects, alone or in combination, are still largely unknown. Research is just beginning."

I left Woods Hole with a new attitude about those boundless seas of ours.

Last year Americans threw away 50 billion empty cans, 30 billion glass containers, 4 million tons of plastics, and more than a million television sets. Where did it all go?

Into the ground, mostly, in open dumps or into "sanitary landfill." Incineration posed problems: Much of the refuse was unburnable. Also, some burning plastics produce toxic smoke, plus fumes that damage an incinerator's pollution-trapping devices.

Trash Mountain Provides Ski Slopes

Landfill poses problems, too. Leaching chemicals sometimes pollute ground water. Rotting garbage can generate methane gas. Dumping sites for a city's trash are getting more and more difficult to find.

Du Page County, Illinois, just west of Chicago, is trying out a creative solution. Its people are turning a mountain of refuse into a

recreational asset. Each day's collection of garbage and trash is spread, tamped firmly, and covered by a six-inch layer of gravel and clay, which controls decomposition and unpleasant odors. So, layer by layer, the hill grows. By July 1971, it will be capped with more clay and soil and, rising some 120 feet, will stand as the highest elevation in the county. Six toboggan runs and five ski slopes will weave down its sides.

Even a garbage-filled mountain must be named. Locally it's called "Mt. Trashmore."

What can be done to reduce the astronomical number of discarded cans and bottles? In a number of U. S. cities, the Reynolds Metals Company is buying back aluminum cans for melting and re-use. Returnable bottles are becoming more popular with conservation-minded housewives—for each one reduces trash-disposal problems by making some 20 round trips in the course of its useful life.

I saw an intriguing answer to the bottle problem in Stockholm, Sweden. It was a plastic beer bottle that would gradually turn to dust after it had been drained and discarded. Sunlight's ultraviolet rays work the transition. U. S. and other scientists are working on similar bottles that would break down in sunlight and dissolve in water.

Consider, now, the nine million cars that currently are disposed of each year. Many of them are simply abandoned on the streets —150 a day in New York City alone—and the cost of hauling them to junkyards puts a heavy financial burden on city budgets.

Suppose a form of "bottle deposit" were added to the car's original price. As the car passed from owner to owner, each one would pay the deposit—say, $50—and recoup it when he sold the automobile. The final owner would be less tempted to abandon the car, for only by turning it in at an accredited collecting station could he get his deposit back. The funds would be placed in trust and the interest used to recycle worn-out cars back into their basic raw materials.

Among other early proponents, Dr. Conrad L. Wirth, former Director of the National Park Service, made such a suggestion years ago. Senator Jacob K. Javits, of New York, has proposed a similar idea in a bill now before Congress.

Even atomic scientists are working on the trash problem. Their incinerator would be a "fusion torch"—using controlled thermonuclear fusion to generate temperatures of millions of degrees. The incredible heat would vaporize trash, reducing it to its basic elements, such as iron, copper, or silicon, for re-use—the ultimate in recycling.

Environmental pollution is not exclusively a city problem. At Cornell University in Ithaca, New York, ecologist Lamont Cole told me about problems down on the farm.

KODACHROME © N. G. S.

Public outcry halts an airport: Forty miles west of Miami this wilderness runway, developed at a cost of $15,500,000, marks the first stage of a proposed international jetport. But the facility, which would attract a large support community, lies within Big Cypress Swamp, a major water source for Everglades National Park. Thousands of concerned citizens wrote to federal officials, who halted the project. The runway is now being used by airlines for take-off and landing practice.

"My grandfather was an Illinois prairie farmer," he said. "Granddad rotated his crops: every few years he'd grow alfalfa or red clover and plow it under to replace the humus and nitrogen in the soil. He used lime, but I doubt if he ever bought any artificial fertilizer. After harvesting a crop, he'd turn his animals into the field, and they'd fertilize it.

"Things are different now. Land out there is so valuable that farmers feel they can't afford to do anything except grow corn on it every year, using chemical fertilizers to boost the yield. But unfortunately those chemicals tend to leach out and add to our problems in rivers and lakes."

I asked Dr. Cole if manure was obsolete.

He smiled. "Nowadays, it's more of a problem than it is a fertilizer. You don't turn cattle out into the field any more. You herd them into feed lots, and bring the feed to them. You wind up with a manure disposal problem in the feed lot and a shortage of organic fertilizer in the fields." *

What should be done? Dr. Cole shrugged. "It seems to me that it would make a lot of sense to get more animal manure back into the fields, where it can do good instead of winding up as a pollution problem. I'd like to see the humus content of the soil built up again, by crop rotation and plowing under clover or alfalfa now and then. It would stop the fertilizers from leaching out so rapidly."

First Need of All: Population Control

Dr. Cole made another point. I'd heard it made before by virtually every ecologist I had interviewed.

"One of our basic errors," he said, "is that we always equate growth with goodness. Everything has to keep growing—the population, the cities, the industries. We have to stop growth somewhere. And, if we don't stop the population explosion, there's very little chance of solving our other problems. It's the key to the whole thing.

"We have to recognize that we're dealing

*See "The Revolution in American Agriculture," by Jules B. Billard, NATIONAL GEOGRAPHIC, February 1970.

KODACHROMES BY JAMES P. BLAIR © N.G.S.; LOUISIANA STATE UNIVERSITY (BELOW)

with systems," he continued. "For example, the World Health Organization went into Ceylon with pesticides to knock down the high mortality rate from malaria. It did a very good job of it. But its success has also contributed to Ceylon's severe overpopulation problem and strained economy.

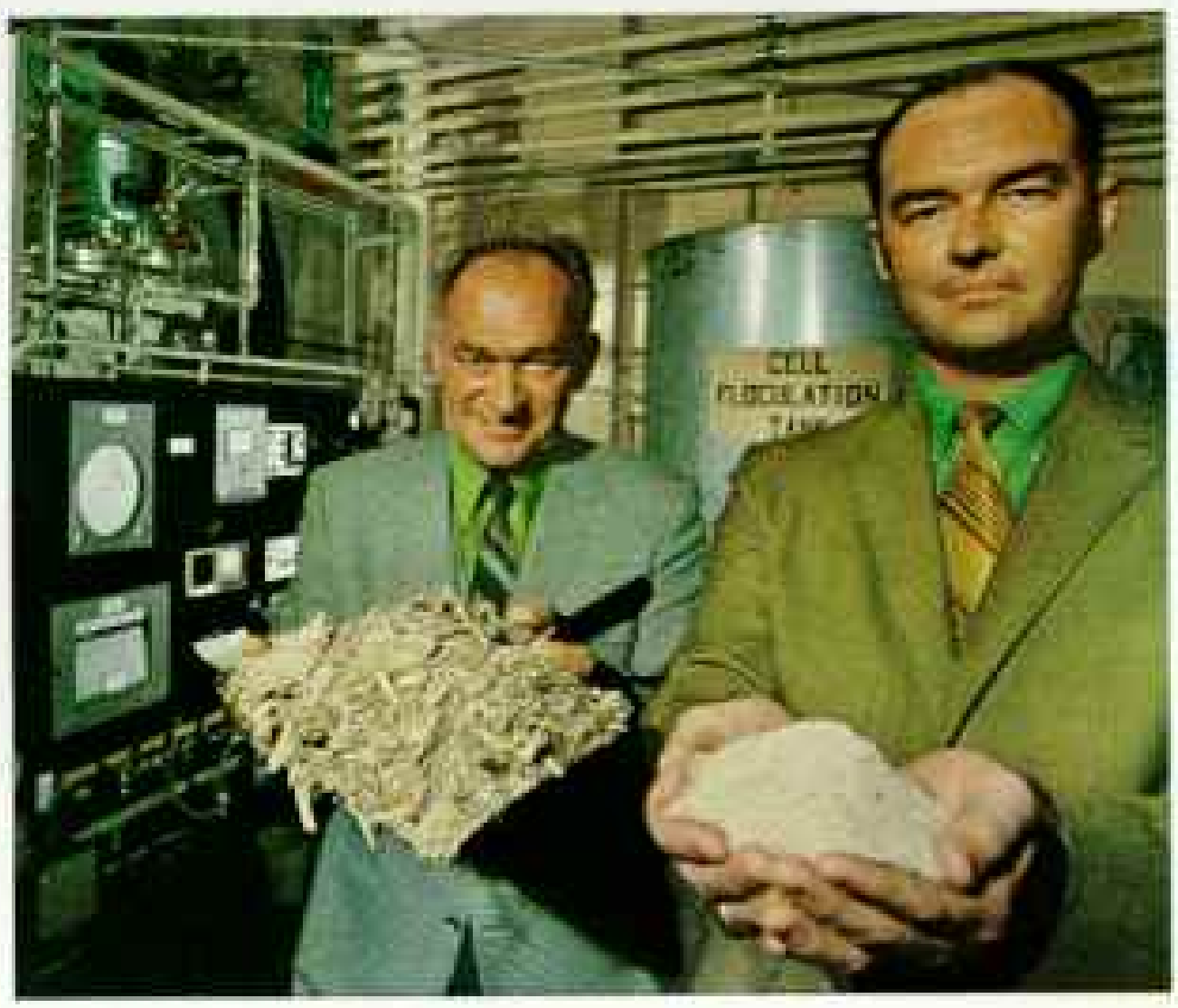
"The human race," the ecologist continued, "may be in even more trouble than we think. Very possibly, man won't know he has passed the point of no return until it's too late."

A horrible idea! I asked him to explain.

"Life depends on quite a few microorganisms doing their job," Dr. Cole replied. "For example, at least six types of bacteria in soil and water are absolutely essential to keep nitrogen circulating from air into organic material, then back to the air again. If any of the bacteria stopped working, nitrogen in the atmosphere would be depleted—or possibly replaced by ammonia."

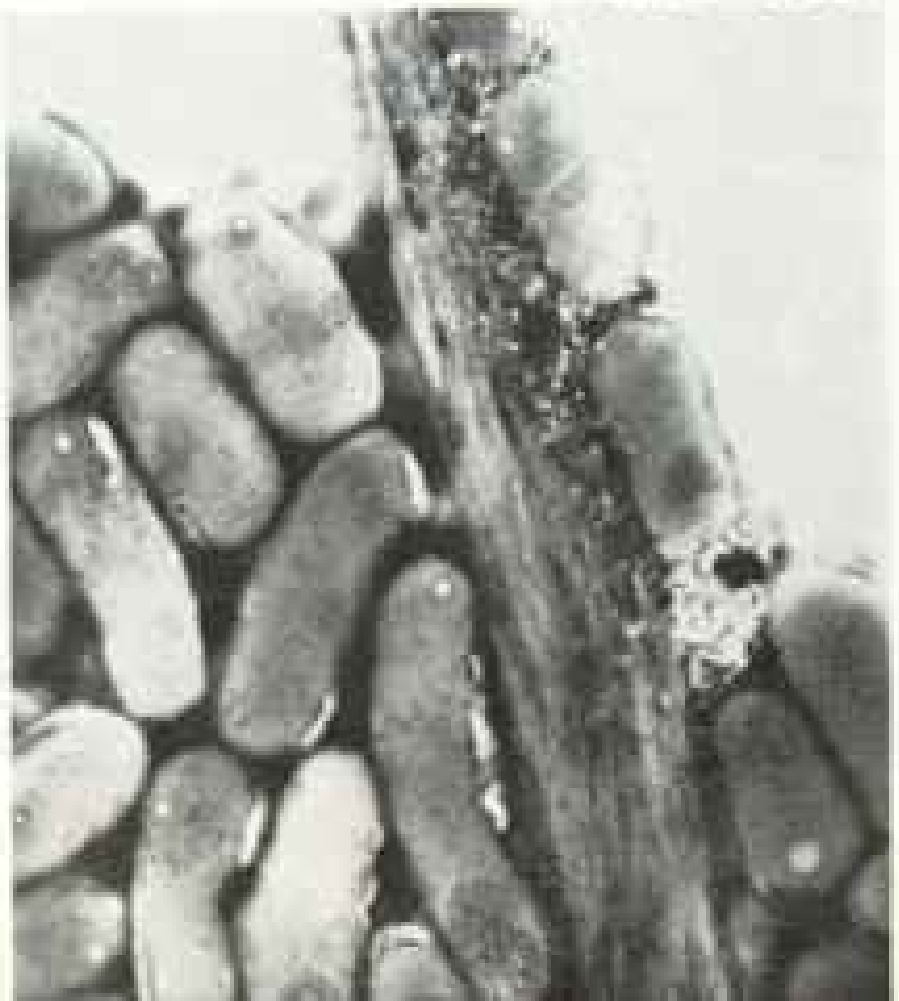
He shook his head slowly. "We're playing a kind of Russian roulette. We keep pouring new chemicals into the environment without

Energy from trash: Utilizing garbage and rubbish from Frankfurt, Germany, the suburb of Nordwest Stadt burns 700 tons of it a day in an incinerator beneath the towering stack. Water tubes in furnace walls generate steam that produces light and heat for 40,000 people. Electrostatic precipitators prevent escape of fly ash. More than 15 cities in Europe, North America, and Japan use similar operations.



And food from waste: At Louisiana State University, engineers have put the oblong bacterium *Cellulomonas* (below) to work gobbling up bagasse, or sugar-cane residue. Dried, the organisms contain 50 percent protein. Five pounds of bagasse held by Dr. Clayton D. Callihan (above, left) produce one pound of protein meal displayed by Dr. Charles E. Dunlap. Tests on farm animals suggest its use as a human food additive as well. The process could consume any cellulose—even city paper trash.

20,000 TIMES LIFE-SIZE

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KODACHROME BY JAMES P. BLAIR © N.G.S.

testing to see what effect they'll have. If one or a combination of them should ever poison the nitrifying bacteria on a worldwide scale, the air would become unbreathable."

Nuclear power-generating plants produce only small amounts of radioactive wastes. But hot wastes resulting from the production of atomic weapons—that's another matter. Usually the material is encased in steel-and-concrete tanks buried in clay, to keep radioactivity out of the ground water. "There are millions of gallons of the stuff in storage depots near Richland, Washington, and Aiken, South Carolina," Dr. Cole told me. "Some of it is so radioactive that it boils and must be artificially cooled."

He rubbed his forehead wearily. "That's quite a legacy to leave our unborn generations. We'll have to tell them to keep close watch on the liquid, and to change the tanks when they begin to leak—and keep at it for the next six to ten centuries!"

Atomic scientists are trying to avoid passing that legacy on. They have succeeded in solidifying some of the hot wastes for burial—about 20 percent of the total, thus far.

What about nuclear power plants? Do they pollute the air with radioactivity? I asked the question of Mr. Harlan K. Hoyt, superintendent of Commonwealth Edison's Dresden Nuclear Power Station, 55 miles southwest of Chicago, Illinois.

"Some radioactivity is present in our stack gases," Mr. Hoyt said. "But if you lived at the fence line downwind of that stack, you would absorb only one-twentieth as much radioactivity in a year as you would get from one chest X-ray."

But environmentalists worry about *any* increase in atmospheric radioactivity, and note the growing number of nuclear power plants. When man takes something from his planet, they point out, there may be hidden costs involved. A town lures a new industry by allowing it to contaminate the local river. A jet speeds 150 people across the country, and cloud cover may increase imperceptibly.

"We ecologists have a word for bargains

Visual pollution: A jungle of distracting signs, compressed by a telephoto lens, dwarfs a lone bench-warmer on U.S. Route 1 in North Miami, Florida. Such on-premise advertising—not controlled by federal legislation—as well as billboards, utility poles, junkyards, and automobile graveyards, mar the roadsides of America.

like those," Dr. Cole said. "We call them trade-offs. Often the bargains are bad ones."

He paused, searching for the best example. "Take the Aswan High Dam on the Nile," he said. "It was put there to expand irrigation, to generate electricity, and to control the annual flooding of the Nile Valley. Actually, those floods had helped keep the farms productive by fertilizing the land with silt. The dam has virtually ruined a sizable sardine fishery along the Nile Delta, because the nutrient supply has been choked off. The catch has fallen from 18,000 tons a year to less than 500 tons. And there's another problem, too: Snails are spreading through the irrigation ditches, carrying the debilitating disease schistosomiasis."

If Lamont Cole seems to take too jaundiced a view of man's attempts to conquer nature, be assured that he has much company among his ecologist colleagues. Dr. Barry Commoner, Director of the Center for the Biology of Natural Systems at Washington University in St. Louis, Missouri, sums up the matter in speeches on college campuses. Dr. Commoner's three laws of ecology are these: (1) Everything is connected with everything else. (2) Everything goes somewhere. (3) There is no such thing as a free lunch.

Innovations Can Backfire

"It's time that we scientists begin making sure we've asked all the right questions," Dr. Donald W. Aitken said to me in Palo Alto, California. Dr. Aitken is chairman of environmental studies at San Jose State College.

"Too many times, some technological or engineering advance is conceived and immediately implemented, and ends up having harmful side effects," he continued.

Dr. Aitken cited the Welland Canal as an example. "Lamprey eels moved into the Great Lakes through the canal and seriously damaged sport and commercial fishing. What will happen, I wonder, if we build a sea-level canal across Central America and let predators from the Pacific and Caribbean invade each other's realms?"

Marine biologists are trying to find the answers at the Smithsonian Institution's research facility in the Canal Zone.*

In Washington I interviewed Dr. Lee A. DuBridge, former President of the California Institute of Technology and until recently President Nixon's Science Advisor. I brought

*See "Panama, Link Between Oceans and Continents," by Jules B. Billard, GEOGRAPHIC, March 1970.

RIDACHROMES BY JAMES P. BLAIR (ABOVE) AND JOSEPH STERLING © N.G.S.

Raw sewage pours into the Hudson River from the New York town of Watervliet (whose name means "flowing water")—a scene repeated in 17 communities along the river, including New York City itself. In 1965 the state voted a billion dollars to upgrade all sewage treatment to the secondary stage (pages 774-5); the job will take a decade.

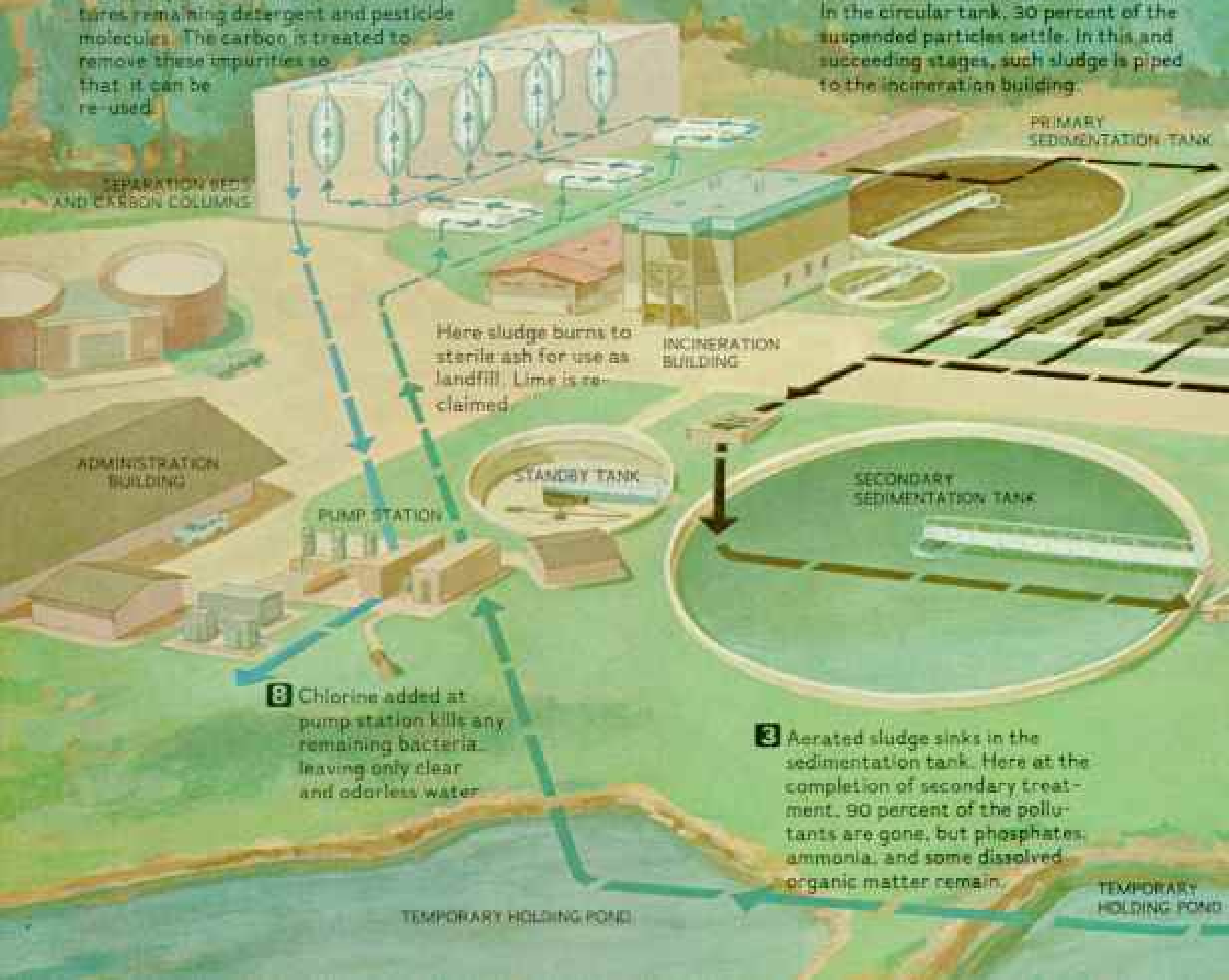
Thousands of dead carp float on the shallow Skokie Lagoons north of Chicago after last spring's thaw. Even under ice, fish survive in water that contains enough dissolved oxygen. But here federal investigators found oxygen-consuming organic wastes and dangerous amounts of arsenic, zinc, copper, lead, and nickel. Carp need less oxygen than game fish, long since gone from many waterways.

POSACHROME BY JAMES P. BLAIR (C) N.G.S.

"**Clean enough to drink,**" says Frank Sebastian of sparkling water that yesterday was sewage entering the pioneering treatment facility at South Lake Tahoe, California (below). His firm, Envirotech, of Palo Alto—one of the burgeoning companies devoted to pollution abatement—installed the chemical-reclamation and sludge-burning systems for the plant.

Voter's choice: As early as 1951, alarmed residents of the south side of Lake Tahoe determined to save its pristine waters. They approved plans and paid much of the $28,000,000 cost for a highly advanced sewage system.

About 30 percent of the Nation's sewage plants utilize primary settling alone. An additional secondary stage, employed by another 60 percent, removes most pollutants and is the goal of federal water-quality standards for all cities by 1973. The Tahoe plant adds even more-sophisticated tertiary treatment. Cost for the entire operation averages less than three cents per day for each residence.



up that matter of asking all the right questions. Had they all been asked before long-lasting pesticides were put into use?

"The side effects of something like DDT show up only after massive use," Dr. DuBridge replied. "Similarly, the smog-creating qualities of automobiles weren't apparent until traffic had built up."

I asked him what we could do to reduce the danger of unexpected side effects.

"The new Council on Environmental Quality will help," he answered. "One of its functions is technology assessment, environmental prediction. Whenever another government agency or an industry is working on a project that might affect the environment, the council can demand a report on its actions and on the precautions it is taking. If the report is unsatisfactory, the council can insist on more comprehensive tests."

But Dr. DuBridge added a cautioning note. "It will have to be a rational process. If restrictions on introducing new ideas became too rigid, they would tend to stop all research and development."

Dr. DuBridge subscribes to the "no-free-lunch" theory. "There seems to be a law of nature that every benefit that is introduced to improve our happiness, our welfare, or our security has a cost factor someplace.

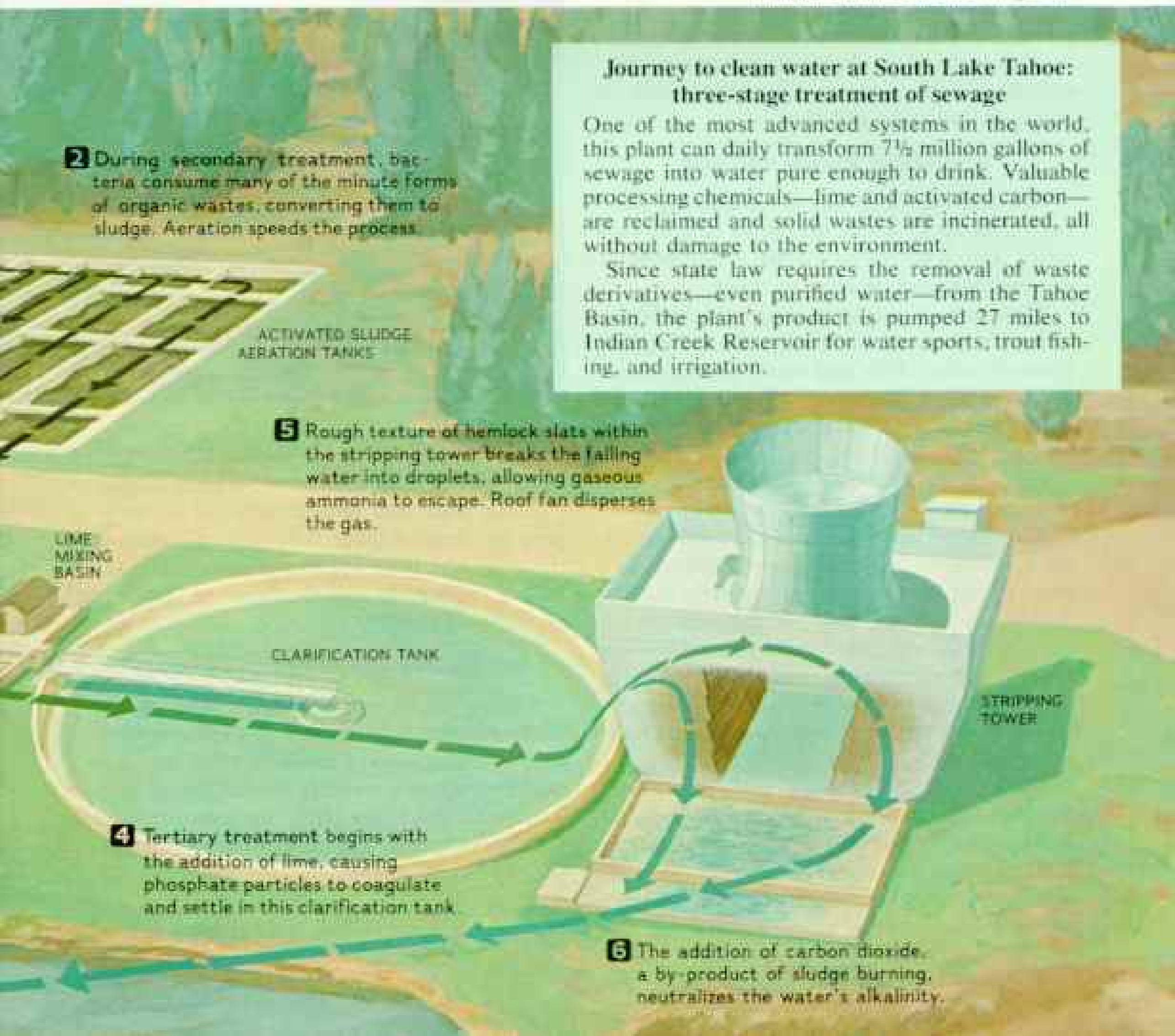
"Sometimes it's a dollar factor," he went on. "Sometimes it's an environmental factor. And that's the real job for human ingenuity today—to develop concepts that will let us measure the benefits against the risks."

Mercury: Man's Helper and Poisoner

All of us—including farmers, industrialists, and sewage-plant superintendents—want a clean and healthful world. Then why is our environment being polluted?

It comes down to this: Engrossed in our

PAINTING BY STAFF ARTIST ROBERT C. MINOR © N.G.S.



Journey to clean water at South Lake Tahoe: three-stage treatment of sewage

One of the most advanced systems in the world, this plant can daily transform 7½ million gallons of sewage into water pure enough to drink. Valuable processing chemicals—lime and activated carbon—are reclaimed and solid wastes are incinerated, all without damage to the environment.

Since state law requires the removal of waste derivatives—even purified water—from the Tahoe Basin, the plant's product is pumped 27 miles to Indian Creek Reservoir for water sports, trout fishing, and irrigation.

own activities, we have little awareness of side effects that those activities may be having on the world outside. Let me illustrate by following one pollutant—mercury—in its course from helper to poisoner of man.

The first mercury seed dressing was developed half a century ago, and became popular because it inhibited seed mold. Other industries were attracted by those fungicidal abilities. Mercury became common in such businesses as papermaking and diaper laundering; mercury is an important catalyst in the manufacture of a basic plastic, polyvinyl chloride.

But Dr. Barry Commoner's "no-free-lunch" rule comes into play at this point. Sweden's pheasant population was drastically reduced because the birds ate seeds treated with mercury. Canadians found mercury in partridges and fish.* Almost 100 Japanese died from eating fish caught in Minamata Bay—a polyvinyl chloride plant dumped its waste there.

Americans became mercury conscious last July, when fish from 20 states and Canada were found to contain concentrations of the poison. The Department of Justice filed suits against eight U. S. chemical and paper companies, insisting on an immediate halt to water pollution by mercury.

Strip Mines Ravage the Land

Perhaps our tardiness in combating mercury poisoning can be laid to its lack of visibility. But what of so visible a destroyer of our environment as strip mining?

This mode of extraction has brought devastation to parts of Kentucky, West Virginia, Pennsylvania, Ohio, and other mining states. Mountains are decapitated, farmlands gutted, wildlife habitats destroyed. Erosion runs wild through the denuded landscapes, choking streams with silt; rains and seepage add deadly acids.

After more than half a century of neglect, most affected states now have laws to curb some of the worst ravages of the strip miners. Today one can see teams of reclamation experts following in the tracks of coal-mining shovels. Aircraft spread tons of seed to revegetate disturbed terrain. Parks, lakes, shopping centers, housing developments are being built on mined lands.

This doesn't mean the destruction has stopped. Reclamation often cannot undo all the damage caused by stripping. Even where it can, there are intervening years of eye-shocking landscape disfigurement. What's more, nobody takes responsibility for the thousands of square miles of "orphan banks"—lands mutilated and abandoned by strippers in decades past. The job of patching these up has been left to nature, which may take a century to restore them—if they can be restored at all.

Sweden Teaches Its Citizens Ecology

Among European countries, one of the leaders in the fight against pollution is Sweden. In Stockholm, I lunched with Tage Erlander, Sweden's recently retired Prime Minister, who heads the planning committee for the International Pollution Control Conference to be held in the Swedish capital in 1972.

*See "Canada's Heartland, the Prairie Provinces," by W. E. Garrett, in the October 1970 GEOGRAPHIC.

Canyons of desolation scar the landscape of Muhlenberg County, Kentucky. The gargantuan shovel, towering 250 feet high, bares seams of coal, principal fuel of the Nation's electric power plants.

The devastation caused by strip mining prompted a state law in 1966: Areas currently being mined must be graded and replanted. First steps of reclamation are visible above the shovel. Older, ungraded "orphan banks" in the distance remain an eyesore.

Streams inherit a sad legacy from such mining. Water seeping through abandoned pits and underground mines picks up sulphuric acid. Fish-killing amounts poison Isaacs Creek (right), turned orange by another mining pollutant, iron hydroxide.

AUDICHROMES BY JAMES P. BLAIR © N.G.S.

Killer fog chokes London on December 8, 1952, as a bus edges blindly through Aldgate. When a severe cold spell increased fuel consumption and temperature inversion held down the sulphurous smoke, some 4,000 deaths resulted.

For centuries London winters were punctuated by grimy smogs, spawned by countless soft-coal fires. In 1852 Charles Dickens compared the black soot to snowflakes "gone into mourning . . . for the death of the sun."

Seventy percent more light reaches the central city and the number of bird species has doubled since London sharply reduced the burning of soft coal. "Jolly good to see the sun," this Londoner told photographer Jim Blair on a spring day in St. James's Park.

"When Rachel Carson's book *Silent Spring* was published here," he said, "it made quite an impact. About that time, too, we looked around to discover that our environment was deteriorating. But you don't just make a law saying there shall be no pollution. To get it under control, we needed public support."

His eyes twinkled. "After all, this has been called a socialist country with a capitalist economy."

Education was the key. A Swedish student starts learning ecology in primary grades, and he'll be exposed to the subject all the way through high school. In college he can cross normal academic lines—for instance, he can major in biology and also in the legal aspects of pollution control. In 1968 adult courses were set up all over Sweden, financed by FOLKSAM, a large insurance cooperative. More than 150,000 adults took the courses in that first year—in a country of eight million.

Hans Palmstierna, secretary of the government's advisory committee on environment, explained the ultimate goal. "Our targets are the people at local government levels," he said. "Before a community agrees to let

a new factory come to town, we want its people to consider more than just the short-range economic gains. Will the new factory create environmental hazards? In our public-education courses, we teach adults to ask just such unpleasant questions."

Instead of allowing industrial plants to pollute their water and air, the Swedes are building a complex of ten special plants to process industrial wastes and used oils collected from all over Sweden. Some of the by-products, such as sulphur, can be sold for reuse to help defray operating costs. Sponsors of the project believe the plants may even become self-supporting some day.

"Recycling is one good answer to the pollution problem," Mr. Palmstierna told me. "Our natural resources, like everyone else's, are limited. It doesn't make sense to dig them up, use them once, and then throw them into the environment as pollutants. We want to use them over and over."

Remember one of Aesop's Fables—the story of the feckless grasshopper who frittered his summer away with no thought of barren months ahead? This has been a planet of grasshoppers.

But no longer. Anxious to mend our ways, we laymen are listening earnestly to a range of experts. The result, too often, is confusion. We're unsure of the priorities—is cleaner air more vital than cleaner water? What can an individual do to help? Must he give up his air conditioner and his car?

I make no claim of expertise—but I have had the rare opportunity of interviewing

RADIO TIMES HULTON PICTURE LIBRARY (UPPER LEFT); ROSECRANSE BY JAMES P. BLAIR © N.G.S.

experts in many countries. Here is the gist of what I have learned:

Virtually every scientist I listened to—and they numbered in the dozens—emphasized that mankind must control population growth. They forecast widespread famine if population soars unchecked. Plagues, too—for in the megalopolitan sprawl of the future there will no longer be sparsely settled buffer zones around cities to curb epidemics.

We have been brought up to equate growth with success. A town should grow, we feel, so each town vies to attract more business and more inhabitants. But many ecologists point out that each resident's share of land and air and water is reduced by growth. At some point, the quality of life declines.

Ecologists think of towns that way. And nations. And the planet itself.

What are the priorities? Most ecologists answered something like this: Clean up the most threatened areas first. Work to unsnarl the fragmented, overlapping responsibility on national, state, and local levels. Focus research on finding environmental answers—there is so much yet to be learned.

Be realistic about immediate goals. At least for now, settle for making a river clean enough to serve its particular purpose. Later, it can be made clean enough to drink.

Get practical, enforceable pollution laws passed—standardized ones that will apply to both sides of a river, for instance, when it flows between two states.

Before using a new chemical, explore for side effects. And when a new product is developed, plan for its ultimate disposal. Work toward recycling: one factory's industrial waste can be another plant's raw material.

And make each individual aware of the problems—and his role in solving them.

"Massive Debt to Our Environment"

Said Russell E. Train, Chairman of the Council on Environmental Quality:

"The astronaut's view of the earth as a small, vulnerable, infinitely precious object is a useful one as a point of departure for a report on pollution. But so is the view from this Washington office—or any city window.

"I can't help wondering whether man has looked carefully at that view recently. Maybe he's become blind to his surroundings and insensitive to his environment in a way he never was when he lived closer to the land. Perhaps we're evolving too quickly, moving too fast, traveling too hurriedly from place to place. Perhaps speed dulls the senses.

"Whatever the reason, we've lost track of the basic truth that man and his environment are interdependent. Pollution is just one symptom of that crucial imperception.

"What's the prognosis? I'm an optimist. I say we *can* get on top of our problems. It's easy to say that we've got a serious situation on our hands; of course we have. What has to be stressed is that its cure is going to take time.

"We're an impatient people. We like to see results. But in this instance we're going to have to be patient. We have barely begun to measure the task that faces us. We'll see improvements in the condition of our rivers in two to four years. Our air will be cleaner by then. But there will be pollutants cropping up that we don't even dream about now. And when it comes to land use, we're way behind most civilized countries. We still hold to the old frontier philosophy that a man can do as he pleases with what he owns, and there's plenty more land if he wears out what he has.

"We're going to have to get rid of that cherished notion, and a few others. We've got to replace them with hard knowledge of a sort we don't yet possess. We have to develop clear-cut national policies to unify our efforts; you can't work separately or segmentally on the several faces of pollution.

"But no policies will work unless people understand them and stand behind them. Our citizens must be informed, urgently and accurately. We need new attitudes: not those of endless abundance, of the ever-expanding frontier, but those of a mature, responsible society.

"If we're to be responsible, we must accept the fact that we owe a massive debt to our environment. It won't be settled in a matter of months, and it won't be forgiven us.

"We're all responsible. We all owe, and we're all going to have to pay. Nineteen seventy may go down in history as the year in which we began to settle our account with our environment, the year in which we made our first down payment on our debt to our world."

THE END

Litterbugs' leavings spoil the beauty of Washington's cherry blossoms. Here around the Tidal Basin, a cul de sac of the heavily polluted Potomac River, refuse left by some of the 700,000 visitors to the Cherry Blossom Festival last April floats beneath the famous floral display near the Washington Monument. PHOTOGRAPHED BY JAMES P. BLAIR © N.G.S.

SPECIAL MAP-AND-PAINTING SUPPLEMENT

The World and How We Abuse It

AS A DOUBLE SUPPLEMENT to this issue, the National Geographic Society brings to its members a large new map, **The World**—and, on its reverse side, a graphic view of **How Man Pollutes His World.** This extraordinary supplement unfolds 17 square feet of up-to-date cartography and thought-provoking art.

The reverse-side painting, by staff artist William H. Bond, illustrates dramatically the dangers described in the issue's lead article, "Pollution, Threat to Man's Only Home." It divides planet Earth into land, sea, and sky—and shows how man is polluting his environment from stratosphere to ocean depths.

Ecologists and pollution-control experts worked closely with the Society in preparation of the painting. Designed as a simple visual reminder of the dangers facing us all from too-careless use of our world's natural riches, it is intended for wide use by schools and community organizations as well as in the home.*

Revisions Include 14 New Nations

The map itself reveals many changes since February 1965, when the Society last issued a global wall map to its millions of members. The winds of the world ripple 14 strange new flags. The sharp-pronged trident of mythology has risen from the sea to emblazon the national banner of newly independent Barbados. And in the African nation of Lesotho (formerly Basutoland), citizens now pledge allegiance to a flag adorned with a conical hat (opposite).

This wave of nationalism has rechristened cities as well. Thus, in the Democratic Republic of the Congo, Léopoldville has become Kinshasa, and Stanleyville is Kisangani. In Zambia, Broken Hill is now officially Kitwe.

In Canada, the Lake Superior towns of Port Arthur and Fort William have vanished—merged into a city, Thunder Bay.

Discovery of oil in 1968 under the tundra of Alaska's North Slope has added another name to world maps—Prudhoe Bay. This lonely area on the Beaufort Sea has gained wide attention as the key to what may be one of the most extensive oil reserves anywhere.

For the first time on a Geographic world wall map, different colors help users distinguish between North and South Korea, North and South Viet Nam, mainland China and Taiwan, and West and East Germany.

Guided by the exploratory work of many nations, our cartographers have redrawn the map of Antarctica. At the base of the Antarctic Peninsula, for example, an area once thought to be land is now shown as part of the newly named Edith Ronne Ice Shelf, facing the Weddell Sea.

The South Magnetic Pole, wandering erratically north toward Australia at about eight miles a year, has moved entirely off the Antarctic Continent. The North Magnetic Pole likewise migrates, lying now on Bathurst Island in the Canadian far north.

In contrast to Antarctica—permanent inhabitants none—such crowded areas as Western Europe and the Far East stand out on a population density inset, a feature of particular interest today because of the effect of ever-growing populations upon the world's pollution problems. Other insets show the 126 members of the United Nations, vegetation and land use throughout the world, and the international time zones.

A glossary of equivalents at the top of the map raises the curtain of mystery from foreign geographical terms—informing the user, for example, that *bahía, bugt, teluk,* and *zaliv* all mean the same thing—bay—in Spanish, Danish, Indonesian, and Russian.

Tables listing the world's largest and most

*In addition to the two-sided world map and pollution painting, copies of **The World** map alone and of the pollution painting alone may be ordered from Dept. 61, National Geographic Society, Washington, D. C. 20036. Prices for the map-painting: $3 on paper, $4 on plastic (rolled); for the world map or painting alone, $2 on paper, $3 on plastic, plus postage and handling.

BARBADOS

BOTSWANA

EQUATORIAL GUINEA

GUYANA

MAURITIUS

NAURU

LESOTHO

FIJI

TONGA

MALDIVES

RHODESIA

SINGAPORE

SOUTHERN YEMEN

SWAZILAND

AQUACHROME BY WALTER MEAYERS EDWARDS, NATIONAL GEOGRAPHIC STAFF © N.G.S.

Symbol of a proud people, the conical straw hat of a Basotho tribesman decorates the new flag (below) of Lesotho, in southern Africa. The former British territory of Basutoland gained independence in 1966. Thirteen other new nations—their standards shown here—appear on the Society's new map, **The World.**

populous countries show that the United States ranks fourth in area (after the U.S.S.R., Canada, and China) and fourth in population (after China, India, and the Soviet Union).

Best estimates place China's present population at 760 million—an increase of 60 million in less than six years. In the same period the United States has grown by 13 million to 205 million.

In the pollution painting on the reverse side, an ominously mushroom-shaped diagram shows the overwhelming population growth in prospect at present rates of increase, especially in underdeveloped countries. Other insets portray the biosphere—earth's zone of life—and trace the concentration of pollutants such as DDT and mercury as they move up the food pyramid to man.

From the mapping of Belmopan, new capital city of British Honduras, to the charting of such ocean-floor features as fracture zones and seamounts, and to pollution-painting notes on supersonic transports and nuclear power plants, the Society's newest supplement is current with a world stirred by change and faced with environmental crisis.

The Fragile Beauty All About Us

PHOTOGRAPHS BY HARRY S. C. YEN
National Geographic Staff

Fine willows, new rushes, for whom
are you so green?

LU YU (A.D. 712-770)

And the answer comes: For those who have eyes to see. Such visual magic can be seen in almost any pond. Harry Yen discovered this spiky curtain of cattails at the Kenilworth Aquatic Gardens in Washington, D. C.

Long since have I marveled
How of ten thousand creatures
there is not one
But has its tune

OU-YANG HSIU (A.D. 1007-1072)

The "tunes" of these two creatures came as a surprise to the photographer. Finding the Eastern box turtle in a wood near his home in Silver Spring, Maryland, he introduced it to a little frog sitting on a lotus leaf in his backyard pond. Unexpectedly, the slow-moving turtle kept walking out of camera range, while the frog sat immobile through a five-hour picture session, winning the friendship of Mrs. Yen, who named it "Nancy."

A sense of the poetry in living things. An appreciation of beauty in the small and ordinary. A quietness of mind that permits the patience to create. To such qualities Harry S. C. Yen brings unusual skill with camera and light. The result: this portfolio of extraordinary photographs.

Born in Hangchow, China, Mr. Yen joined the Geographic photographic laboratory staff in 1964. In capturing nature on film, he uses a Nikon camera with a Micro-Nikkor and other lenses, augmenting sunlight with high-speed flash for dramatic effect.

Harry Yen hopes his pictures will serve an anti-pollution purpose by arousing new appreciation of nature. A young woman in Indiana expressed the same thought recently when she wrote the Geographic: "Seeing what a beautiful earth I live on has encouraged me to take better care of it."

Terrapene carolina carolina and *Rana clamitans melanota*
Ektachrome (Type), opposite) and Kodachrome © N.G.S.

Hygrophoroi; 4 times life-size Ektachrome © N.G.S.

Though I am different
from you,
We were born involved
in one another

TAO CH'IEN (A.D. 365-427)

Miniature trumpets of gold and reddish-brown, wax-gill toadstools sprout from the bole of a decaying tree.

"I was walking in the woods near my home," says the photographer, "when I spied these inch-high toadstools. I knew that they would last only a few days and that no one else would see them, so I quickly took their picture to preserve their beauty."

Corkscrew tendrils of a grapevine attract a leafhopper. The half-inch dandy, with wings of magenta and green, caught Harry's attention in an overgrown lot, a favorite haunt for the nature photographer.

"What on earth do you find to take pictures of here?" a man walking with his wife stopped to ask. When Harry let them look through his lens at this colorful creature, they were astounded. "Maybe now they will stop and take the time to look around," he remarked.

To many people, insects are just pests to be sprayed with poison. Yet some are beautiful; others are essential to plant pollenation or beneficial in various ways. In a world without insects, many of our best-loved birds would be doomed, and spring would be silent indeed.

Graphocephala coccinea, 3 times life-size Kodachrome by Harry S. C. Yin © National Geographic Society

Some people say that God lacks any concern
for leaf or flower.
The myriad-formed! The skill that fashioned them all!

LIU K'O CHUANG (A.D. 1187-1269)

Tender shoots of a tree beckon to an inch-long moth caterpillar. While arranging a table decoration, Harry's wife suddenly spied

1½ times life-size

the creature and let out a shriek. But Harry quickly decided it was a "nice worm" and put it to work modeling.

Ektachromes @ N.G.S.

Insect-riddled leaf veils black-eyed Susans. Finding an entire branch of these leaves, Harry looked through each one until he found this frame for the flowers.

The flying birds two by
two return.
In these things there lies
a deep meaning

T'AO CH'IEN (A.D. 365-427)

Mouth agape, a hatchling begs for mother robin's offering. Last spring, when life began to quicken, a pair of robins selected the Chinese holly outside Harry's study for their nest.

"It was just five inches from my window," he said. "I watched them build the nest, and then the mother laid two blue eggs. After they hatched, I carefully raised both window and screen to photograph the feeding babies." Harry changed nature's color scheme from green to red by using infrared film.

This gentle thrush—named robin because it reminded English colonists of their little redbreast back home—has suffered severely in many areas from use of DDT. The poison is concentrated in the earthworms on which the robin so largely feeds.

Εκκλησιαστικό © National Geographic Society

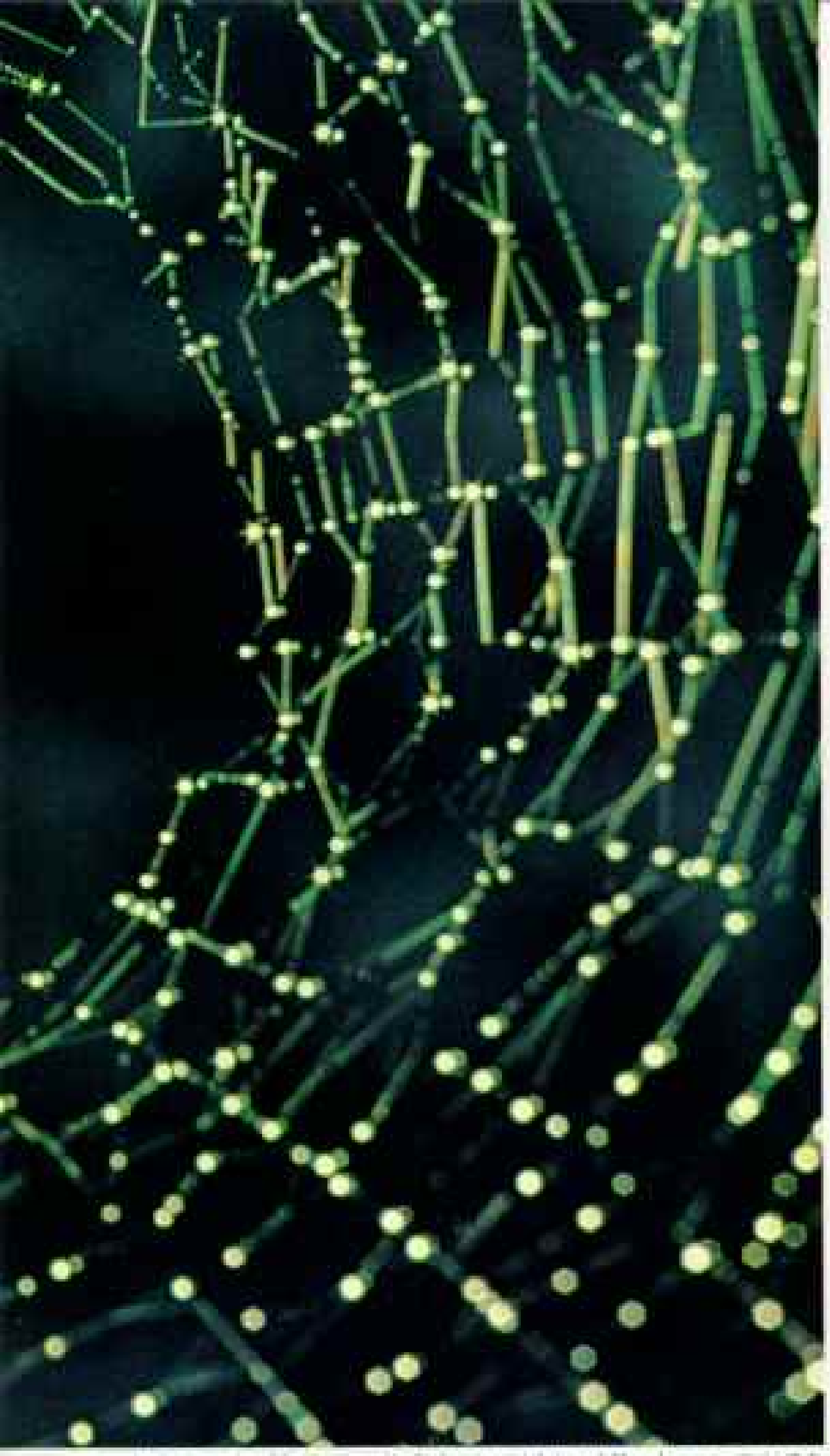
All things are stirring.
I have beheld them in the place
where they return.

LI ERH (6TH CENTURY B.C.)

Spinning its own universe, an orb-weaving spider waits for a meal to entangle itself in the web. Harry spied the gossamer net in the grass a foot from the ground. He dug a hole beneath it large enough for his head and camera, so that he could shoot spider and web against the sky.

Lavender sister to the buttercup, the hepatica heralds the onset of spring. Taking a spade from his automobile trunk, Harry carefully lifted plant and ample soil to a spot suitable for photography. He replants some flowers in the original spot; others he adds to his growing wild-flower garden.

Hepatica, life-size



Argiope, twice life-size

Aquilegia canadensis, life-size

Kodachrome (right) and Ektachromes © N.G.S.

Taraxacum officinale, 4 times life-size

Flowers of all kinds
blossom one after another,
Well aware that they will fall
in a little while.

PO CHU-I (A.D. 772-846)

Like Christmas bells out of season,
columbine blossoms dangle
stamens resembling clappers.
Harry had found a columbine plant
in his neighborhood wood the
previous spring, but the blossoms
had fallen. Noting the spot,
he returned a year later.

Pinwheels of silver hair will ride
the wind and carry dandelion
seeds to fertile soil. Most have
already blown away; Harry's
close-up reveals the delicate
beauty of two lingering wisps.

Mycena, Tuft 500-608 Illustrations by Harry S. C. Yee © N.G.S.

Each has its season
coming early or late;
But to all alike
the fertile soil is kind.

PO C80.4 (A.D. 772-846)

Cluster of parasols, mushrooms spring from a decaying log. To capture the delicate symmetry of the gills, Harry gently changed the angle of the log.

From big beeches, little violets grow.
Soil caught in the gnarled roots
of this patriarch in Washington's
Rock Creek Park nourished
these spring flowers, spotlighted
by morning sunlight.

Dainty lady's-slipper blooms in early spring at the National Arboretum. Harry created the background for this portrait by lightly swabbing red, blue, and yellow oils on a piece of cardboard. This wild orchid becomes ever rarer as bulldozers clear land for new highways and buildings. THE END

Cypripedium calceolus, half life-size

KODACHROMES (INCLUDING PRECEDING PAGES) BY KAL MULLER © N.G.S.

A strapping Melanesian balances near the top of an 83-foot tower on Pentecost Island in the New Hebrides. Then he leaps (opposite). Springy vines tied to ankles check his fall just as his head touches the ground.

The author, photographing life among South Pacific tribesmen, became the first outsider known to attempt the heart-stopping plunge.

Land Diving With the Pentecost Islanders

ARTICLE AND PHOTOGRAPHS BY
KAL MULLER

I WATCHED INTENTLY as Ahia climbed the tree-and-vine tower. Reaching a point 50 feet above the ground, he stepped onto a short platform and stood silhouetted against the sky.

Around me, the people of Bunlap and surrounding settlements stamped their feet in the dirt, raising a choking cloud of dust, and chanted a forceful song to encourage the young man high above them.

Ahia lifted his feet—both ankles bound by lianas, or vines—over two crossbars on the platform, and stood poised at the edge. He steadied himself for a moment by touching another platform near his head.

Then, with his gaze fixed on the horizon, he pulled a few croton leaves from his belt and released them. As they drifted to earth, he raised one hand over his head, a sign that he wished to speak. Immediately the singing and stomping ceased.

Ahia's speech concerned a tusker pig he had recently bought at an exorbitant price. The subject seemed a curious one, but it befitted the place and circumstances. For we were in a remote corner of the New Hebrides island of Pentecost, where tusker pigs represent wealth, and I was photographing an impressive spectacle: an authentic land dive seldom witnessed by outsiders.

Soon Ahia finished his speech, and the people resumed their vigorous dancing and singing (page 803). The men hopped three short steps back and forth, their eyes constantly on the erect young man overhead. As if in a trance, Ahia slowly raised his arms over his head and clapped his hands three times. His toes gripping the edge, he clenched his fists and closed his eyes. Then, arching his back, he slowly leaned forward.

Suddenly he was hurtling toward the ground, headfirst. The lianas, one end tied to his ankles and the other to the platform, fluttered in the breeze. Just as his head touched dirt, the lianas snapped taut, breaking the fall. Six men hurried forward to untie the vines. Smiling proudly, Ahia jumped to his feet to show he was unhurt.

Now it was my turn.

Guest Performs Without Rehearsal

I carefully picked my way upward through the tower's labyrinth of branches and logs. With a certain optimism, I, too, had chosen a point 50 feet above the ground. Two islanders, Benkat and Telkon, who had volunteered to assist me, waited just below my platform, lianas in hand. As I stood on the inside portion of the platform, the two men quickly tied a liana to each ankle. Completing the last knot, they nodded. The next move was mine.

My wooden *sigol*, or platform, projected six feet beyond the body of the tower. Its width was a scant 16 inches. Slowly I walked to the edge, swinging my ankles around both horizontal crossbars. The lianas now hung in long loops below me.

Before me a breathtaking panorama unfolded. The ocean sparkled just beyond the low coastal hills. Nearer, majestic spreading banyans dominated tropical green valleys of tree ferns and coconut palms. Clustered below, the villagers chanted a song composed by an old man, Sali, in honor of their first white land diver—me.

As I gazed at the horizon, I recalled an adventure tale I had read a long time ago, as a child in Hungary. The hero, shipwrecked off an island, was captured by cannibals. They offered him a choice: He could be roasted alive or he could jump off a tremendously tall tower.

I don't remember which he chose, but my situation was not so dramatic. The people of Bunlap had invited me to jump, an invitation I had sought for more than two years. Ever since witnessing my first land dive, I had wanted to try it myself.

Strangely, I felt no fear. All the fear had drained from me the night before, a sleepless night during which I berated myself for being a reckless fool. By dawn, my outlook became far more positive. If these men and boys could jump, why couldn't I?

I knew the tower well. For two weeks I had explored it from every angle, bottom to top, and often in precarious positions, all for the sake of photography. So, I convinced myself, I was prepared.

The singing, whistling, and periodic shouts —*"Eah hey! Eah hey!"*—welled up from below with increasing intensity. The men waved war clubs and the women agitated their hands over their heads. I took some croton leaves from my belt and, conforming to longtime custom, released them.

"Talk-talk" Delays a Determined Diver

Just then Bong, the village chief who was standing in the tower behind me, cut in. "Kal, you sent em one talk he go. Allgetta want to har em talk-talk belong you." He wanted me to make a speech, but all I wanted at that moment was to get the jump over with!

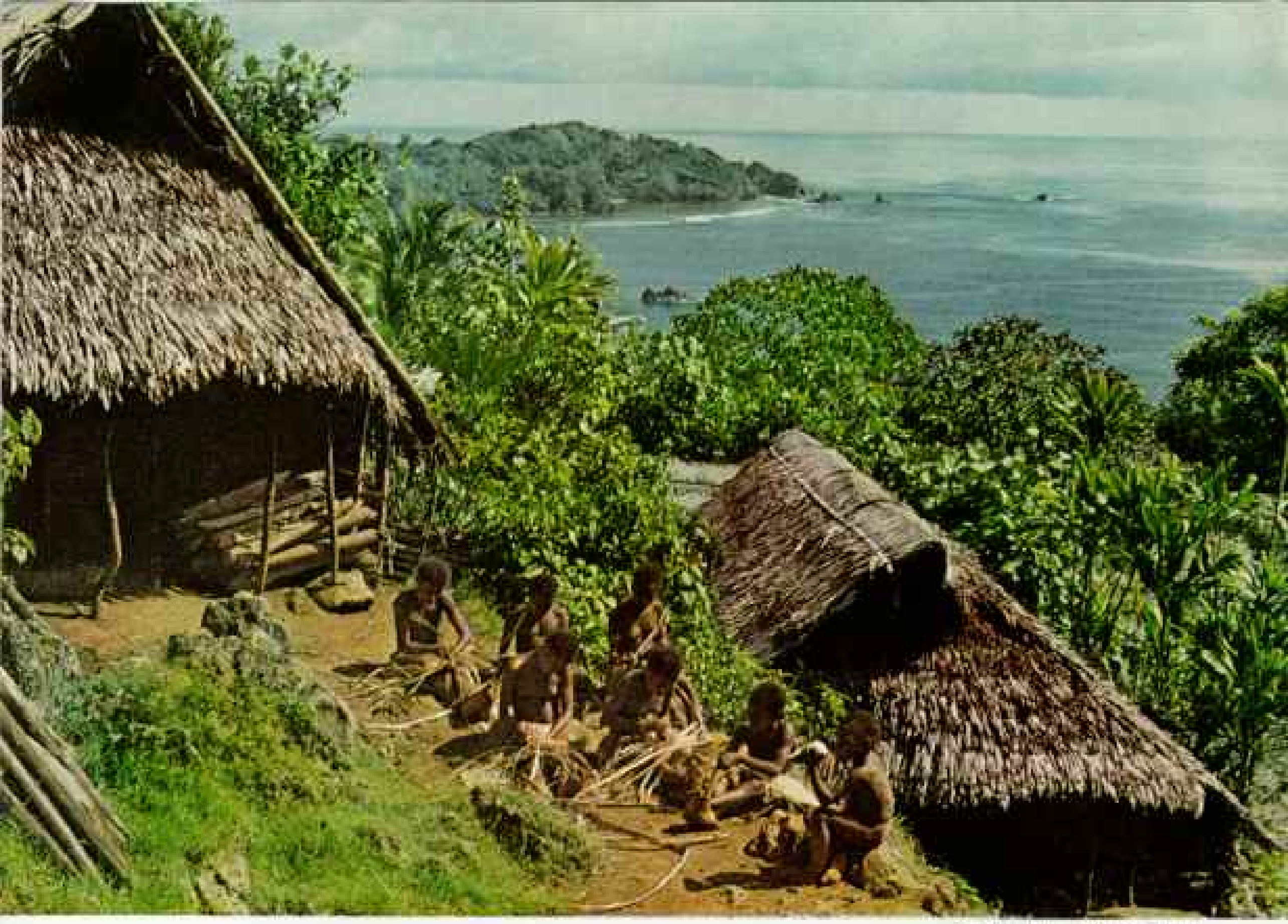
I kept the speech as short as tradition permitted. My mastery of the local language was not sufficient for an off-the-cuff discourse, so I used the local variety of pidgin English.

"Me fella, me glad too much belong me stop wit em you allgetta. Me learn em plenty someting long custom belong you fella. Me like em you fella too much. Now here me fella glad too much you allgetta you let em me jump long land dive."

I clapped my hands three times over my head. The singing, shouting, and whistling resumed and welled into a crescendo. I glanced at the thick lianas securely wrapped around my ankles, fervently hoping they would hold. The excitement was enveloping me; I felt almost exalted.

Stretching my arms over my head, I arched my back and leaned forward. At the last second, I pushed slightly forward, and my body floated high over the ground. Then, I was hurtling headfirst toward the softened earth (page 817).

Walking stick's last stroll amuses its young captor, who will shortly roast and eat it. Islanders relish the insects—along with such other delicacies as wildcats and crickets—as supplements to their starchy staples: yams and taro. Cooked crickets taste not unlike caviar on burned toast, says the author. KODACHROME © N.G.S.



REDRAWN BY RAL MILLER © N.G.S.

Pocketed in primitive life between jungle and sea, fiber-skirted girls plait mats at Bunlap, the Pentecost Island village where the author and three assistants lived for seven months. Coral reefs long preserved the isolation of these people, but, as today's tide of travelers moves closer, the 130 villagers find it harder to maintain their traditional culture.

I held my arms tight against my chest so that I wouldn't break an arm when I touched ground. My knees were slightly bent, as proper form prescribed. I had been warned not to open my eyes during my fall, but I did anyway. The brown mass of earth rushed up as if to embrace me.

With incredible precision, the lianas snapped taut. The platform, supported only by slender branches, collapsed under the strain, absorbing the shock of the fall. My head barely touched dirt as I rebounded, finally coming to rest upside down.

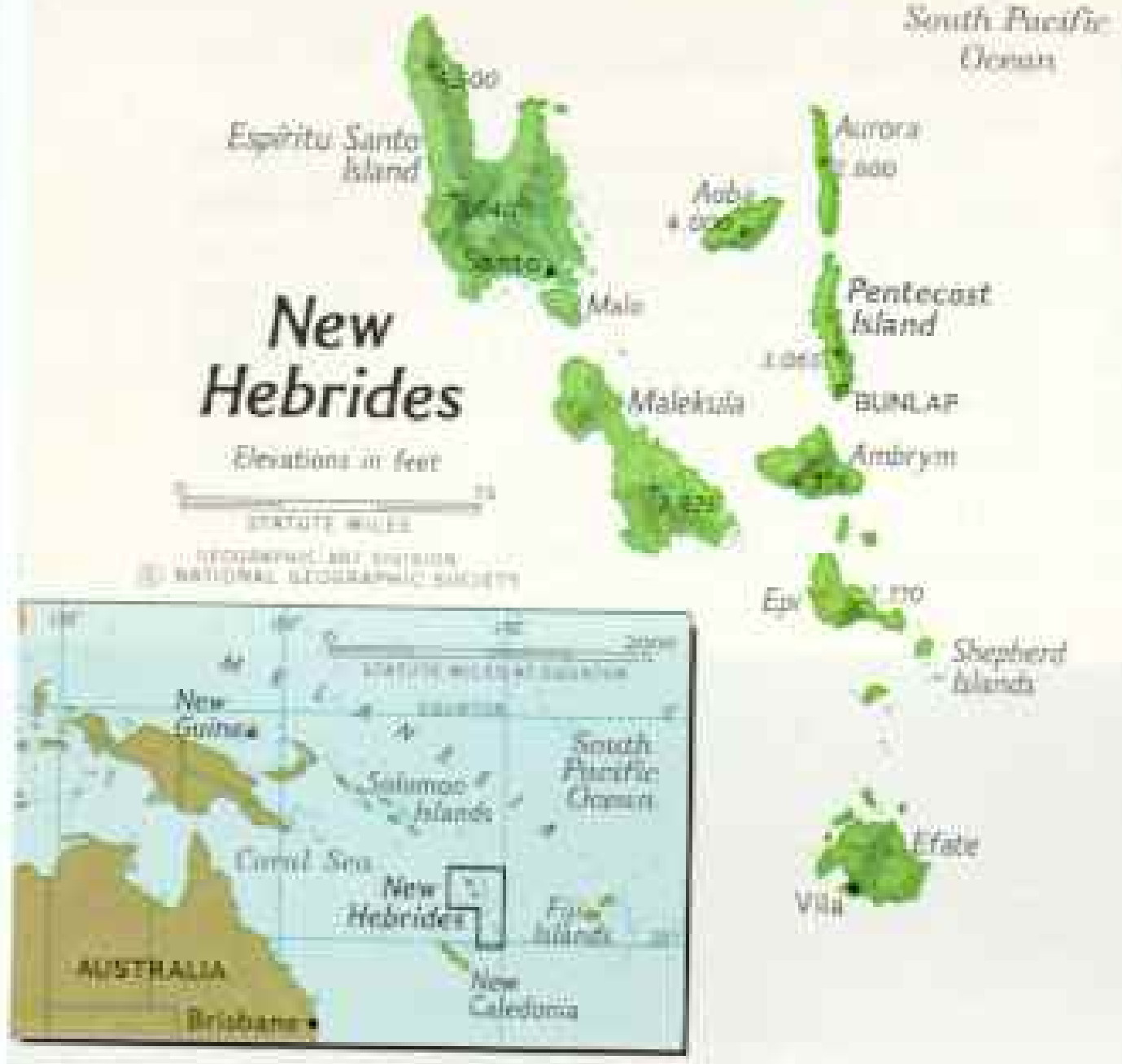
Twenty men rushed to me. They cut the vines and carried me triumphantly off the landing area, pressing cycas fronds into my hands. Everyone shouted about how well I had jumped.

"Me look you no fright," my friend Meleun told me. It was a perfect moment for me.

I felt oddly unshaken. The excitement had overridden any physical discomfort. And my past experiences as a parachutist certainly helped prepare me for the land dive. I did not escape totally uninjured—some of the skin was ripped off one ankle. It could have been far worse: I learned the next evening that one of my lianas had broken. Then I really began worrying about what might have happened.

The land dive was the culmination and the most exciting moment of my seven months' stay in Bunlap. I had been in the New Hebrides on several occasions, but knew little of the people of Bunlap except that they formed a very close group, did not care for strangers, and usually refused to be photographed, especially during their ceremonies.

Despite the villagers' isolation, their chief, Bong (opposite page), has had extensive contacts with whites. As a boy he worked for the United States Army on Espiritu Santo, largest island in the New Hebrides and site of a major World War II military base. He remembered how well our troops treated his people then. These memories helped immensely in my contacts with the villagers.



PERACHROMES © N.G.S.

String of verdant beads, the New Hebrides lie 1,300 miles east of Australia. France and Britain jointly govern the archipelago.

Bunlap leader Chief Bong (upper right), who worked at an American base on Espiritu Santo Island in World War II, approved filming of the land dives by the author and helped him overcome the villagers' suspicion of foreigners. Branch-waving damsels, in skirts made especially for the occasion (right), encourage the jumpers.

Bunlap stands on a series of escarpments by the sea (map, above). With a population of 130, it is one of the largest non-Christian concentrations in the New Hebrides. Some thirty thatched huts line both sides of the main trail, and an open ceremonial ground stands at the village's highest point.

When I first arrived there, I immediately noticed the differences between these people and those in other parts of Pentecost, where land dives attract a growing number of tourists.* Inhabitants of these areas, Christianized for two or three generations, wear Western-type clothing. But Bunlap men usually don only a fiber belt and sheath, while the women dress in traditional fiber skirts.

Fringing reefs along the eastern coast of the island make landings virtually impossible. Thus, Bunlap was overlooked by 19th-century labor recruiters who, sometimes at gunpoint,

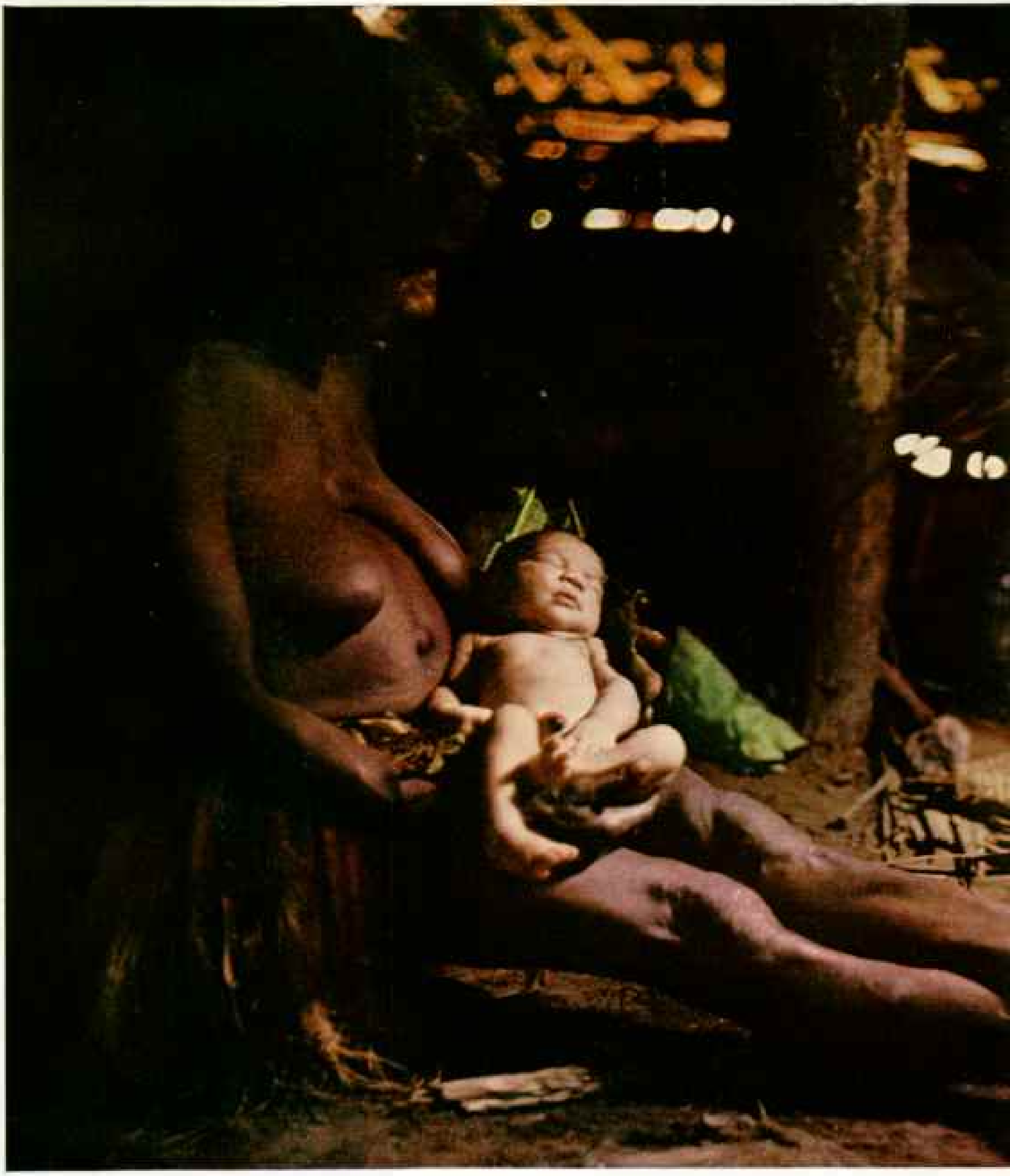
*This spectacular custom was portrayed in "South Seas' Incredible Land Divers," by Irving and Electa Johnson, in the January 1955 GEOGRAPHIC.

obtained "volunteers" for plantations of other Pacific islands and Australia. By the latter part of that century, they began to have some contact with outsiders, but even now Bunlap lies off the beaten track.

Bong, who feels strongly that Bunlap's traditions should be maintained, organized a meeting soon after my arrival. I explained to my audience, most of Bunlap's 30 adult males, that I was making a visual record of New Hebrides people. The pictures, I said, would enable their children to remember how their parents lived.

The men approved, and so two months later I returned with my crew. Beatrice Bomo handled sound recording and occasional photography, Jacques Gourguechon served as a cameraman, and Louis Nedjar did some filming, cooked, and substituted for Beatrice where local taboos barred women.

Our months in Bunlap proved educational, both for the villagers and for us.

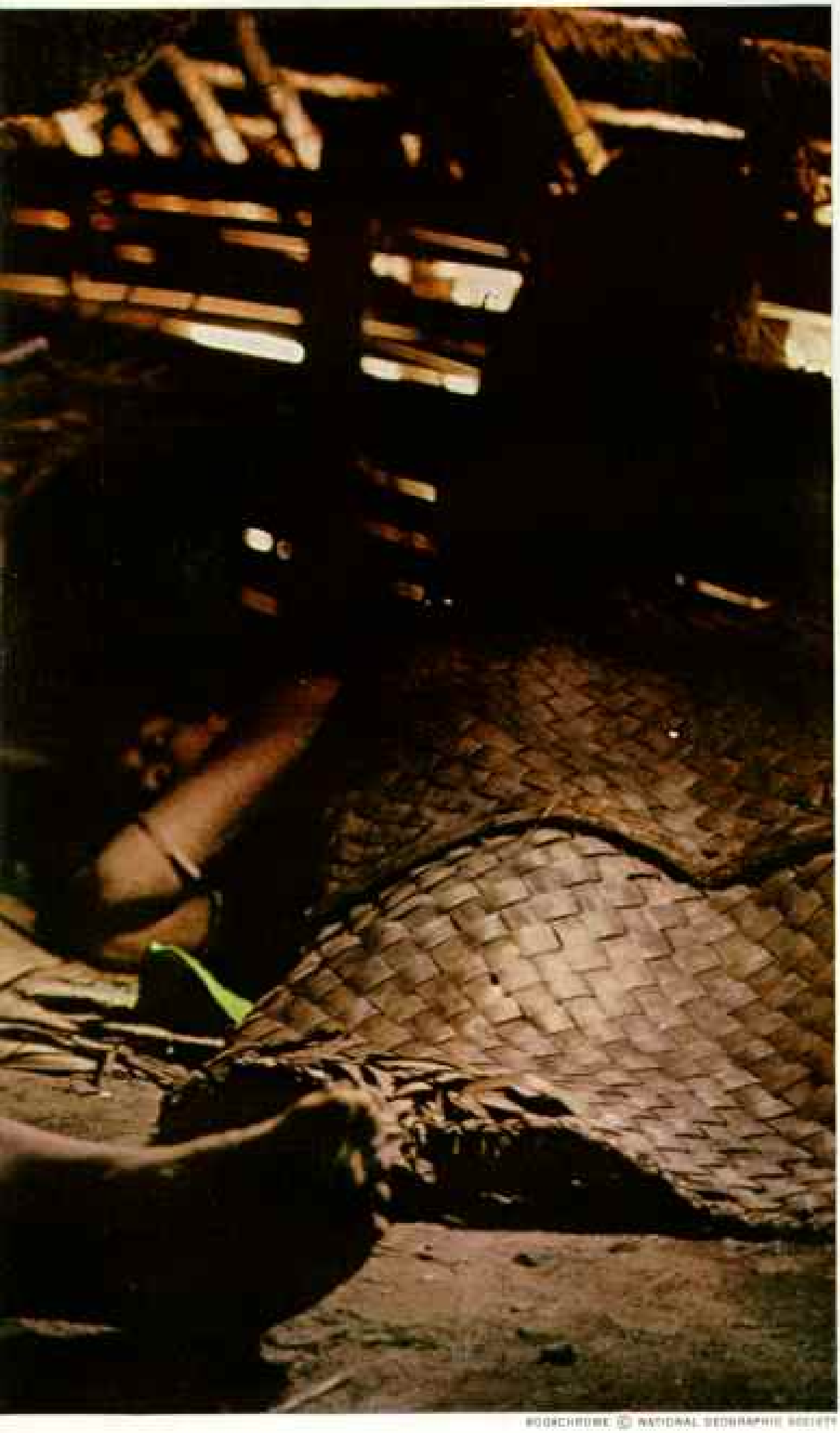


Many of them knew little about other islanders of the New Hebrides. Using a battery-powered projector, I showed my films of the Big Nambas and Small Nambas—tribes of Malekula—and the people of the Espiritu Santo "bush," as well as footage of a land dive performed for tourists by Christianized inhabitants on the west coast of Pentecost.

"What em someting im here?" a startled youngster at the first showing asked, trying to determine if little people were performing behind the viewing screen. "Ee got small fella inside?"

As each scene unfolded, the villagers grunted, exclaimed, whistled, laughed, or made clucking noises. Afterward I was bombarded by questions: Are these other people real? Where do they live? Why do they dress differently? I showed the films at least ten times, and they always wanted more.

While we were filming the villagers, we lived in a small house they had built for us



New pulse in Bunlap's ancient rhythm, a baby lies sun-washed by light filtering into a dim hut. Covered by a mat, right, the exhausted mother gazes at her child, whose tawny skin will later darken to a walnut hue.

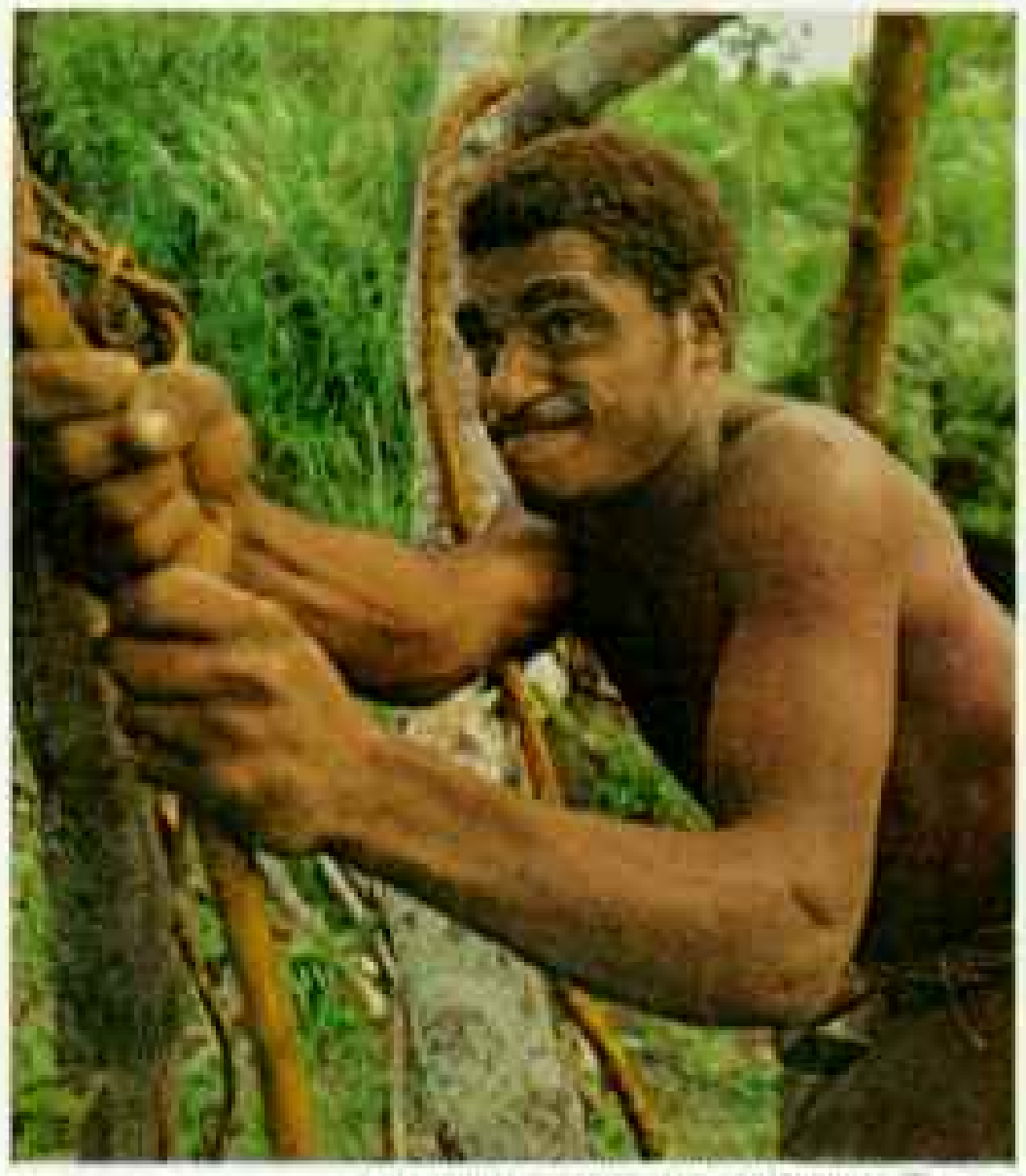
Villagers named an earlier child, the first girl born during the author's stay, after a woman on his production crew. That child died five days later; a high infant-mortality rate claims many of the newborn.

The next baby, a boy, was named for the author, a special tribute in a land where mothers traditionally scold children by saying, "Be good, or the white man will get you!"

BOOKCHROME © NATIONAL GEOGRAPHIC SOCIETY

Jungle steeplejacks build a skyscraper without steel (left), using a live tree and poles for support. Singing to quicken the work tempo, they bind 1,000 logs and thick branches with four miles of vines, raising the structure in 10 days.

Completed tower (right) stands shrouded by vines selected and hung by the jumpers who will use them. This man shreds vine ends to knot around his ankles. At night men guard the tower against the weakening influence of a mythical "poison man."



Tugging on a liana, a builder secures logs without wire or nails. Lest women bring bad luck, they are barred from the construction site and from parts of the jungle where materials are stockpiled.

EXTACHROME (OPPOSITE) AND KODACHROME © N. G. S.

and shared their food. Their staples are yams and taro, with variety provided by such delicacies as ten-inch praying mantises, brochettes of metal-green crickets, and other insects (page 801). They're quite tasty, if you don't think too much about what you are eating. With a little imagination, you might believe a cricket is caviar on a slice of slightly burned toast.

Our diet also included *laplap*, a native pudding made with yams, taro, or manioc; a wide assortment of fish; and such tropical fare as purse crab, flying fox, octopus, and wildcat. We brought a few food items with us, including Chinese noodles, which so amused the villagers that, trying to eat them, they laughed so hard they couldn't swallow.

During rainy periods I conducted classes for five young boys and two adults. Using a simplified Roman alphabet, I taught them the 17 most common sounds in their language and the letter equivalents. Within four months they could read and write simple words, and knew some arithmetic and New Hebridean history and geography.

After school I turned on our transistor radio. At first the students wanted to break it open to see the people inside. Eventually they grew used to it.

Usually we listened to programs from Vila, seat of the British-French government in the New Hebrides, where broadcasts are given in French, English, and pidgin English. At the end of a program, when the announcer bade farewell to his audience, every villager, taking his remarks personally, politely replied, "*Tata* —goodbye."

The villagers went out of their way to make life pleasant for us. Women brought fresh water in bamboo tubes daily and regularly provided yams, taro, bananas, papayas, and watermelons. Every night we met with the men to discuss, over orange-leaf tea, their traditions and practices.

For the agricultural people of Bunlap, the

In full flight, a vine-tethered diver hurtles toward the target area, a plot of softened earth sloping away from the base of the tower. When the lianas snap tight, slender supports beneath his diving platform collapse, letting it swing downward to lessen recoil.

Divers give a short speech, perhaps airing a marital problem or personal injustice before they fall forward. Those on the higher levels must dive outward, since the tower begins to curve back at the 50-foot mark (left). No ridicule awaits those whose courage fails. Highest diver fell more than 80 feet.

yam provides more than subsistence; it lies at the heart of the villager's ceremonial life. The land dive, a ritual to ensure a good yam crop, plays an important role in this society.

The origin of the land dive is legendary. Tradition holds that once a man, Tamalié, so mistreated his wife that she ran away and climbed a banyan tree. He found her and climbed after her. She had tied lianas around her ankles and, just as Tamalié reached out to grab her, she jumped and he followed. The lianas saved her life, but he died. The other men, determined that no woman should trick them, began practicing dives with lianas around their ankles.

The land dive serves several psychological purposes: It gives the men a chance to demonstrate their courage, to show off in front of women, and to get a public hearing of their troubles. Some men, before jumping, discuss their marital difficulties. And the wives must stand there and listen.

Laughter and Song Lighten Labors

For two weeks I watched the 83-foot Bunlap tower rise, a marvelous feat of engineering. More than 22,000 feet of vines bound together 1,000 logs and thick branches. Not a nail, not the smallest piece of wire, nothing that belonged to the white man was used in the construction (preceding pages and above).

The atmosphere of cooperation was wonderful. While some men gathered materials, others toiled on the tower, laughing and singing in unison. As the tower took shape, I felt it almost come alive, acquiring an independent existence that was more than the sum of all the care the workers put into it. When the

Faces etched by concern, feminine spectators endure the awful tension just before a dive. In this moment of male glory, women may not sing, only whistle. By legend, a woman began the ritual by leaping from a tree to escape her cruel

project was half-completed, the people told me that the spirit of Tamalié had come to live in the tower.

As tradition demanded, women were excluded from the site during construction and in fact were forbidden to cross areas where building materials were accumulated. New paths were cleared so the women would not come close to the tower, which stood in a garden area about half a mile from the village.

The dive site offered a flat area where viewers could congregate, and a sloping place for the landing spot—to give the divers a better chance of survival if the lianas broke.

During construction, the workers joked with me as I climbed into precarious positions to take pictures. Although I had said I would jump, many villagers were not convinced. "Kal, bambai [by and by] you think you savvy jump?" one asked. "Me no think white man he savvy jump, bambai you fright too much."

I usually contented myself with smiling and suggesting they wait and see.

Construction of the tower was a collective effort. The tower itself was completed in 10 days, and the numerous log platforms took another three or four days. Each jumper built his own platform and selected his lianas. Since

husband. Vine-anchored, she survived, while his free-falling pursuit proved fatal. Male pride dictated that men perfect the art.

I didn't trust my own skills. I accepted the offer of two Bunlap friends to construct my platform and choose the lianas.

Boys as young as 5 or 6, preparing to dive from a lower part of the tower, built their own platforms.

For Bunlap youngsters, learning to land dive begins early in life. A lad first practices by leaping headlong off the shoulders of his father, who holds the boy's ankles. On several occasions I watched small boys build model towers, some seven or eight feet high, complete

(Continued on page 816)

Too young for the tower, a big-eyed boy watches others perform. His day may soon come, for some lads make 20-foot dives when only five years old. Both he and an elder (below) wear pig-tusk pendants. To achieve the curl, a boar's two upper tusks are removed, allowing the bottom two to grow in a circle.

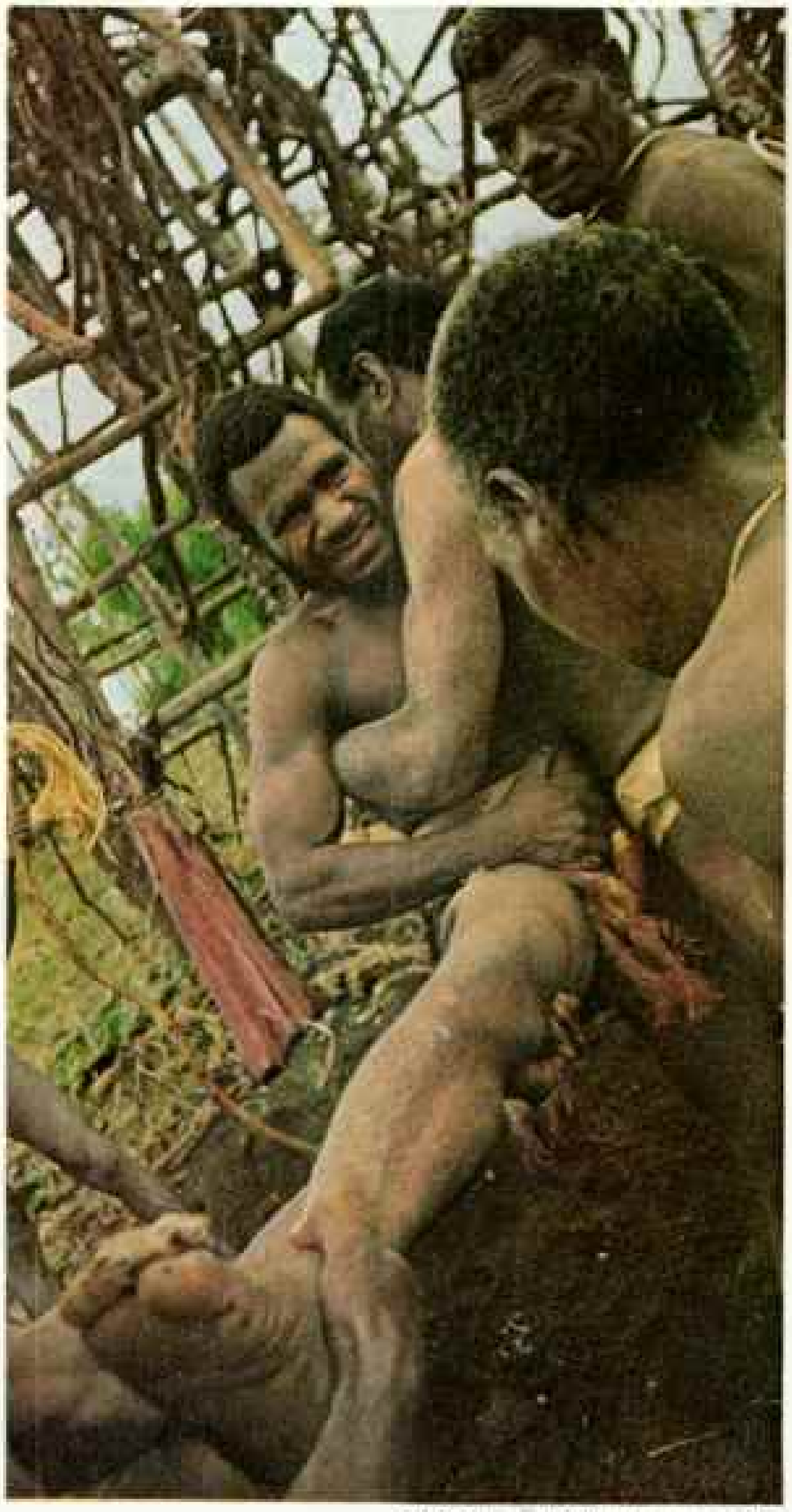
Human projectile, a diver plummets earthward (left) trailing lifesaving lianas. The vines, precisely measured, stretch from tower platform to within body length of ground. Even a stiff, drying breeze might trigger a remeasurement for shrinkage before assistants tie them to a jumper's ankles (above).

The critical computation involves several factors—tower give, length of the breakaway platform, elasticity of vines—to ensure that the diver's head barely touches the ground. The best divers rebound in a graceful arc that leaves them on their feet at the higher ground near the tower. Others dangle in an ungainly sprawl (below) that at least signals an end to their ordeal.

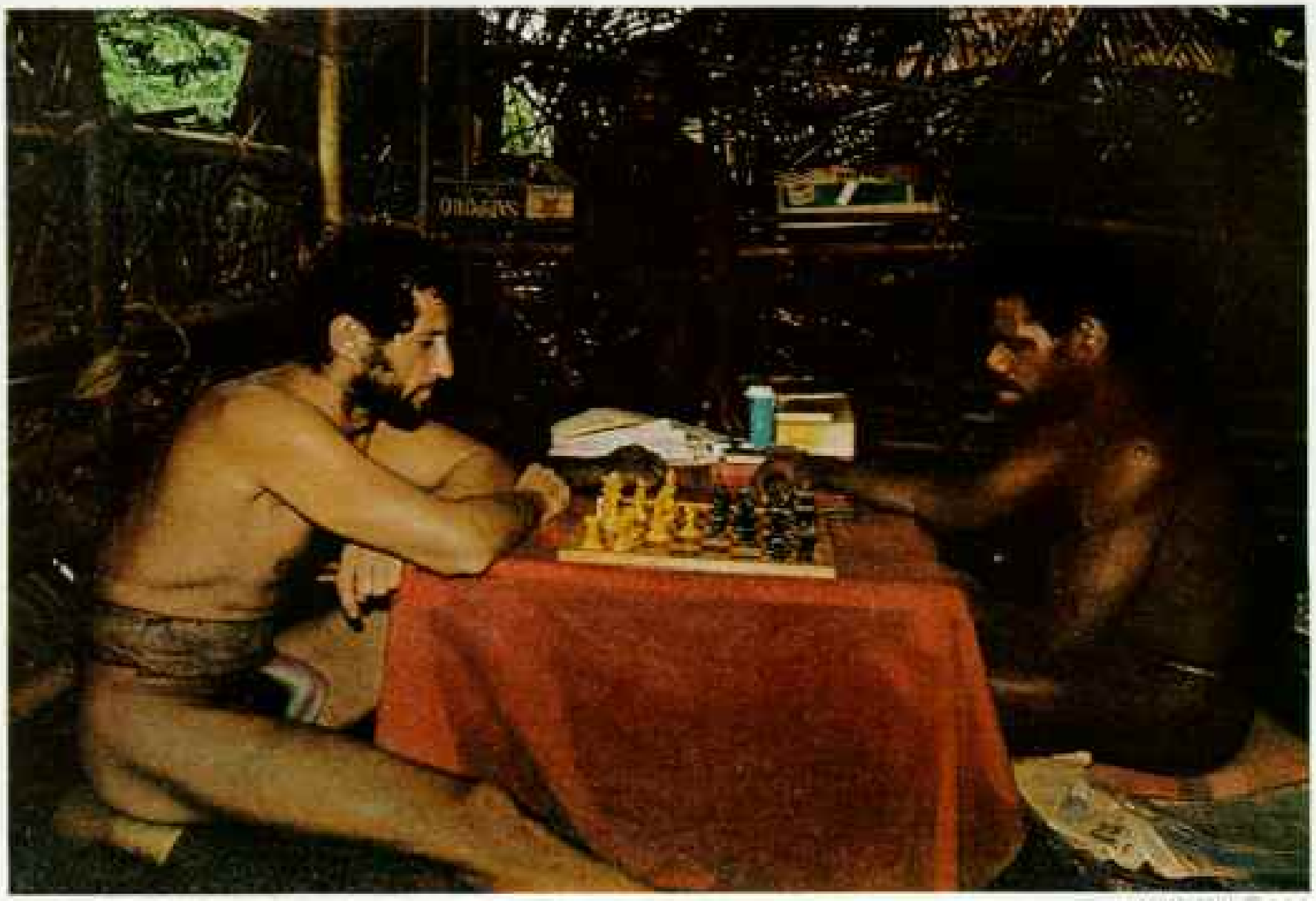
ENTACHROME (RIGHT) AND KODACHROME © N.A.G.

Jubilant diver, in the arms of his supporters, (right), greets his gallery with the aplomb of a circus aerialist. Relatives and friends will soon envelop him, shouting with joy and sharing in his triumph.

Less fortunate, an injured jumper (below), winces in pain from a pulled muscle as sympathetic comrades embrace him and massage his leg. Surprisingly, the dives caused no serious injuries, and, islanders claim, no deaths have ever occurred.



EKTACHROMES © NATIONAL GEOGRAPHIC SOCIETY



Meeting the challenge of chess, a villager takes an intellectual flier with the author, who wears only a fiber belt and sheath in native fashion. Hungarian-born Mr. Muller, an amateur anthropologist from Tucson, Arizona, spent rainy days during his Bunlap residence teaching a small class reading and arithmetic. Using such aids as NATIONAL GEOGRAPHIC's article on the moon landing and the Society's book on African wild animals, he gave the islanders their first far-reaching glimpse of the outside world. He gained additional respect and affection from the people by participating wholeheartedly in the life of their village.

with platforms, and drop pieces of wood from various levels as if they were divers.

The day before the dive, workers cleared the surrounding area of plants, trees, and stumps, and softened the sloping ground of the landing spot to a depth of about ten inches. That evening every male villager guarded the tower lest a "poison man" plant evil things in the ground to make the lianas break.

Before dawn the next morning the men underwent a ritual wash in the sea, anointed themselves with coconut oil, and decorated their bodies according to rank and fancy. All the men and boys wore boars' tusks around their necks (pages 803 and 811). And every woman and girl donned a new fiber skirt before gazing on the tower for the first time.

Quietly, the men slipped into the jungle as the women gathered near the base of the tower and started to dance back and forth. Then the men charged into the clearing, singing, shouting, and waving old war clubs. They danced toward the women, and the intensity of noise rose to a higher pitch. As everyone worked himself into a frenzy, the dives began.

A few of the youngest boys leaped from the lowest platforms, some 20 feet above the ground. These youngsters making their first jump showed plenty of courage and pride. But sometimes a slight shove from behind helped send a young diver on his way.

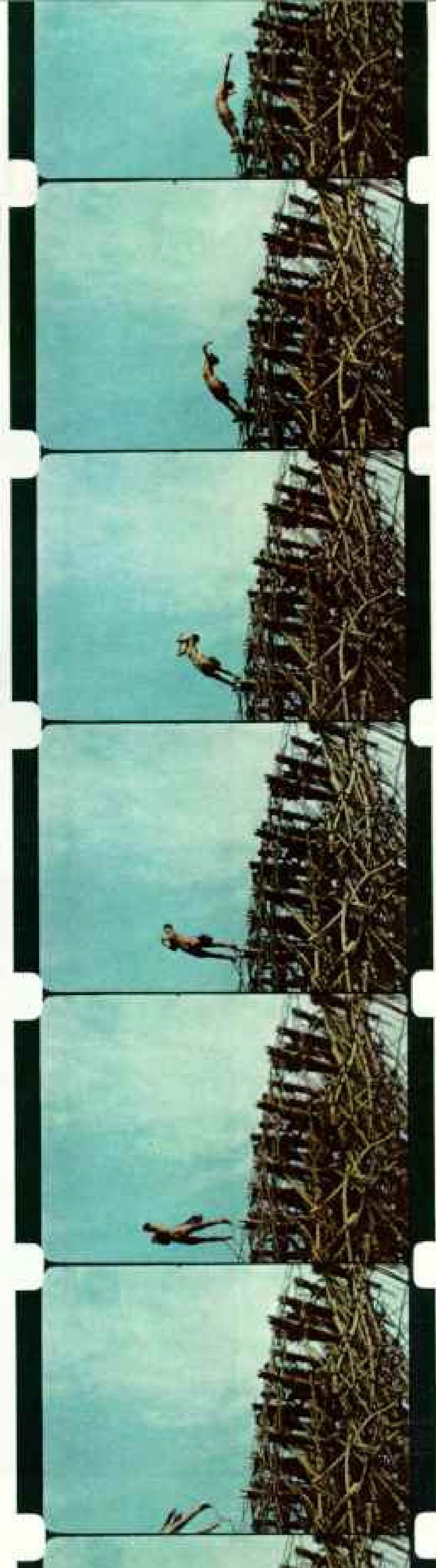
Then came the diving by the men. At each jump the spectators shouted. Then, as the diver hung head down, men rushed from the audience to cut him loose, and his relatives congratulated him. If he jumped well, the older men gave him a frond of cycas.

A few balked, making a last-minute decision not to jump. Their places were quickly taken by others, and they were in no way ridiculed. One man particularly enjoyed diving; he jumped five times.

The platforms stood on 15 levels. As the divers jumped from higher levels, the tension mounted. A few minor accidents did occur.

"High point of my life . . ." said Mr. Muller of his 50-foot jump, recorded on movie film (right). Island men lauded him in song as he mounted the tower. In his prejump speech, he thanked them for allowing him to join in a ceremony seldom seen by outsiders. Although one of his vines broke, the former parachutist suffered only a skinned ankle, and won a bouquet of cycas for his dive.

EXTACHROME SEQUENCE BY BERNICE BOND, COURTESY THE FILM STUDY CENTER, HARVARD UNIVERSITY



Sometimes one or both lianas broke, but not before they safely took up the shock of the dive.

The dive even provided a comic incident when a young man about 16 years old jumped from a 70-foot-high platform. Both of his lianas broke, and he lay face down on the ground, seemingly dead. His mother and sisters started sobbing, while the men rushed out to help. Just then the boy jumped up with a shout and a laugh and embraced his family. He had been pretending.

Last to Go Falls the Farthest

The divers jumping from the highest platforms displayed supreme skill and coordination. Because the tower's front starts sloping back around the 50-foot level, they must dive outward as well as down (pages 808-9). Their helpers, stationed below them on the tower, keep the lianas from tangling in the previously used and broken platforms.

The excitement reached a crescendo for the final diver, a powerfully built 24-year-old man named Lala. Just a month earlier Lala had returned from the nearby island of Aoba after a year-long absence from Bunlap. Because he cut the first large trunk used to support the tower, he enjoyed the privilege of jumping from the highest platform—more than 80 feet above the sloping ground near the base.

Lala performed beautifully. He seemed at first to be floating, then was hurtling earthward, displaying perfect form. One liana broke as he touched the ground. When the other ankle was cut loose, everybody rushed out to congratulate him and to dance and sing around him.

That evening everyone still was talking about the successful land dive. Some of them congratulated me again, and asked if I could come back another time to jump with them—this time from the top of the tower.

Perhaps, bambai. THE END

Old Salem

MORNING STAR OF MORAVIAN FAITH

By ROWE FINDLEY
National Geographic Senior Staff

Wonder shines in young eyes at the Christmas Eve lovefeast in Old Salem, North Carolina. A tranquil fold of the past set in the heart of modern Winston-Salem, the restored town recaptures the sights and sounds known to hardy Moravians who built it on a wilderness hillside beginning in 1766. The Protestant denomination, formally the Unity of Brethren, predates Luther by 60 years and claims 360,000 followers across the world. Moravians may mark any special occasion with a love-feast, the sharing of a simple meal with music and meditation; two Christmas Eve services in Old Salem's Home Church are held especially for children. Candles symbolize the Christ Child's coming, God's answer of love to the world's dark hates.

Photographs by ROBERT W. MADDEN

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

YOU MUNCH a plump brown bun and sip a mug of steaming coffee, and that's all there is to a lovefeast, as far as the fare is concerned.

But a lovefeast is a feast of the heart, and for those who pack Old Salem's Home Church each Christmas Eve, it is rich fare indeed.

Moravians from Pennsylvania and Europe settled in this North Carolina Piedmont country in 1753. Twelve years later they began to clear land for their central town, which they named Salem—from the Hebrew word for peace. And on every Christmas Eve since 1771, when women and children began to join the menfolk in the raw new village, there has been a lovefeast here. Now my wife, three sons, and I were about to attend one.

"Just follow the crowds." This advice, overheard as we hurry along Academy Street, is hardly needed. Everyone in town seems headed for the hooded front entrances of Home Church as late-afternoon shadows climb the leafless tracery of trees that arch over Salem Square.

Bell Ringers and Carolers Proclaim Joy

Now we sit in the bright white sanctuary, our gaze upon a painting above the chancel showing the manger of Bethlehem. It is on a translucent panel and softly back-lighted, a traditional bit of Christmas from the 18th century. Over it hangs another traditional piece, a glowing Moravian star, its many long, slender points reaching out to the whole universe. As we sip the coffee and eat the bun, the sounds of Christmas swell over us—in the mighty rumble of the organ's great bass pipes, in the reverberating carols of young bell ringers, in the high unwavering purity of a young boy's voice. . . .

"Morning Star, O cheering sight!
Ere Thou cam'st, how dark earth's night!"

Echoing their small leader's song, a phrase at a time, the congregation celebrates the coming of the Christ. For me, fresh from a reading of the Moravians' bittersweet history, flood tides of other events rush to mind —events beginning with John Hus, Czech patriot and preacher who was burned at the stake in 1415 for demanding church reform. His call for a cutting away of pomp and dogma led to the founding, four decades later, of the Moravians' Unity of Brethren. Because of his anticipation of Luther's ferment, the Brethren know him proudly as "the Morning Star of the Reformation."

And as I visualize a pioneer town's candlepoint of civilization against primeval forest, the song seems to celebrate Salem itself.

Now chandeliers dim, and into the gloom march *Dieners,* or servers, bearing trays of flaming beeswax candles, one for each worshiper. With candles flickering like stars (opposite), the congregation stands and sings:

"Praise the Lord, Whose saving splendor
Shines into the darkest night;
O what praises shall we render
For this never-ceasing light!"

The 45-minute service didn't seem nearly that long. "I wasn't ready for it to end," said my wife Virginia, echoing my mood. We drifted outside and clustered together, a little uncertain island amid a purposeful current of people that swirled toward hollied doorways and crackling hearths.

"This way to the Salem Tavern for pumpkin soup, roast duck, and apple dumplings," I said.

"What else is it famous for?" son Steve, 12, wanted to know.

"Washington slept there," offered David, 15.

"Who said 'apple dumplings'?" asked 6-year-old John.

What David said about George Washington was true; our first President slept in the Tavern on two spring nights in 1791 during a state visit. You can read in Salem's official diaries how he was welcomed with trumpets, French horns, and trombones, how he admired the town's system of running water, attended a spirited *Singstunde,* or congregational singing, and made enough appearances to please farm families who surged in for a glimpse of "the most notable man in this country."

When you sup at the Tavern today, you do not go to the restored 1784 brick building, kept as it was in the 18th century. Instead, you find a table next door in the cheerful yellow-frame annex, built in 1816 to handle overflow guests and now equipped with modern kitchens to serve several hundred hungry people a day (see No. 35 in painting, pages 824-5). There, by a cheery upstairs fire, we dined off pewter, joined in some caroling, and had turnip soup because the pumpkin soup was gone.

The Salem Brethren who greeted Washington cocked an ear heavenward in all that they did, and their tight-knit community reflected this total reliance upon the Almighty. The church owned all town property, and the 100,000 acres of surrounding land purchased from Lord Granville, one of Carolina's royal

"Christmas 1800" returns to Salem as bandsmen fill the crisp December night with "Joy to the

proprietors. Society was divided into groups, or choirs, according to age, sex, and marital status: little children, older boys, older girls, the adult single brothers, the single sisters, the married men and women, the widowers, and the widows. The single sisters and the single brothers lived in separate communal houses (above). Fun and worship as well as work were often conducted by choirs, and when members died, and were laid in God's Acre, they were buried not in earthly families but in their proper choirs.

Even in marriage, the church polled divine will through a curious device—the lot (page 828). All important questions were decided by drawing one of three hollow reeds from a wooden bowl. One reed held *"Ja,"* one *"Nein,"* and the third was blank, meaning the question was premature or needed rephrasing.

The lot developed out of the Moravians'

World." Half-timbered Single Brothers House once sheltered all unmarried males from age 14.

absolute faith in divine guidance in all things affecting their lives. Thus they surveyed and resurveyed sites when the lot rejected the first five locations chosen for Salem.

But it was the issue of marriage that foredoomed the lot. From America especially, the ruling synod in Europe heard increasingly of sad plights, such as the seven noes drawn by leading Salem citizen John Vogler and his intended. At last, in 1819, the synod exempted matrimony from the lot bowl's tasks. John wed his Christina, a union lasting 44 happy years. The lot was on its way out.

The Old Salem that greeted us last Christmas Eve had long since ceased to be the tight-knit pioneer settlement it was, but the sights, sounds, and spirit of those early days were very much alive.

"We think Old Salem is different from other restored communities because people

still live here and work here, or go to jobs in Winston-Salem," explained James A. Gray, Chairman of the Board of Old Salem, Inc., the nonprofit corporation that runs the historical district. "Some of our homes are restored by private owners, under our control and guidance, and they live in them the year round."

The presence of the Home Moravian Church on the Square, with about 1,900 members, also helps make this a living town. The Christmas Eve lovefeasts, when the church fills up four times and still must turn people away, and the annual Easter Sunrise Service, when 20,000 or 30,000 people come to God's Acre, are two examples of a program that spans all seasons.

"Fires in the Fireplaces, Apples in the Bowls"

A man who worries about how lively and real Old Salem seems to its visitors is Nicholas B. Bragg, the Director of Education and Interpretation.

"What do you do with the Single Brothers House, the Boys School, or any of our other six walk-through buildings to convey the mood and environment of early Salem?" he asks. "The important thing is to bring action and life to the old houses. That's why we have a tinsmith making candle sconces or cookie cutters, a dyer brewing yellow dye in a pot of onion peels [page 831], a gunsmith shaping a maple stock [page 827]. That's why we have a village pump for you to work, fires in the fireplaces, apples in the bowls."

Nick Bragg has no need to worry. From the 50 states and many foreign lands the visitors come—100,000 a year—and find the world of today falling away. Teacher Marjorie Corum of Kernersville, North Carolina, shepherded her fifth-graders through the town and said, "They seem to feel they are actually walking the streets in the 1700's." Joe McDonald of Columbus, Ohio, began visiting relatives in Old Salem each Christmas and became fascinated with making beeswax candles. To date he has made 2,000 for his state historical society, which uses them in historic Ohio homes.

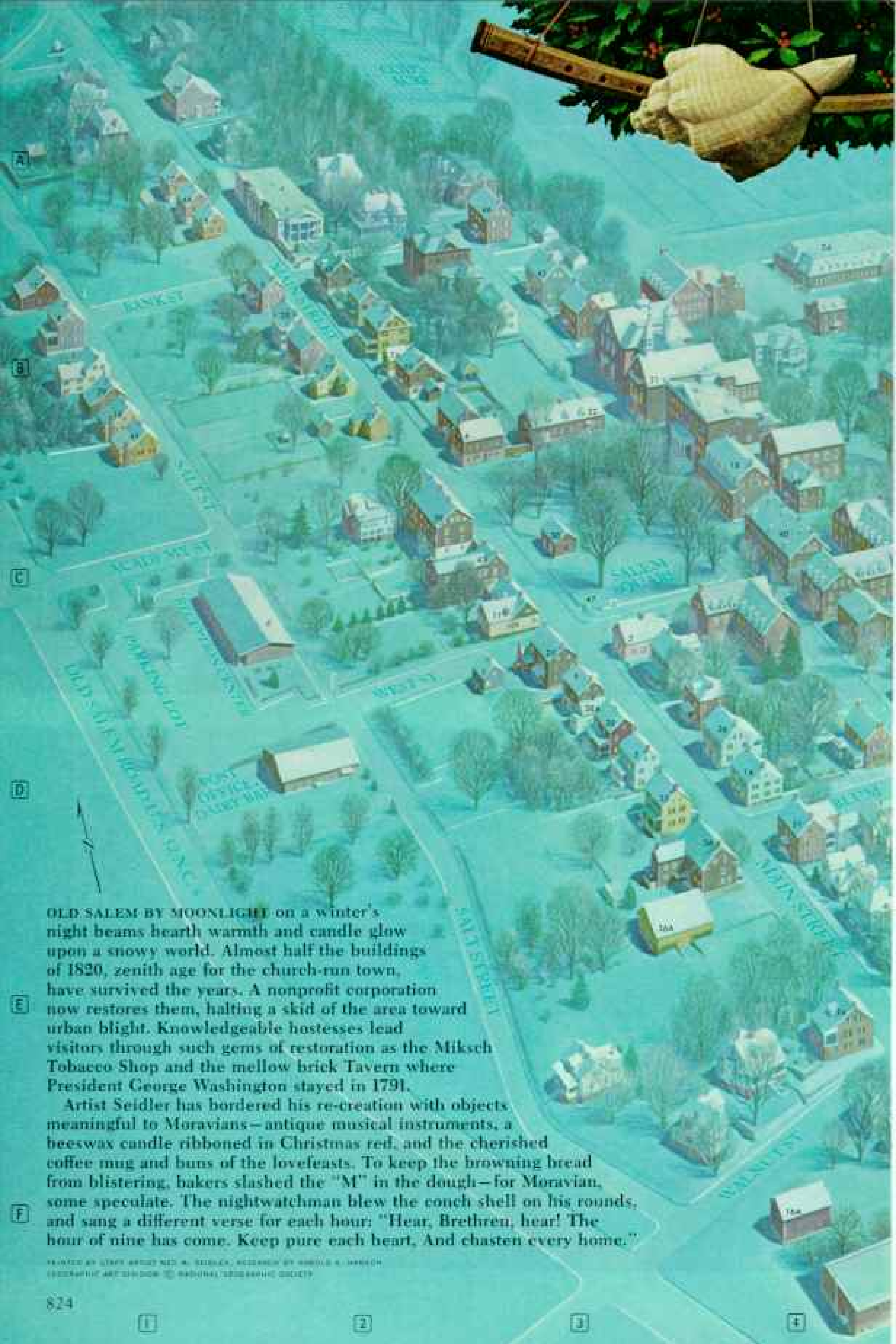
Seeking the Salem of the past, our boys seemed strongly moved by their sense of smell—right through the Dutch door of the Winkler Bakery, where Master Baker Edwin P. Hale (page 826) directs a crew of six each weekday morning in producing 125 loaves of assorted white, honey-wheat, and pumpernickel bread, plus 20 pounds of Moravian cookies, plus 25 trays of gooey brown Moravian sugar cake.

But it was the small 18th-century pipe organ in the *Saal*, or meeting room, of the half-timbered Single Brothers House that brought the Moravians' past back most sharply for me. No syrupy triller of tunes, this instrument, but a harsh and biting enunciator of sound that bespoke iron character and faith forged in flames of persecution and death. I could see resolute John Hus's face through the smoking faggots of his funeral pyre, hear the musketry and cannonading that marked the growing wars between the Brethren and Romish forces in Bohemia and Moravia, wars that culminated in 1621 with defeat for the Unity, and 100 years of persecution.

Window on a simpler age frames 20th-century visitors to restored Main Street. This view from the 1769 Single Brothers House looks out on a corner of the 1771 Miksch Tobacco Shop and across the street to the hooded front of the 1800 Winkler Bakery. Some 100,000 people annually visit Old Salem, whose exhibits remain open all year.

To feed a multitude, lovefeast *Diencrs*, or servers, fill coffee mugs swiftly from two-gallon tin pots kept shiny by use. The efficient team serves nearly 1,000 partakers in a few minutes. Coffee comes sugared and liberally laced with milk to help wash down brown buns. The sharing of simple meals by early Christians inspired the lovefeasts, first celebrated by the Moravians in 1727 at Herrnhut in Saxony, where the Unity had flowered after a century of persecution in Bohemia and Moravia.

BOTTOM PHOTO © NATIONAL GEOGRAPHIC SOCIETY



OLD SALEM BY MOONLIGHT on a winter's night beams hearth warmth and candle glow upon a snowy world. Almost half the buildings of 1820, zenith age for the church-run town, have survived the years. A nonprofit corporation now restores them, halting a skid of the area toward urban blight. Knowledgeable hostesses lead visitors through such gems of restoration as the Miksch Tobacco Shop and the mellow brick Tavern where President George Washington stayed in 1791.

Artist Seidler has bordered his re-creation with objects meaningful to Moravians—antique musical instruments, a beeswax candle ribboned in Christmas red, and the cherished coffee mug and buns of the lovefeasts. To keep the browning bread from blistering, bakers slashed the "M" in the dough—for Moravian, some speculate. The nightwatchman blew the conch shell on his rounds, and sang a different verse for each hour: "Hear, Brethren, hear! The hour of nine has come. Keep pure each heart, And chasten every home."

PAINTED BY STAFF ARTIST NED M. SEIDLER, RESEARCH BY HAROLD E. MIKSCH
GEOGRAPHIC ART DIVISION © NATIONAL GEOGRAPHIC SOCIETY

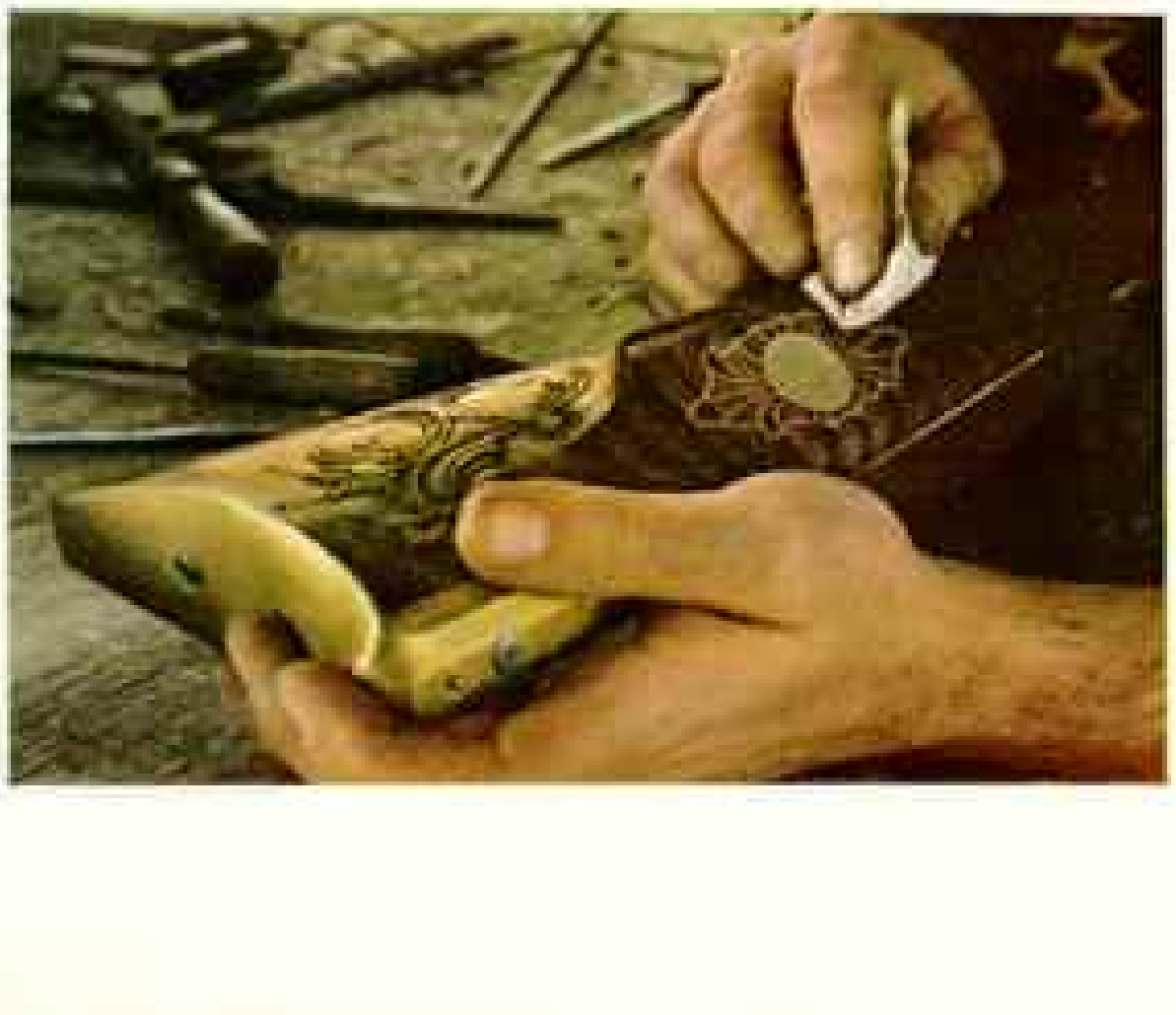
OLD SALEM LANDMARKS WITH DATES OF CONSTRUCTION. (R) INDICATES RECONSTRUCTED BUILDINGS. (SC) SALEM COLLEGE BUILDINGS.
1. ANNA CATHARINA HOUSE, 1772 C3
2. BAGGE HOUSE, 1787 (R 1970) C3
3. BANK OF CAPE FEAR (GALLERY OF CONTEMPORARY ART), 1847 B2
4. BELO HOME, 1860 A2
5. BLUM HOUSE, 1815 D3
6. BOYS SCHOOL (WACHOVIA MUSEUM), 1794 B2
7. BUTNER HOUSE, 1829; 7A, SHOP, 1828 (R 1968) B2
8. CHRISTMAN HOUSE, 1823 B1
9. CHRISTOPH VOGLER HOUSE, 1797 C3
10. COFFEE POT, ABOUT 1827 A1
11. COMMUNITY STORE, 1775 C3
12. DENKE HOUSE, 1823 B1
13. EBERHARDT HOUSE, 1832 F6
13A. SHOP, 1834 (R 1967) F5
14. EBERT-REICH HOUSE, 1793 D4
15. FIRST HOUSE, 1768 (R 1969) A1
16. FOLTZ HOUSE, 1816 F5
16A. BARN, ABOUT 1800 F6
17. FOURTH HOUSE, 1768 A1
18. GIRLS BOARDING SCHOOL (SC), 1805 B4
19. HAGEN HOUSE, 1816 B1
20. HALL HOUSE, 1827 A1
21. HOME MORAVIAN CHURCH, 1800 B3
22. INSPECTOR'S HOUSE (SC), 1810 B3
23. JACOB SIEWERS HOUSE, 1847 E5
24. JOHN SIEWERS HOUSE, 1844 E4
25. JOHN VOGLER HOUSE, 1819 C3
26. JOSHUA BONER HOUSE, 1844 D4
27. KUHLN HOUSE, 1831 E5
28. LEINBACH HOUSE, 1822 B2
29. LICK-BONER HOUSE, 1787 B1
30. MARKET-FIRE HOUSE, 1803 (R 1955) C3
31. MIKSCH TOBACCO SHOP, 1771 B3
32. MUSEUM OF EARLY SOUTHERN DECORATIVE ARTS, 1965 F5
33. PHILIP REICH HOUSE, 1826; 33A, SHOP, 1822 D3
34. SALEM COLLEGE FINE ARTS CENTER, 1965 A4
35. SALEM TAVERN DINING ROOMS, 1816 D5
36. SALEM TAVERN MUSEUM, 1784 D4
36A. BARN (FARM MUSEUM), ABOUT 1800 E5
37. SCHROETER HOUSE, 1832 (R 1968) B3
38. SCHULZ HOUSE, 1819; 38A, SHOP, 1827 D3
39. SINGLE BROTHERS HOUSE (CRAFT SHOPS), 1769, 1786 C3
40. SINGLE SISTERS HOUSE (SC), 1786 C4
41. SOLOMON LICK HOUSE, 1823 B1
42. STEINER HOUSE, 1822 B3
43. THE OLD SALEM STORE, 1867 C3
44. THIRD HOUSE, 1767 (R 1969) A1
45. TIMOTHY VOGLER HOUSE, 1832 E5
45A. SHOP, 1831 F5
46. VIERLING HOUSE, 1802 A3
47. VILLAGE PUMP, 1787 (R 1955) C3
48. VORSTEHER'S HOUSE (MORAVIAN ARCHIVES), 1797 B3
49. WASH HOUSE, GIRLS BOARDING SCHOOL (SC), 1805 C4
50. WINKLER BAKERY, 1800 B3
51. ZEVELY HOUSE, 1842 D4
CHURCH STREET
BACK ST.
5
6
WINSTON-SALEM
Calvary Moravian Church
Old Salem
UNDER CONSTRUCTION
Bethlehem
Trenton
Harrisburg
PENNSYLVANIA
N.J.
Dover
Annapolis
W. VA.
MD.
DEL.
Washington, D.C.
VIRGINIA
Richmond
Norfolk
KENTUCKY
Nashville
TENNESSEE
Bethabara
Kernersville
Winston-Salem
Durham
Raleigh
NORTH CAROLINA
SOUTH CAROLINA
ALABAMA
GEORGIA
Columbia
Birmingham
Atlanta
Atlantic Ocean

Heritage of time-tested recipes stands behind Master Baker Edwin P. Hale, cutting out heart-shaped cookies. An oak-and-hickory fire built directly in the yawning oven each weekday morning heats it to 440° F. When the coals are raked out, baking proceeds in descending order of temperature needs—white bread, rye or honey wheat, Moravian sugar cake, cookies. Output of the Winkler Bakery seldom equals demand.

I could hear the notes of hope that surged in 1722 when a tiny band of exiles escaped to refuge in Saxony on the estates of devout Nicholas Lewis, Count of Zinzendorf, who allowed them to found a village called Herrnhut on his lands, and became their beloved patron and leader. Here the church suddenly flowered from its "hidden seed" so carefully and perilously nurtured during the century of hiding, and from here flowed a wellspring that sent Moravian missionaries all over the world, and settlers to plant the faith on the untamed lands of North America.

I could see the deep-set eyes and heavily jowled chin of Bishop August Gottlieb Spangenberg, first leader of the Unity in America, as he captained an exploration party heading southward from the congregational town of Bethlehem, Pennsylvania, in the fall of 1752 to seek a site for settlement in Carolina. By January 1753, he would write: "It is the middle of winter, and the ground is covered with snow; but we are camping in the forest, well and content, under the wings of the Almighty. . . . The land on which we are now encamped seems to me to have been reserved by the

EXTERIORS BY ROBERT W. MADDEN © N.G.S.



Tap of the cobbler's hammer drives wooden pegs by the light of a "shoemaker's window," waterfilled globes that magnify and concentrate a single candle. One globe produces the effect, but four can serve as many craftsmen. E. Rom Ray works in a shop in the Single Brothers House.

Gunsmith's pride, curly-maple stock of a long rifle glows with silver inlay, a brass butt plate, and a rubbing of linseed oil. Pacifist Moravians made only hunting weapons in pioneer days, but in the Civil War they formed regimental bands for Confederate units. Today they leave military service to individual conscience.

Lord for the Brethren. . . . It has countless springs, and numerous fine creeks; as many mills as may be desired can be built. There is much beautiful meadowland. . . ."

"Women's Liberation" 300 Years Ago

Except when Moravians put on colonial homespuns for a pageant, they don't look different from anybody else, but I knew that they were different. I went to talk about that difference with Dr. J. C. Hughes, for 16 years Pastor of Home Church, and Chairman of the Central Elders, a body representing 14 of Winston-Salem's Moravian churches.

"Moravians have always been contemporary in most respects," Dr. Hughes told me. "Two of their outstanding differences, in education and music, arose originally from the teachings of John Hus."

Hus never contemplated forming a new church, but wished to reform the old one, chiefly by putting Christian duty before dogma and by returning to the people the practices of worship—the singing, and the reading and explanation of the Scriptures. The latter two points required literacy and musicianship; Moravians became leaders in both.

Dr. Dale H. Gramley, President of Salem College, helped me understand why women were included in the Moravian educational system, contrary to the custom of the times. He referred me to a quotation from John Amos Comenius, a Moravian bishop and educator (1592-1670). Legend has it that Comenius turned down the presidency of Harvard to remain close to his Moravian people, then under severe persecution in central Europe. More than 300 years ago he wrote:

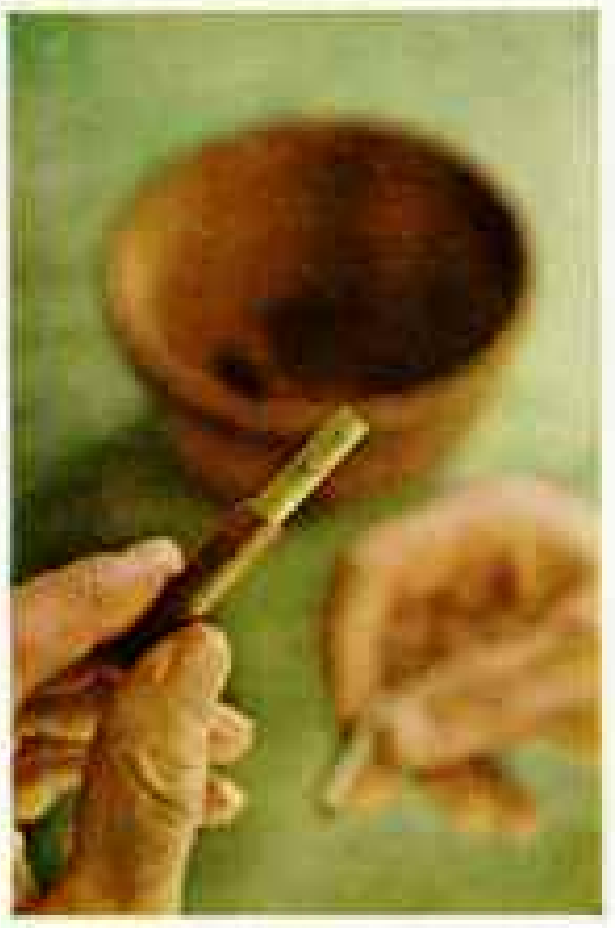
"No reason can be shown why the female sex . . . should be kept from a knowledge of language and wisdom. For they are also human beings, an image of God, as we are. . . . Why then should we merely dismiss them with the A B C and drive them away from books? Are we afraid of their meddling? The more we introduce them to mental occupations, the less time they find for meddling, which comes from emptiness of mind."

"In 1772," Dr. Gramley said, "the Salem community opened a school for its two little girls, although they were only 3½ and 5 years old. That was a year before they began a school for the boys."

The girls' school soon became Salem Academy—a still-vigorous institution with 155 students—from which Salem College evolved in the 1880's. The college now enrolls some 570 girls and a few boys from 27 states and three foreign countries. There will be a 200th-anniversary celebration in 1972.

As for music, it is as much a part of Moravian life as food and drink. Moravians joke that they give their babies horns in place of rattles. Pioneer Moravians in America were performing Bach and Handel when other settlers were happy to hear a jew's-harp or some raspy fiddlin'. The Brethren greeted each festival day with trombone fanfares, sounded horns from rooftops in thanks for the completion of new buildings, announced births, marriages, and deaths with special hymns, and in between times sang or played just for the fun of it.

Colonists of more puritanical persuasion doubted that the Creator could look with favor upon so much music-making. Moravians delight in the story of an exchange



"*Nein,*" says the lot, used by early Moravians to seek divine guidance on major decisions, including marriage. The lot bowl held three reeds: "*Ja,*" "*Nein,*" and a blank that meant the question was premature or poorly phrased. The practice finally died about 1836.

Bowed heads ask blessing on a candlelit meal in the Single Brothers House. Students in a seminar on historic restoration wear 18th-century dress for a Moravian cook-in: stew, slaw, hoecake, molasses, cider.

between a zealous young preacher and a more practical-minded older minister, after both had enjoyed a lively concert by musically talented Brethren. Was it proper, the young cleric wondered, for these performers to use the same instruments to worship the Lord? "And shall you, sir," the older minister countered, "preach with the same mouth with which you are now eating sausages?"

Whether making sausages or music, Moravians had a tendency to excel, a habit which was noted in Salem's earliest days, when a provincial North Carolina assembly debated ways to improve the colony's lamentably weak craftsmanship. It was proposed to offer prizes for excellence in the crafts, and one legislator rose to say he endorsed the proposal, with the stipulation that Moravians be excluded from the competition, lest they carry off all the awards.

When I asked about the source of Moravian incentive, Nick Bragg credited it all to their pietistic religion. "They believed that anything worth doing was worth doing well," Nick said. "They believed that the Lord was equally concerned with all aspects of life, noble or humble."

Town Was Drifting Toward Destruction

Salem village fathers of 1849 might claim divine guidance in keeping their town from becoming the new Forsyth County seat, which was located instead no more than a mile to the north in the new town of Winston. They made Salem an urban backwater that remained fairly static while Winston grew and changed around it.

But by the 1930's and '40's Salem had become such a backwater that a slide toward slum conditions seemed irreversible. Snack

stands and neon-faced markets rose in the shadow of Home Church and Salem College; utility wires sagged from creosoted poles. Salem appeared marked for lingering death from urban blight.

The Allen Sisters Save a Tavern

A few worried voices tried to arouse the citizenry, but hardly anyone seemed to be listening.

One worrier decided upon direct action in 1929, when the historic old Tavern was about to be converted to apartments. Miss Ada Allen, petite Salem College alumna—a former art teacher there, and for years a Winston-Salem interior decorator—persuaded the Tavern owners to lease the building to her. Then, because the lease was taking her rent money, she and three sisters moved in. They lived there for ten years.

Her holding action worked. She stirred the concern of R. J. Reynolds, Jr., of the tobacco family, and he bought the property for the Wachovia Historical Society, which later leased it to Old Salem, Inc.

The vision of a restored Moravian town began to stir others. Mr. and Mrs. William K. Hoyt bought the 1793 Ebert-Reich House in 1937. Dr. and Mrs. George E. Waynick moved into the 1831 Kühln place and started restoring it.

Then Charles H. Babcock, Sr., son-in-law of the senior R. J. Reynolds, decided the time was right for uniting citizens into a body that would restore Salem. And that is how Old Salem, Inc., was born, in 1950. Miss Allen became a trustee.

"I never had money to put into it," she told me, "just enthusiasm. But once Winston-Salem people start on a project, you can count on them."

It has been a unique partnership, and not always an easy one, but it has worked. Private citizens, local foundations, the governments of Winston-Salem and Forsyth County, the Moravian Church, Southern Province, and, in recent years, the State of North Carolina all have contributed money or effort. No Federal assistance has been sought.

Today's flourishing Old Salem program makes it difficult to recall those shaky early days. But Board Chairman Jim Gray remembers them well.

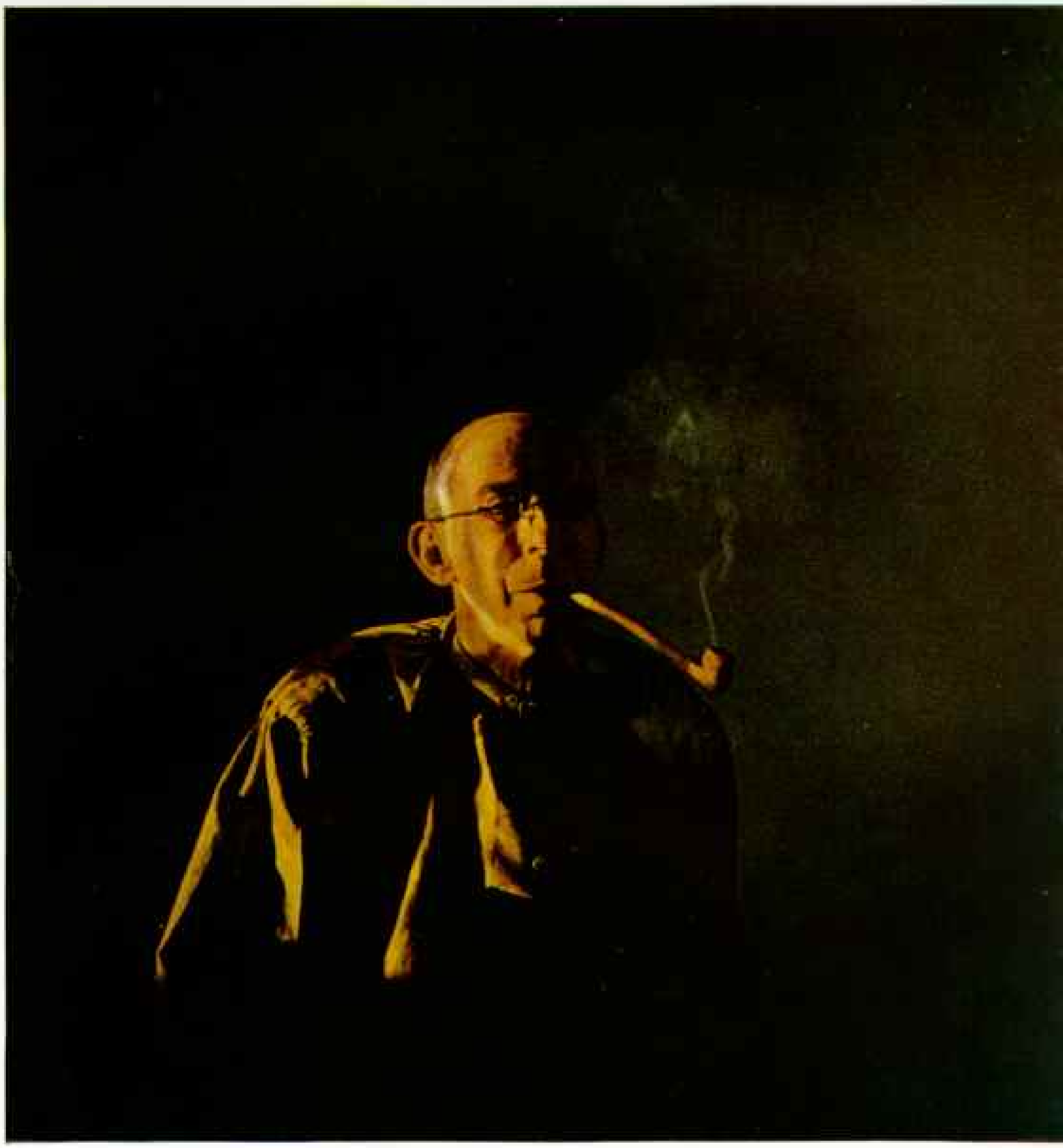
"We operated for 18 years under a zoning ordinance that nobody believed would stand up in court," he told me. To protect the historic area, the city statute provided architectural controls that had never been authorized by any state legislative action.

When one property owner seemed determined to test the zoning law in court, Jim bought the house and held onto it until Old Salem, Inc., could take it off his hands.

Today Old Salem has a zoning law solidly based on a 1965 state statute calling for the

With a gasp and a gush, the town pump provides a foot bath for children. Salem boasted a gravity-flow water system, with hollowed-log pipes, that won George Washington's admiration. Across the Square, the 1786 Single Sisters House remains a house for single sisters; it's a girls' dormitory of Salem College.

Boiling brew of onionskins offends the nose but makes yellow dye to tint yarn. Like craftsmen of old, Salem dyers use only natural substances—elderberries, maple bark, Queen Anne's lace, sassafras root, to name a few. In early Salem, ribbons were badges of a woman's status: blue for married, white for widowed, pink for single adults, pale pink for little girls, cherry for older girls.



Profile of a Moravian: Salem has always known kin of Peter Blum, Jr., who left an electronics job to become town tinsmith, turning out candle sconces and sausage stuffers. As youngsters watch, he shapes cookie

preservation of historic areas as a common heritage.

Other problems continue, however. The traffic that clogged Main Street had to be rerouted over a new bypass; unsightly utility wires went underground. Some $6,000,000 has gone into making Old Salem live again.

The man responsible for the actual restoration still marvels at how he became involved.

"I was an antique dealer," Restoration Director Frank Horton said, "and I wanted to check details of an early house. So I went to the archives of the Moravian Church. There I met Dr. Adelaide Fries."

Dr. Fries, for three decades the church's chief archivist, compiled a multi-volume history that not only evokes professional awe but reads better than most novels. Perhaps she perceived in intense young Frank Horton a worthy recruit for the cause of preserving the Moravian past. She dazzled him with the wealth of records available on Old Salem buildings and got him as thoroughly hooked on the old structures as he was on antique

CATACHROME BY ROBERT W. MADDEN © N.G.S.

cutters in the form of a child's hand—"the best tool ever made, I tell them." Clay pipe comes from an 18th-century mold, octagonal glasses from a grandfather. His silver cornet sweetens church bands (page 821).

furniture. He has been restoring buildings for Old Salem ever since, and he has never accepted a cent of salary.

The trail of the past has led not only into musty local attics and cellars, but across the Atlantic to far-off Herrnhut, behind the Iron Curtain in East Germany.

"The plans and elevations for many houses in Salem, including the first house built, were found in the archives there," he said.

The first buildings in nearby Bethabara, initial site of Moravian settlement, have long since vanished, though the 1788 church still stands. On a late-winter afternoon I drove six miles northwest from Salem to view it in the gray of dusk. The name means "House of Passage," and that's just what its founders planned it to be, a transition town to be used until Salem was ready for occupancy.

But before that could happen, there came the French and Indian War, from 1754 to 1763. The pacifist Brethren built a stockade for protection. After the war, visiting Cherokees confessed that it was not the log walls

that deterred them, but the frequent ringing of a bell and playing of horns—big medicine indeed to men whose ears had never been bombarded by such sounds!

Though Frank Horton turned to restoring buildings, he never gave up restoring antiques. As a measure of his talents, he created a new institution for Old Salem, a joint venture with his mother, Mrs. Theo. Taliaferro, also an authority on antique furnishings. The resulting Museum of Early Southern Decorative Arts, at the foot of Main Street, contains 15 rooms furnished by period from 1690 to 1820.

Special recognition came to Frank and to Old Salem, Inc., last month, in the form of the most prestigious prize that can be awarded by the National Trust for Historic Preservation—the Louise duPont Crowninshield Award for superlative achievement in restoration.

"Sleepers, Wake!" Say Predawn Easter Bands

Bridging the present and past (and as old as the Christmas Eve lovefeasts), Salem's traditional Easter sunrise service brings the biggest throngs of the year to Church Street and the grassy aisles of God's Acre.

"It takes 2,000 people just to stage the service, and almost 500 of them are members of the bands," said Dr. Edwin L. Stockton. We talked in his office, where he works as Treasurer of the Moravian Church, Southern Province, across upper Church Street from his carefully preserved early-19th-century home. "You ought to go out with one of the six church bands that begin playing on street corners at 2 a.m."

Grooming God's Acre for Easter requires toothbrushes to scour the incised lettering of headstones to uniform whiteness (above); flowers bedeck virtually every grave. Thousands gather at Easter sunrise to proclaim, "The Lord is risen!" and march into the graveyard to the antiphonal chorales of half a dozen bands.

Flat stones show humility; uniform size reflects the democracy of death. Burial is not by families but by choirs—groupings by age, sex, and marital status.

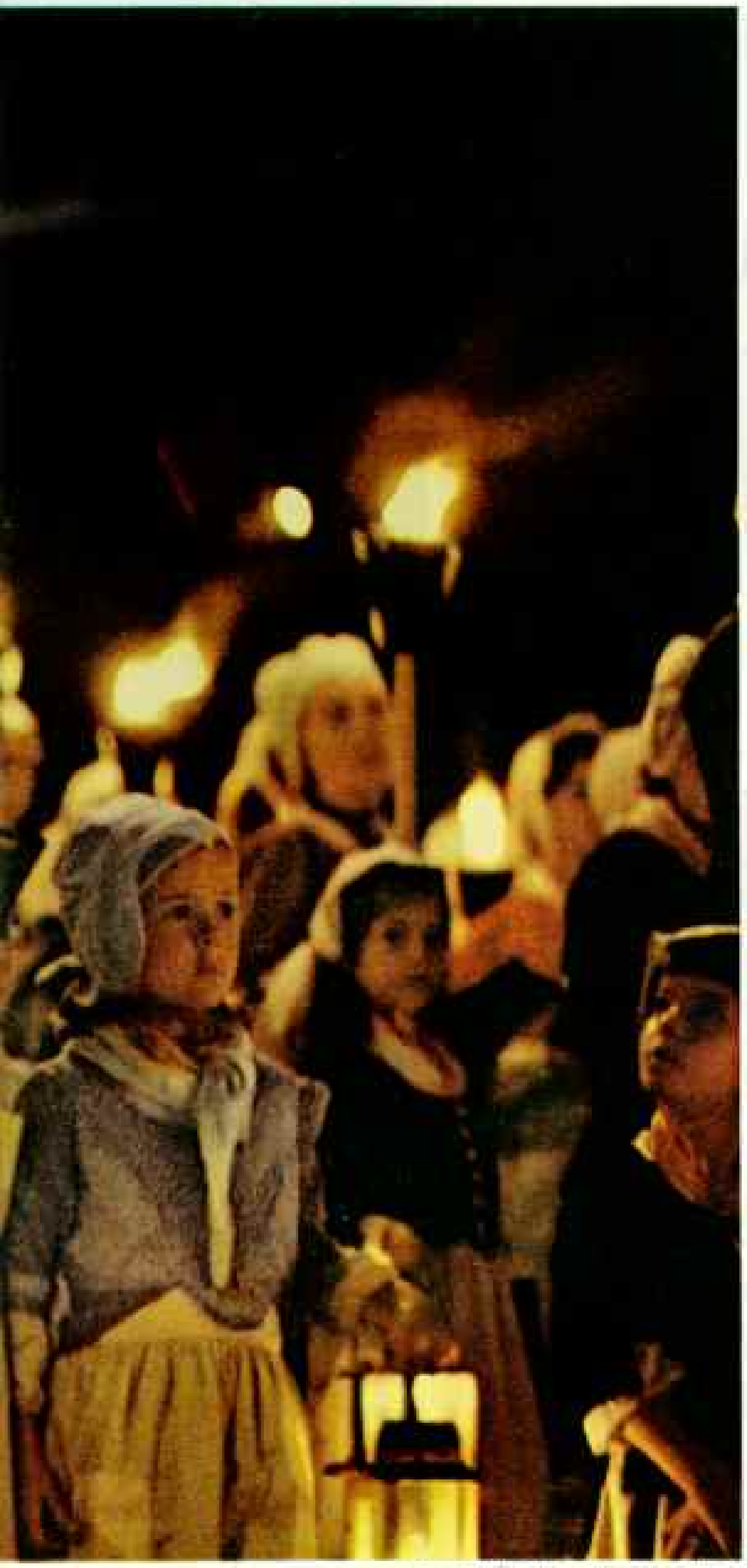
Benediction of peace, 1783: Salem salutes the Nation's first Independence Day without war;

With Dr. Stockton's help, son Steve and I got invited to follow musicians of Calvary Moravian Church. I was happy to see that they were led by my friend Peter Blum, Jr., Old Salem's resident tinsmith. They would make their way to Home Church, pausing to play here and there. Since they would cover quite a distance, they would go by bus. I was glad of that, too, for it was raining.

"Sleepers, Wake!" the brass choir commanded on a corner outside Calvary Church, and the chords of the opening chorale drifted into the dark and drizzle. Then we all clambered onto the bus, being careful of the clearances for the tubas and trombones.

After a two-hour musical pilgrimage, we reached Home Church, where the rest of my family joined us for the traditional predawn band breakfast for almost 500 musicians.

We had to pass up seconds on the homemade biscuits in order to be in Salem Square before 5:30. As the silver-toned bell atop the



detailed accounts permit this authentic restaging.

church chimed out, church pastor Dr. Hughes emerged from the front entrance and, mounting a green wooden dais, proclaimed:

"The Lord is risen!"

"The Lord is risen indeed!" responded the multitude, stretching away out of sight—an estimated 20,000 strong despite the drizzle.

The traditional Easter liturgy begins at the church and concludes a few hundred yards to the north in God's Acre, where more than 4,000 Moravian dead await the coming of Christ. While the throng shuffles silently, reverently up Church Street, the six bands play antiphonally, one proclaiming a musical phrase from the Square, another answering from a point along the way. Reassembling in the graveyard, the massed musicians under veteran bandmaster Austin E. Burke, Jr., make the gray dawn vibrate with the throbbing triumph of Beethoven's "The Heavens Are Telling."

And with that, the thousands of people sing:

"Then let the last loud trumpet sound,
And bid our kindred rise;
Awake, ye nations under ground;
Ye saints, ascend the skies."

After such an Easter, I did not expect that my emotions could be played upon much by any other observance Old Salem had to offer. I was wrong. There was the Fourth of July. Old Salem has brought it to life again as it was in 1783 on the first Independence Day after peace with Britain was signed (left).

An extraordinary job of historical detective work, begun by the late Dr. Fries and concluded by the able researchers of the Moravian Music Foundation, has brought to light the original "Psalm of Joy" sung on that day, as well as records of the other activities. The Brethren celebrated in response to a proclamation by the governor that North Carolinians hail the day "with solemn Thanksgiving." This the Moravians did with great feeling, for as pacifists they had suffered mistrust, abuse, and exploitation by both sides during the eight-year struggle.

But it was not the restaging of those 1783 events that I found so moving, nor was it the singing again of the "Psalm of Joy," although that was glorious music.

What stirred me the most was a custom that Home Church has followed since 1837, during an early-morning service on the Square. Members sing patriotic hymns, and the pastor reads the Declaration of Independence. . . . "We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness. . . ."

As those words rang across the historic Square, it occurred to me that I could think of no more appropriate way to mark the Fourth. Those words got right to the heart of the matter. The way John Hus did. The way lovefeasts do, with a direct simplicity that is part of the Moravian genius. THE END

Frederick G. Vosburgh Retires as Editor; Gilbert M. Grosvenor Succeeds Him

By MELVIN M. PAYNE, Sc.D.
President, National Geographic Society

AFTER NEARLY 37 YEARS OF SERVICE to the National Geographic Society, Frederick G. Vosburgh has retired as Editor of its magazine and other publications. To succeed him, the Board of Trustees elected Gilbert M. Grosvenor, 39, who had risen to Associate Editor since joining the staff 16 years ago.

I was present at the board meeting during which Mr. Vosburgh announced his decision. It was no surprise: He had passed the Society's normal retirement age of 65 and continued as Editor an additional year at the board's request, but he had told us he wished to retire this fall to devote more time to writing.

Nevertheless, when the words brought us face-to-face with the finality of his decision, they had a startling impact. The NATIONAL GEOGRAPHIC, it came home to us suddenly, was losing the services of a man whose talents were peculiarly suited to its needs, whose voice had been heard and heeded on every major editorial decision taken in the past 20 years. All of us at the GEOGRAPHIC would henceforth be without our daily contacts with a colleague who could at times be a scathing critic, but on whose fairness and firm friendship one could always rely.

As the meeting closed, Dr. Melville Bell Grosvenor, Editor-in-Chief and Chairman of the Board, summed up in the language of the sea that comes naturally to him:

"No magazine ever had a steadier, more reliable helmsman than Ted Vosburgh. This ship will miss his hand on the tiller, although I know the crew he has gotten together will do a great job."

Mr. Vosburgh has also retired as a Vice President of the Society, but he remains a Trustee.

Driven by a Curiosity That Never Quits

I had been with the Society little more than a year when, in October 1933, Ted Vosburgh joined the magazine's editorial staff. With him the slim young man of 29 brought a bachelor's degree in liberal arts from Syracuse University, a Phi Beta Kappa key, and 11 years' experience as a reporter, the last seven with the Associated Press.

He brought other assets, of course, and not the least was a reserved yet dynamic enthusiasm that never, in all the passing years, dwindled. In our cafeteria dining rooms I have many times heard staff writers, researchers, photographers speaking in awed tones of Ted's persistence with a story idea he thought good.

"Start boning up on the solar system," one of them remarked

Eye of the Editor scrutinizes every picture, every word that appears in the magazine. Here Frederick (Ted) Vosburgh, right, near screen, evaluates illustrations for a March 1970 article on Japan's Kansai region.

In the Everglades, Ted and wife Pat explore the Anhinga Trail, pursuing a lifetime rapport with wildlife. Their companions: Dr. Alexander Wetmore, left, a Society Trustee and famed ornithologist, and naturalist-photographer Frederick Kent Truslow. As Ted left the GEOGRAPHIC helm, Pat retired as Editor of the American Psychiatric Association magazine *Hospital & Community Psychiatry.*

ANTACHROME (TOP) BY GORDON GAHAN; KODACHROMES BY NATIONAL GEOGRAPHIC PHOTOGRAPHER OTIS IMBODEN © N.G.S.

B. ANTHONY STEWART

Revisiting his home valley after World War II, Ted Vosburgh wrote "Drums to Dynamos on the Mohawk," July 1947. Here he rides the New York river with skipper Edgar J. Beverly.

J. BAYLOR ROBERTS

Far afield, Mr. Vosburgh tours Taiwan in a pushcar in 1949. His timely "Formosa—Hot Spot of the East" appeared soon after the Nationalist Chinese fled there from the mainland.

At the bottom of the world in 1960, Ted visits Marble Point, near Antarctica's strange dry valleys. His GEOGRAPHIC travels have taken him to the South Pole and within six degrees of the North Pole by air. Subjects of his articles have ranged from the Adirondacks to postwar Berlin and Japan, from jet airplanes to fireflies. During World War II he served three years overseas with the U. S. Army Air Forces.

KODACHROME BY KEN HUBER, © N.G.S.

Tossing out the first ball, Ted opens the National Geographic Society's 1964 softball season. His interest in athletics was whetted when he covered sports as a young reporter.

a year and half ago. "Ted's got a thing about planets." Result: the memorable Weaver-Pesek article, "Voyage to the Planets," last August. But he was also fascinated by birds, and American Indians, baseball, Mexican archeology, Antarctica, bioluminescence, gypsies, space travel, swamps . . . the list could go on indefinitely.

His own signed articles in the GEOGRAPHIC —more than 20—reflect some of his interests. One of his best stories, "Threatened Glories of Everglades National Park," in October 1967, revealed how deeply he and his collaborator, Frederick Kent Truslow, felt about wild creatures and their preservation in an increasingly artificial world. It also set the staff a shining example of how to saturate an article with valuable, accurate facts and figures and at the same time make it a sparkling personal-experience account.

With naturalist-photographer Fred Truslow, his long-time friend (page 839), he roamed Florida's drought-ravaged "river of grass," meeting many of the park's creatures, from deer and eagles to rattlesnakes and alligators. Their story pointed out without editorializing, without stridency, the threat posed to this irreplaceable treasure by man's diversion of the life-giving water that once seeped naturally southward from Lake Okeechobee to the sea.

"The GEOGRAPHIC's way is to hold up the torch, not to apply it," I have heard Ted say of this democratic method of furthering a good cause by focusing on a problem and letting the readers decide what to do about it.

Concern over the danger to our total environment is reflected in the article that leads this issue—and, in a sense, this one demonstrates, perhaps better than his own signed stories, Ted Vosburgh's most valuable role at the GEOGRAPHIC. For though he is a fine and prolific writer, his major contribution has been as an editor.

New Dimensions in Map Making

The name Frederick G. Vosburgh appeared on the magazine's masthead as Assistant Editor in 1951, as Associate Editor under President-Editor Melville Bell Grosvenor in 1957, and as Editor ten years later. As Editor from August 1, 1967, to October 1, 1970, he exercised decisive judgment as to what the magazine should and should not publish, and on this he had strong views.

He believed that it was the function and duty of the GEOGRAPHIC to portray with a broad and sweeping brush the vast changes taking place in the world around us, for better or for worse.

"Our publication may be 80 years old," he told a staff writer one day, "but it is also as young as tomorrow." This conviction produced a series of what we sometimes call the "revolution" articles: "The Coming Revolution in Transportation" (September 1969), "The Revolution in American Agriculture" (February 1970), and last month's lead story, "Behold the Computer Revolution."

Maps, too, reflected his ideas. The June 1970 issue included as a special supplement a traveler's map of Italy, the first of its kind ever published by the Society. On a 23-by-33-inch sheet it presents not only a map but also paintings of important sites, a history of Italy, discussions of her art, music, and literature, a list of annual festivals, and more. It was a Vosburgh idea from the start, and he can be assured there will be traveler's maps of other lands in future issues.

Champion of Clear Prose

Were you to ask Ted's colleagues what it is like to work with and for him, you would hear first of all that it was never wise to hand him wordy or complicated copy. He has an impatience with dullness, a fondness for clarity. He once wrote in a memo to the editorial staff: "Our fundamental obligation is to make ourselves understood."

Next, you would learn that a writer had best know everything there was to know on his subject, cover everything that needed covering, and above all, never turn in an article that contained even a single badly written or evasive sentence. Ted would catch that sentence every time, no matter how many editorial eyes it had passed before it reached his desk.

Naturally, we've had staff members slow to forgive their chief for blistered egos. No one, however, could ever accuse him of rudeness. "Courtesy is one of the Society's chief principles," he told an Editorial Council meeting, and meant not just courtesy to outsiders, but good manners around the shop as well.

Finally, those who worked daily with Ted Vosburgh were impressed by his unwavering insistence upon accuracy. He examined, studied, probed with a mind and eye that

Plaudits from a poet: Carl Sandburg, left, wrote the inscription while preparing his "Lincoln, Man of Steel and Velvet," for the February 1960 GEOGRAPHIC. Here he is given a photograph of himself addressing a Joint Session of Congress on the 150th anniversary of Lincoln's birth. Of Mr. Vosburgh, Editor-in-Chief Melville Bell Grosvenor, center, said recently: "He is one of the great editors of our time. His insight in developing articles of interest and lasting value has been a prime factor in the Society's gain of 1,300,000 members in little more than three years."

were endlessly questioning. We have a staff of researchers second to none. Its veteran chief says, "He's caught us out a hundred times. I don't know how he operates in this respect. It must be a sixth sense."

A young staff writer put it this way: "The man can read a hole through a piece of paper."

In any event, the GEOGRAPHIC during the Vosburgh years came closer to absolute accuracy than any other publication I know, and I think the Society's growth in members over this period (from 900,000 in 1933 to 6,900,000) is in considerable part due to the fact that Ted helped give them a magazine they could not only enjoy, but trust as well.

More than once in the last years preceding his retirement, Ted would say to me, "I consider that my most important obligation to the Society and its magazine at this stage is the training of younger members of the staff to carry on the high standards we have always set for ourselves." How well he succeeded will be apparent, I am sure, in the years to come.

The new Editor, Gilbert M. Grosvenor, represents the third generation of his family to hold the position. He came to the GEOGRAPHIC in 1954 after graduation from Yale University. In the years since, with a two-year interruption for military service, he has worked for the Society and the magazine in a wide variety of capacities, playing an increasingly important role in the editing of photographs and in the selection and editing of manuscripts. As a photographer and writer he has produced articles on subjects ranging from the Netherlands and Monaco to Bali and Ceylon, the last three in collaboration with his wife Donna.

Experience Spans the Society's Activities

As Chief of the Editorial Control Center, Mr. Grosvenor has guided and coordinated the long-range planning of the Society's books, maps, and globes, as well as the monthly magazine. He has served as Editorial Director of the new Special Publications Division from its inception and has headed our Committee on Lectures for 12 years.

Early in his career at the Geographic, he completed a two-year apprenticeship in the administration department, serving with the Secretary, the Treasurer, the membership-fulfillment section, and the correspondence office. When he returned to the editorial side, he brought a real knowledge of how the magazine relates to our millions of members.

He was named Assistant Editor in 1964 and has served as an Associate Editor since 1967. He is a Vice President of the Society and a member of its Board of Trustees.

"Gil has played a major role in the improvement of the magazine, especially its illustrations," Mr. Vosburgh told the board. "Like his father and grandfather, he has a genius for pictures, and a sure knowledge of how the GEOGRAPHIC can best serve its educational purpose.

"He has been the source of many brilliant ideas, from the best way to photograph a Balinese farmer catching eels in the blackness of night to taking advantage of the latest advancements in papermaking and printing. An administrator with exceptional qualities of heart as well as mind, he has emerged as the natural leader of the talented young men and women of the staff who give so much hope for the future." THE END

New Editor Gilbert M. Grosvenor (center) joins President Melvin M. Payne (right) at the helm as Mr. Vosburgh retires. The election took place June 11, 1970, effective October 1.

KODACHROME BY JAMES K. SUGAR © N.G.S.

By FRANK X. OGASAWARA, Ph.D.
Photographs by EIJI MIYAZAWA, Black Star

Scientist Studies Japan's Fantastic Long-tailed Fowl

WOULD YOU BELIEVE your eyes if you saw a rooster with a 30-foot tail?

Breeders in southwestern Japan have been raising the remarkable long-tailed fowl for some three centuries.

A beautiful bird, evolved from the common domestic chicken, the long-tail is usually black and white but sometimes red and black or all white. The Japanese call it Onagadori, from *"O"* for tail, *"naga"* meaning long, and *"dori"* for fowl. Only the roosters can grow the long tails.

I am an avian physiologist of Japanese descent, though my Japanese vocabulary is limited. I became interested in the long-tail during a 1967 visit to Nagoya University, where research on the bird was under way. With support from the National Geographic Society, I returned to Japan in April 1970 to learn more about the creature. My plans included the hope of bringing back some eggs to the United States. Successful hatching could give this country breeding stock for research in genetics, cell growth, and the molting process.

I went to Japan harboring a false impression. Pictures I had seen of the long-tailed fowl showed it perched on a stone lantern or pine branch amid manicured temple grounds. From this I deduced that the Onagadori had fallen under the care of the priests of certain religious sects.

Showy cousins of common chickens, Japan's Onagadori grow feathers that may exceed 30 feet, but they must live nearly a decade to achieve such magnificence. Nine-year-old patriarch (opposite) parades a snow-white train. Stately black-and-white (above) remains unruffled while his owner untangles tail plumes.

Not so. I quickly learned that this bird has become the trust of fanciers and hobbyists, many of whom are by no means affluent. They cannot properly display the long-tails at their homes, and so they take them to those settings that do justice to their fabulous feathers.

Long Tails Limit Movement

A yen to specialize overtakes most breeders. They concentrate on developing color changes or greater length of tail, or on producing fowl to meet certain highly specific judging standards.

With photographer Eiji Miyazawa and interpreter Syuichi Itoh, I traveled southwest from Tokyo to Kochi on Shikoku (map, below) to meet a man who has achieved remarkable changes in color, a specialty called experimental breeding. Most Onagadori in Japan derive from the birds of Masashi Kubota.

Mr. Kubota had agreed to let us see and photograph his outstanding collection, developed over many years through selective breeding. He raises the three principal long-tailed varieties—the black-and-white Shirafuji and the two others that spring from it, the red-and-black Akazasa-onaga and the pure-white Shiro-onaga.

Mr. Kubota keeps most of his birds at his new Onagadori Center, beside the highway in a Kochi suburb called Nankoku. Visitors drop in to buy tea and sandwiches from one of his attractive daughters. For about 30 cents, they may proceed to the center's showroom to observe the long-tailed fowl.

We met Mr. Kubota at his Onagadori Center, and he led us through the teahouse to the showroom in the back, which he designed especially for the husbandry and exhibition of his valuable birds.

"There are no real secrets to raising the long-tailed fowl," he told us. "One must have good breeding stock and look for birds of calm disposition, and one must keep them in good health and train them to withstand confinement."

Several birds faced us from tall specially built roost boxes (page 851). A glass door on one of the narrow boxes let one see its occupant, his tail rolled into loops and suspended by a cord from a hook on the rear wall.

Except when being exercised or exhibited, the birds are kept constantly in the boxes to protect the yards and yards of tail feathers. If a bird gets sick or falls from his perch, the tail feathers may break off.

In adjacent breeding pens roosters with clipped tails enjoyed greater freedom. Birds chosen for breeding are usually those that won't adjust to the confinement of the roost boxes.

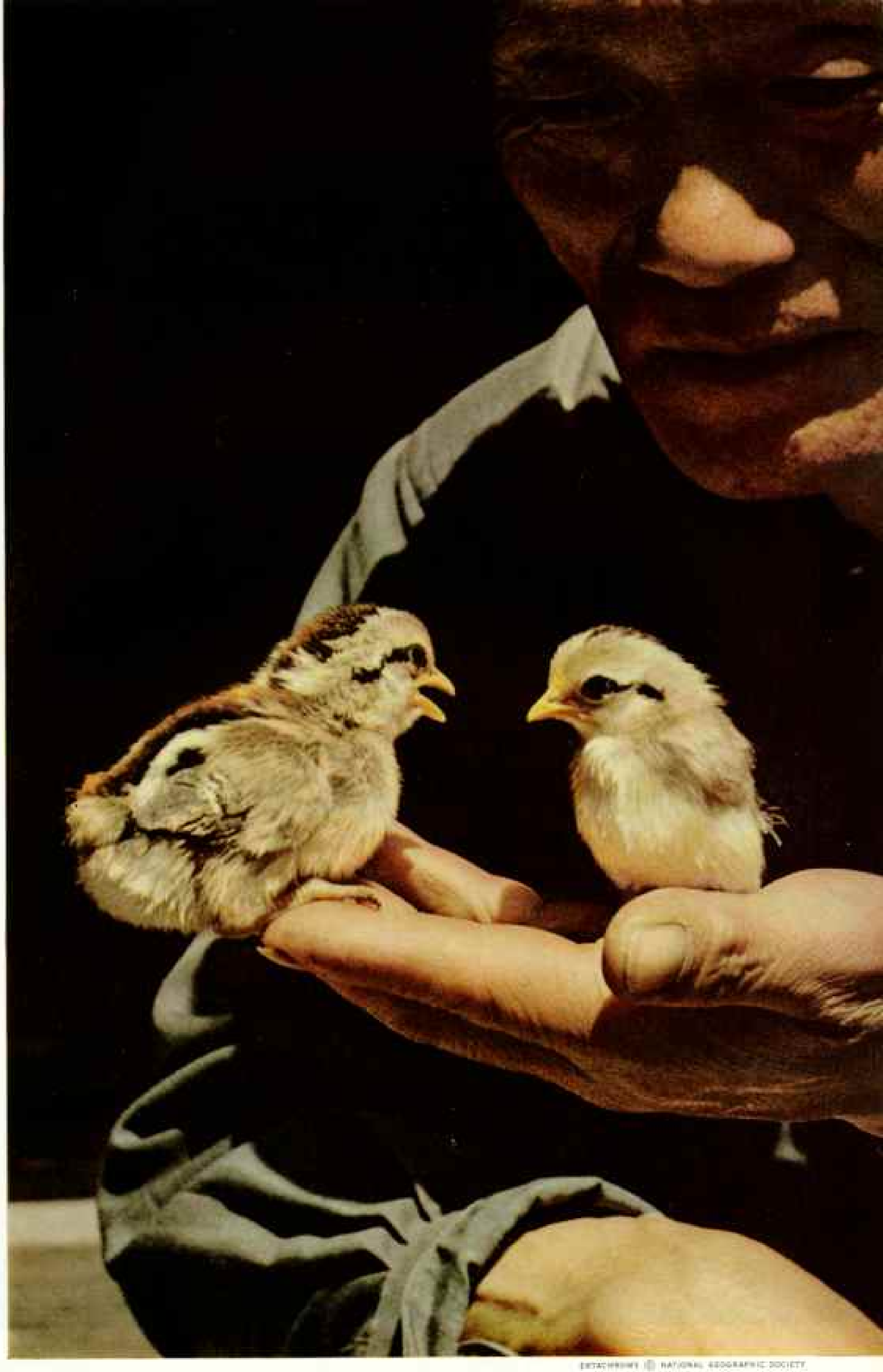
Regal Bird Requires a Trainbearer

We accompanied Mr. Kubota as he took a white Shiro-onaga for a walk in a field behind his house. He carried the bird's 25-foot tail as a trainbearer follows a king, to protect the feathers from snagging stones.

At the center Mr. Kubota had shown us his Onagadori eggs, which strangely produce two females to every male. Smaller than those of other chickens, the eggs are difficult to hatch. I felt deeply honored when our host gave me 30 to take back to the United States.

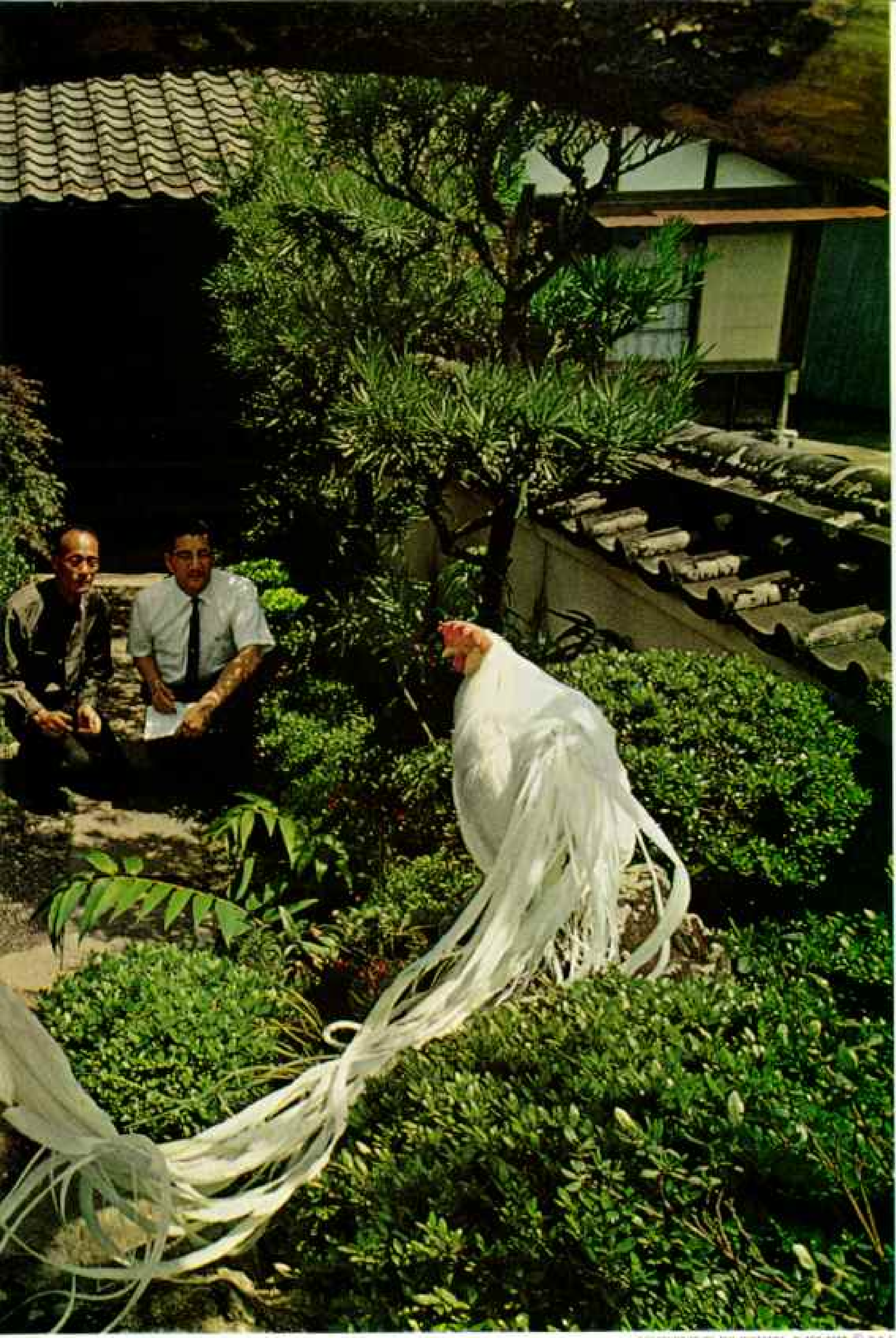
The story of Onagadori begins in Japan 300 years ago, when the bird was bred from the domestic chicken.

These chicks in hand are worth any number of ordinary fowl, for they carry the genetic blueprint for the long-tailed trait—painstakingly nurtured over the centuries by breeders on Japan's island of Shikoku (map, left). Both the male and female Onagadori can pass the special genes on to their progeny, but only the male grows the long feathers.



DETACHMENT © NATIONAL GEOGRAPHIC SOCIETY

Fountain of plumes graces an ornamental pine in the garden of breeder Masashi Kubota near Kochi. The author, right, is an avian physiologist from the University of



REARCHIVING BY EIJI MIYADAWA, BLACK STAR © N.G.S.

California at Davis. He journeyed to Japan on a National Geographic Society grant to study the three long-tailed varieties: black-and-white, red-and-black, and all white.

Delighting in extremes, the Japanese also raise tailless oddities known as Uzurao (left).

Males of the long-tailed variety tend to break or lose plumes when used for breeding (below, left). Mating and other activities are denied to show birds in order to protect feathers of the tail region—sickle, saddle, and covert—which never stop growing.

Mr. Kubota (right) feeds a long-tail in one of 16 special cages in his display room. As this bird's plumes lengthen—about three feet a year—they will be coiled and hung on a hook by a loop of twine. Birds usually begin lifelong confinement at five to six months of age.

Fragile feathers break off easily if birds are active. Loss of plumes can also result from sickness, irregular feeding, shock, or other forms of stress. Nodule contains the bird's oil gland.

Feudal pageantry of 17th-century Japan seems to have spurred development. Every other year the lords of the land had to serve as personal attendants to the shogun, living with their wives and children at his court. Standard-bearers carrying highly decorated spears led the procession to Edo (now Tokyo).

Lord Yamanouchi, second Baron of the Kochi area, seeking a distinctive standard, wanted one of feathers. He demanded tribute in long feathers, and had his people make coverings for his ceremonial spear blades.

Actual development of the bird is ascribed to Riemon Takechi, who lived about 1655 in Lord Yamanouchi's domain. A stone monument to Takechi stands near the electric railway between Kochi and Nankoku. Two long-tailed fowl are carved on the side facing the passing trains.

Takechi busied himself with breeding fowls for their long tails. To gain prestige with his lord, he presented him with some long-tailed birds.

The feathers of the 17th-century fowl —it was probably the Shokoku—could not have been any longer than three feet. The Shokoku is one of several still-surviving breeds—others being the Minohiki, Totenko, Kuro Gashiwa, and

Ohiki—having genes that produce long tails. But these birds molt each year, and thus cannot rival the true Onagadori, which may keep the same tail feathers through a lifetime.

Survival Threatened by War

The passing of feudalism in the 19th century wiped out demand for Onagadori feathers. Yet a tradition had taken root, and fowl fanciers somehow stumbled onto the genetic combination that led to the true long-tails.

In 1908 breeders formed the Long-Tailed Fowl Preservation Association. Then in 1923 the Japanese protected the bird by designating it a Natural Commemorated Object. The turmoil of World War II nearly wiped out the fowl, but the association was revived, and a governmental decree in 1952 made the Onagadori a Special Natural Commemorated Object.

Today the long-tail is fairly numerous in Japan, although the country probably has fewer than two dozen remaining

Carefully coiling yards of tail, Mr. Kubota prepares to take a prize bird to a showing (page 855). The special carrying case has compartments for food, water, the bird, and its tail.

House pet with a 17-foot tail poses novel problems for an apartment dweller.

fanciers and breeders. Husbandry of the bird is concentrated in Kochi Prefecture and around Ise on Honshu.

From Kochi we went to Ise to meet Mototaka Kawanami (next page), who raises Onagadori primarily to attain maximum length of tail (pages 845 and 854). He proudly showed me a regal red-and-black Akazasa.

"I have very little stock," Mr. Kawanami explained. "This causes problems through inbreeding. Last year with this stock I obtained only 15 eggs and was able to save only two breeding females."

Finally, in Nagoya, we visited the apartment home of Isamu Kawamura, who raises long-tails primarily as show birds for their judging qualities—plumage color, comb type, and body shape. Mr. Kawamura was at work when we called, but Mrs. Kawamura showed us three roost boxes, ingeniously fitted into the back room of their small flat. At the time two white-and-black Shirafuji roosters were in residence (below).

KODACHROME (ABOVE) AND KODAK EKTACHROME © N.G.S.

says Mrs. Isamu Kawamura of Nagoya, who with her husband raises long-tailed fowl for show. She takes her birds for walks, carrying the plumes protectively. Each dawn she frets that the birds' crowing will disturb the sleep of her neighbors.

And thereby hangs a tail. Champion fowl, with plumes measuring 34.8 feet, fascinates guests at a *ryokan*, or inn. The breeder, Mr. Kubota, calls the length a record for Kochi Prefecture. Though renowned in art and lore, long-tails remain a curiosity, and many Japanese have never seen a living specimen. A 1951 postage stamp honored the birds.

Europeans imported long-tails from Japan in the 19th century, and now Americans have begun to raise the show birds, but none of them claim to have produced plumes that rival those of the true Onagadori.

Of the 30 eggs brought back to the United States by author Ogasawara, 15 hatched. Future studies will probe secrets of the abnormal cell growth that produces the long feathers.

Stepping gingerly lest he damage a single feather, breeder Mototaka Kawanami of Ise bears a noble long-tail through his garden.

As we sipped green tea in the sitting room, five stuffed roosters looked down on us. Trophies won by fowl exhibited at fairs filled a cabinet, and a citation won in a national poultry contest hung on one wall.

"Do your neighbors object to your keeping the fowl?" I asked Mrs. Kawamura.

"No, they are very understanding. They know that my husband and I love these birds. But we worry that the crowing early in the morning will disturb these nearby friends."

After five weeks in Japan, I flew home with my 30 Onagadori eggs packed in Styrofoam. Now, in my laboratory at the University of California at Davis, 15 birds have hatched from the eggs—

EXTACHROME (ABOVE) AND KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

chicks that hold real research potential.

Hippocrates in the fifth century B.C. launched the science of human embryology by certain deductions he made in a study of chicken embryos. Berthold's transplants of rooster testes in 1849 started the complicated field of endocrinology, and Peyton Rous's experiments with chickens in 1911 first demonstrated the role of a virus in tumors. The long-tailed fowl may well make its own special contribution to science.

Researchers Have Much to Learn

Many questions remain. How do the special cells in the feather follicles of Onagadori respond to the hormones circulating in the chicken's blood?

What would happen to these cells if they were transplanted in the embryo stage to tissues of the tail in the normal embryo of a barnyard hen or rooster? The whole molting process—the periodic shedding of feathers—still poses major physiological riddles.

I believe we must make strenuous efforts to save all varieties of long-tailed fowl so that the genes can be preserved for posterity.

In the meantime, major credit for the protection and development of the long-tails belongs to the fowl fanciers of Japan. Through their patient efforts the Onagadori will continue to intrigue —even to enchant—those travelers who take the trouble to seek out this proud high-born rooster with its incredible length of tail. THE END

Searching Out Medieval Churches in Ethiopia's Wilds

ARTICLE AND PHOTOGRAPHS BY
GEORG GERSTER, Ph.D.

WE STOPPED OUR LAND-ROVER at the edge of a 200-foot-deep gulch in the wilds of northern Ethiopia. Beyond the chasm loomed one of the mesa-like *ambas* that dot the Ethiopian highlands. Cliffs rose a sheer 500 feet in what looked like an impossible barrier (page 858).

But somehow, I knew, I would cross the gorge and scale the cliffs. For in the distance, just below the cliff's top, stood the monastery of Abba Salama—ancient, mysterious, unvisited, I believe, by any foreigner since its founding in early medieval times.

I was pursuing a lovely legacy. Through the incredibly rugged fastness of the highlands, among mountain peoples who may react violently against outsiders seeking their religious secrets, I was searching on foot, by muleback, and from the air for the shrines at which Ethiopia's Orthodox Christians have been worshiping since the Middle Ages.*

Hundreds of these, it has become known in the past decade or so, lie hidden in the jumbled heights. Most famous are the eleven churches of Lalibala, carved from living rock, with some brilliant Byzantine-flavored frescoes depicting the lives of Christ and the saints of the Ethiopian Church.

Visiting them, speaking of them, I was given hints of others not listed in any records, not even governmental ones, unseen through the centuries except by local Ethiopians who travel wild and dangerous trails. Deeply interested in art and architecture, I determined to add my own efforts to those of experts from many countries already seeking to learn if these churches did indeed exist.

In most instances they did. The current list of "discoveries," some of them my own, now contains well over fifty names. The remarkable thing about the list is that nearly every one of these churches is still in daily use.

And sometimes one of them brings its finder an unexpected reward: It will fit into the jigsaw puzzle of Ethiopian history, a confusing maze of legend and documented fact. Architectural details, an inscription on an age-old painting, a manuscript, spoken tales of monks and priests long dwelling in isolation —these illuminate, if not scientifically fill,

*See "Ethiopian Adventure," by Nathaniel T. Kenney, NATIONAL GEOGRAPHIC, April 1965.

EXTACHROME (ABOVE) AND KODACHROME © N.G.S.

Marks of faith, tattooed crosses on a woman of Aksum symbolize her rugged homeland's 16 centuries of Christianity.

Eve and the serpent decorate a wall of the ancient Church of St. Mary at Qorqor, in Tegre Province. The author discovered such treasures during his quest for the almost unknown rock churches of Ethiopia's remote highlands. Cut from the living stone, most of these structures still serve as places of worship.

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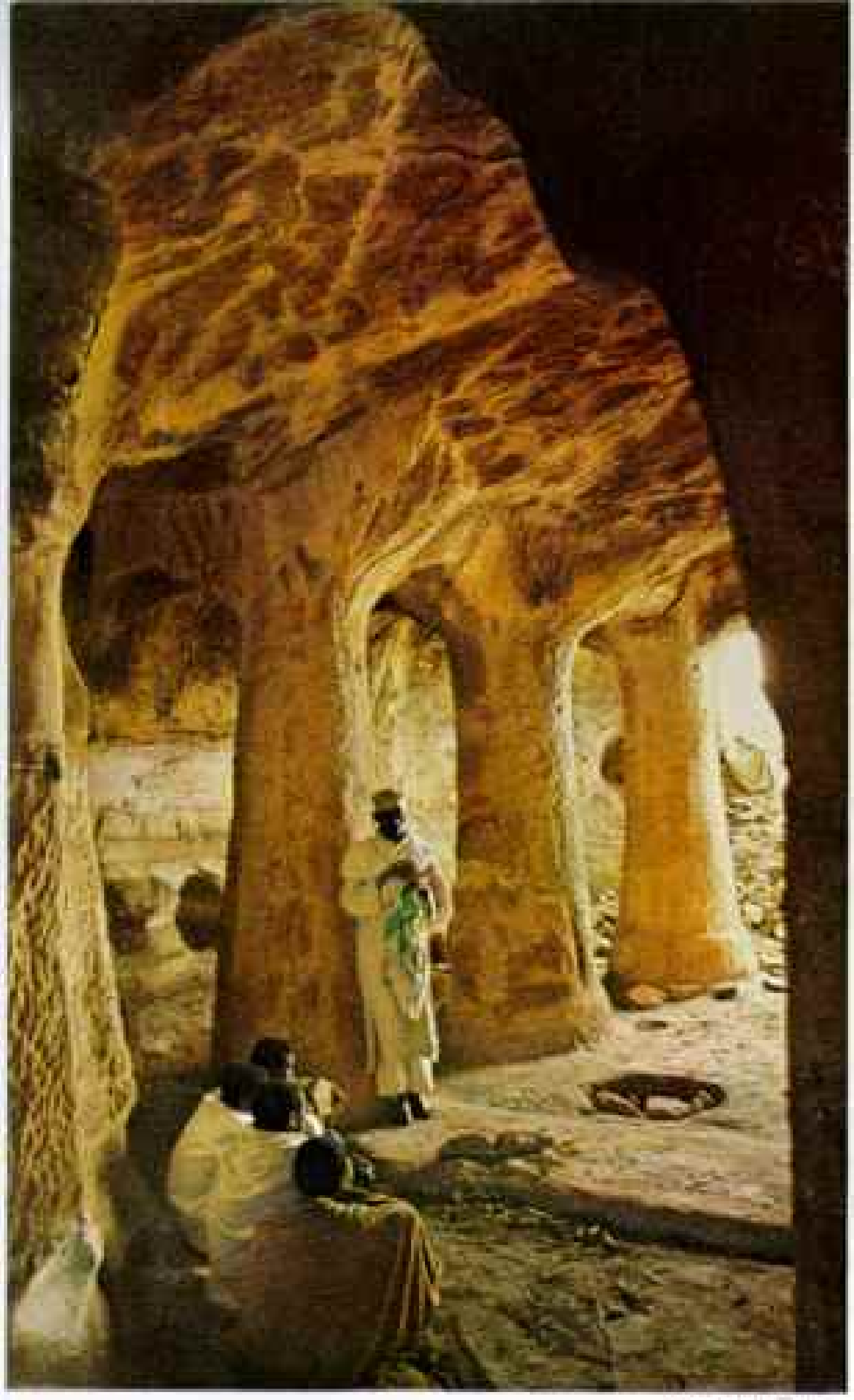
Awesome
ascent
to the shrine
of a saint

KODACHROME (ABOVE) AND EKTACHROME BY GEORG GERSTER © N.G.S.

ABBA SALAMA MONASTERY hides in the mountains of northern Ethiopia. Its founder, Frumentius, a Syrian captured by pirates, became known in Ethiopia as Abba Salama, "Father of Peace." About the year 330 he converted the ruler of the ancient Ethiopian kingdom of Aksum to Christianity and was named the first chief cleric of the Ethiopian Orthodox Church. Seeking solitude in his old age, Abba Salama retreated here. Monastic tradition holds that a niche nearby holds the saint's bones.

The author, who believes he is the first foreigner to see the shrine, inched his way up a sheer cliff by finger- and toehold, despite his admitted terror and an injured hand. Farmer-guides led him through a rock chimney (far right) to a 60-foot chain he had to climb (right) to reach the top. The route of the final ascent appears in the circle above. Tin roof of a new church gleams at left.



Carved from the cliff just below a mesa's rim, crude round columns hint at Abba Salama's great age; it dates from early medieval times. Fearful that the structure might collapse, the monks now worship in the recently constructed church atop the mesa (page 858).

some void in the story of Prester John's legendary lost Christian kingdom.

Such a reward was mine at Abba Salama, high point of my hunt. When, shaking from the terrifying ascent, I gained the top of the cliff, I stood, I am convinced in my heart, where the man who began Ethiopia's conversion to Christianity in the fourth century had spent his closing years. Furthermore, it is possible that I viewed his mortal remains.

Again and again the name Abba Salama had cropped up in talks with friends, but none had ever been there. However, the Princess Aida, wife of the Governor General of Tegre Province and granddaughter of Emperor Haile Selassie, was able to tell me at precisely what point along the Makale-Abi Addi dirt road I must turn off across trackless countryside to reach the monastery (map, page 865).

"I only wish I could go with you," the princess said. "But most Ethiopian monasteries prohibit women in, and sometimes even near, their sanctuaries."

As I stood on the brink of the gorge, my heart sank at the sight of the perilous path to my goal. It looked like an impossible venture (page 858). It meant treading an infinitesimally narrow ledge above a dizzying drop, and scrabbling up and down smooth rock walls by hand- and toehold.

To add to my gloom, only a few minutes earlier our driver had slammed the Land-Rover's door while my right hand still gripped the frame.

"There it is," announced my friend and guide, Ato (which means Mr.) Araya Gesese. "You'll make it." Then, glancing at my crushed fingers, he added, "I hope."

Reasonably enough, I thought, he declined to climb with me, and I set forth with farmers from the surrounding fields as guides. Without rope, pick, or piton, we descended into the crevasse, then started up the opposite face.

Chain Provides the Final Link

Men born to the mountains took nimble advantage of every tiny lip of rock; desperately I followed their lead. Halfway up we crept along a slim ledge, skirting the abyss until we reached a rock shaft, the sort known to mountaineers as a chimney (preceding page).

My companions urged me upward, pointing out grips and footholds. I reached a small platform where the lower end of a chain perhaps 60 feet long dangled from an invisible anchor point atop the overhanging cliff.

The chain seemed to rise straight to heaven, and my guides, eager to demonstrate its practicality, scuttled nimbly up and down it like the angels on Jacob's ladder. Before my courage sank too low, they secured a leather thong around my waist—and I was off. If I lost my grip on the chain, the man atop the cliff holding the other end of the thong would—perhaps—keep me from tumbling.

Above, a monk greeted me with extended crucifix, his thin smile acknowledging the foreigner's tenseness after the vicious climb. He was the only monk present. The *memhir*—the abbot—and three dozen other monks had gone to Abi Addi for the Friday market, to trade the produce of the fields below, from which the community makes its frugal living.

The monk led me through an exuberant

growth of cactuslike euphorbias, past the modest huts of his fellows, to the crumbling entrance of a church hewn from the rock just below the mesa's edge. It was a simple edifice, with no ornamentation, either painted or carved. I was intrigued, though, by the columns that separated the two aisles from the nave in the classical basilica pattern. I believe that rounded columns—instead of squared-off pillars—are, in Ethiopian architectural tradition, a sign of great age (opposite page).

Niche May Shelter Saint's Remains

Apparently the threat of a cave-in had prompted the ecclesiastics, quite recently, to abandon this church, and to build a new one above it on the mesa top. The monk led me there but refused to let me enter. He did, however, show me manuscripts and iron processional crosses of great age (right), and he talked to me at length, obviously recounting the monastery's history.

But he spoke in Tigrinya, the local tongue, which I cannot follow. In sign language, therefore, I persuaded him to accompany me back to the Land-Rover, where Ato Araya awaited my return. We sat on a rock beside the vehicle. As Araya translated the Tigrinya, I realized the extent of my discovery.

Abba Salama is the Ethiopian name for Frumentius, the Syrian from Tyre who brought Christianity to this ancient land in the fourth century. He planted the Cross, and it became the rallying point for disparate and fiercely independent highland peoples. Around it grew the Ethiopian empire, Christian island in a Moslem sea, to stand off wave after wave of Islamic assaults, to persist into our times. Without Frumentius, no man can say what Ethiopia might have been today.

"So the saint finished his great work and in time died on the amba," concluded the monk, rising to return to the sanctuary. He started off, but stopped and looked back.

"Return when the abbot is at home," he said, with a nod toward me. "Perhaps he will take you to see the saint's very body."

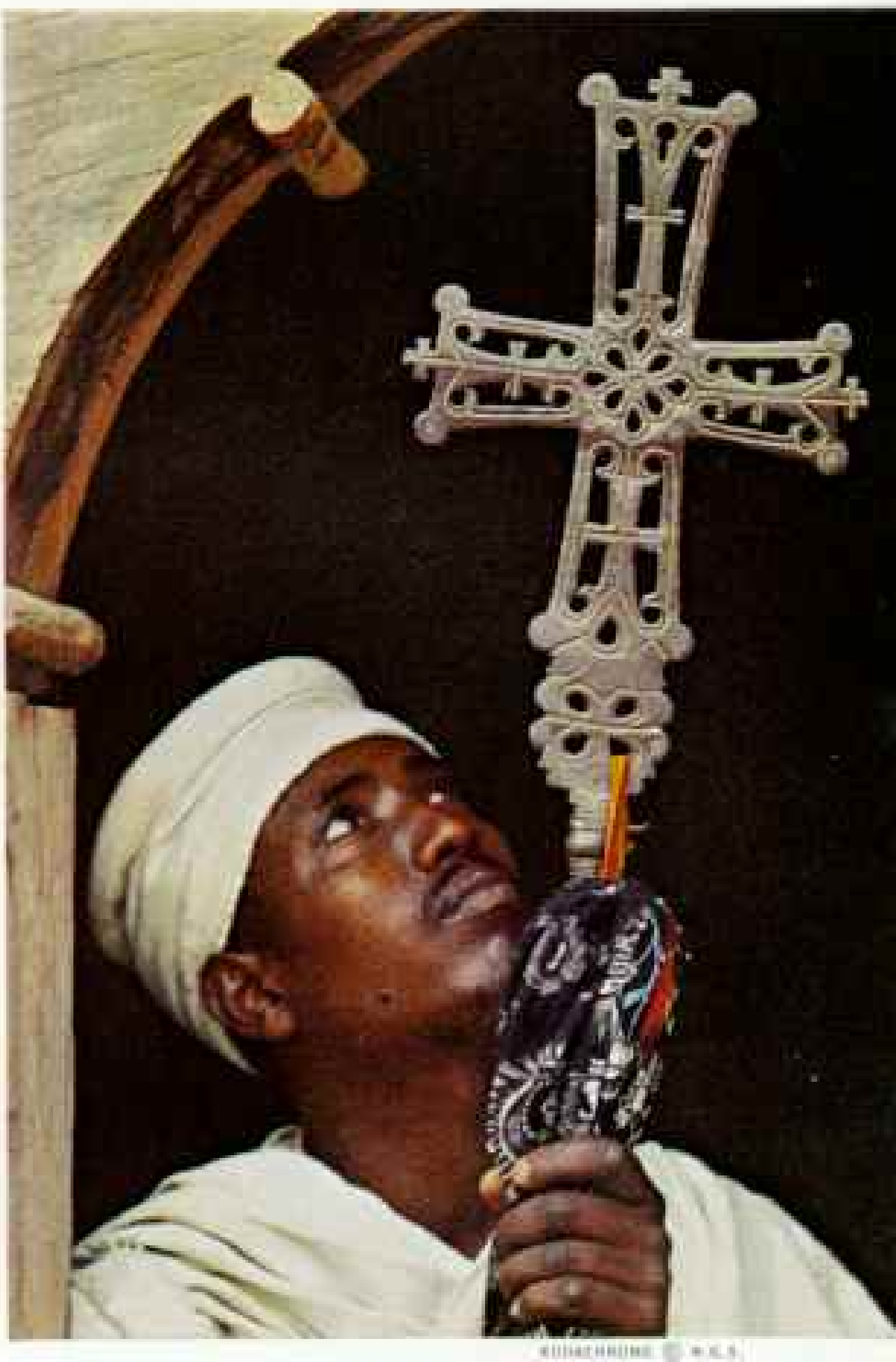
It was two years before I made the harrowing climb again, but I did so, and with the abbot saw in a dusty niche beneath the amba's rim the cloth-wrapped bundle of bones that could have been those of Frumentius, Abba Salama, "Father of Peace." There is nothing about the amba and its story that does not fit perfectly into the structure of Ethiopian history.

The abbot reached far into the niche and scraped a handful of dust out of the soft rock.

"With these powders," he said, "we shall produce holy cures among the sick."

As a young man Frumentius set forth on a voyage to the East. On the trip back, he was captured by pirates, and taken as a slave to the king of Aksum in Ethiopia's interior, not far from Abba Salama Monastery.

Cradle of Ethiopian civilization, Aksum was a world power in Frumentius's time, on a par with Rome, Persia, and probably China. Haile Selassie claims descent from a ruler of Aksum. She was known as the Queen of Sheba, and to Solomon of Jerusalem she bore a son who became the first king of Ethiopia and founder of Haile Selassie's imperial line. From a historical standpoint, the legend may



Cherished for its history as much as for its beauty, this iron processional cross may have belonged to Frumentius. Ethiopian Princess Aida's report that she had seen a similar one, brought down from Abba Salama, spurred the author's search for the secluded monastery.

LIKE A PROPHET OF OLD,
a monk exhorts the faithful at Lalibala, Ethiopia's "New Jerusalem" (pages 870-73). The wayfaring preacher lives on alms as he spreads the Gospel among all who will listen.

KODACHROME BY GEORG GERSTER © N.G.S.

have flaws, but it gives the Ethiopian throne a spiritual strength it has found useful.

Probably aided by Byzantine merchants, who with other Mediterranean traders did business at Aksum, Frumentius sowed the seeds of Christianity in the Ethiopian kingdom. Since that time Ethiopia's Christians have embraced a faith closely akin to that of Egypt's Coptic Church.

Archeological evidence suggests that the king's conversion took place around A.D. 330, and that the royal convert was Ezana. Early coins struck during this sovereign's reign carry the pagan symbols of crescent and disk; later pieces bear the Cross.

Aksum's rulers embraced Christianity with fervor, and scattered churches throughout their realm. They built for the ages, decorated with taste, and bequeathed to Ethiopia a uniquely styled legacy of ecclesiastical art and architecture.

Ancient Skills Mystify Modern Man

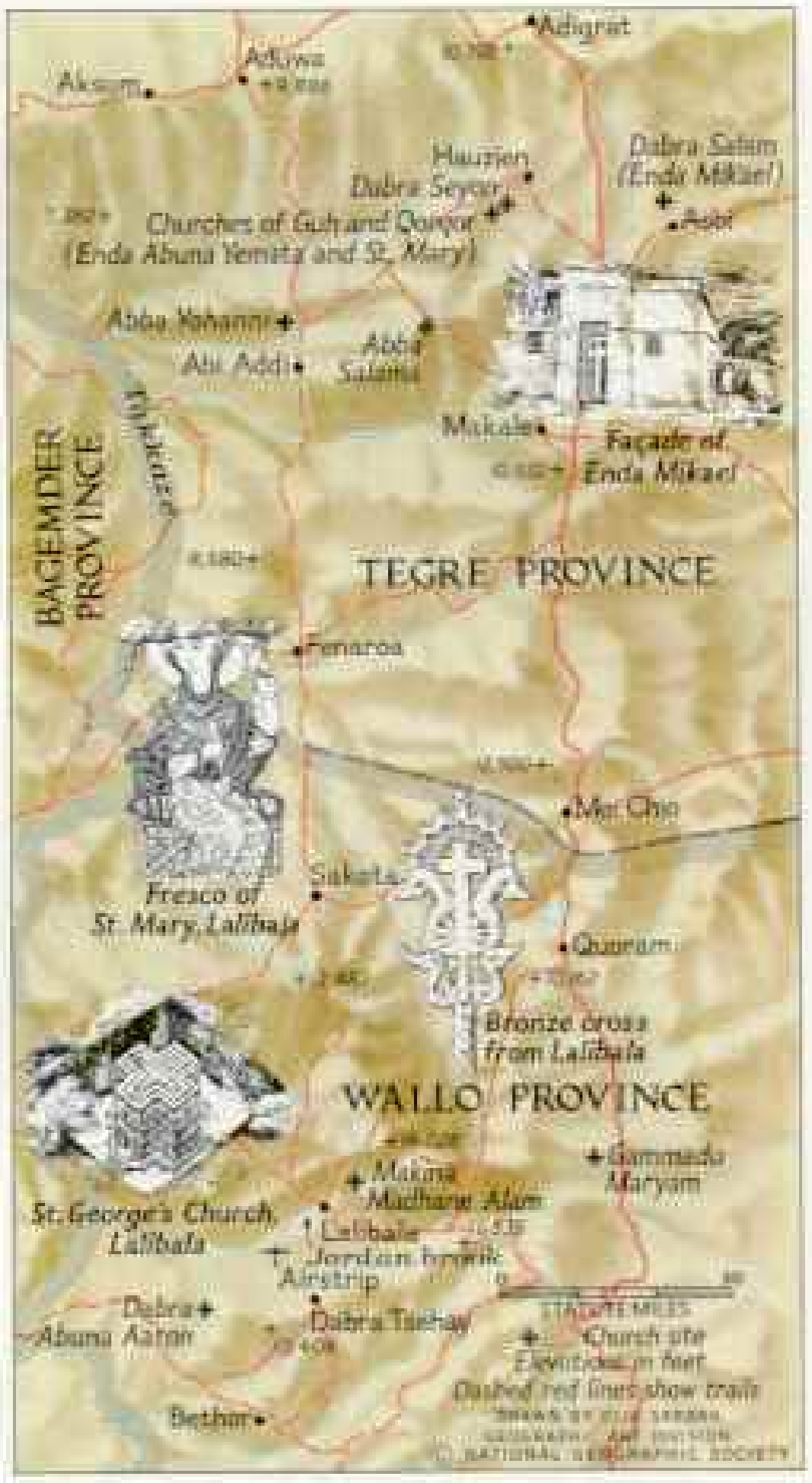
As was natural, they started with forms their artisans already knew. One may study these today in the ancient capital city of Aksum, now little more than a sleepy village. Here the pagan Aksumites erected a number of huge steles, one of which still stands.

How they quarried, moved, and raised such tremendous slabs of solid rock puzzles even modern engineers. The 110-foot-tall giant of them all, now lying in pieces on the ground, ranked as the largest monolith in the ancient world.

The exteriors of the skyscraper-like steles, the uses of which are not surely known, were carved to resemble buildings familiar to the artisans. They depict tall dwellings of wood and masonry still used in southern Arabia, whence the dominant Ethiopian peoples migrated to Africa in the very long ago.

The first Christian churches were actually executed in wood and masonry, with monumental door and window frames, latticed stone windows, recesses breaking the wall lines, and above all, sandwich wall construction of alternate layers of wood and stone (page 881). In such buildings the ends of round logs, locally called "monkeyheads," protrude from the exterior walls.

The builders also used solid rock as their



Rock-bound reaches of northern Ethiopia may harbor as many as 1,500 medieval churches. Hundreds are still unknown to the outside world. Their remote locations stem more from a desire for monastic solitude than from thought of defense.

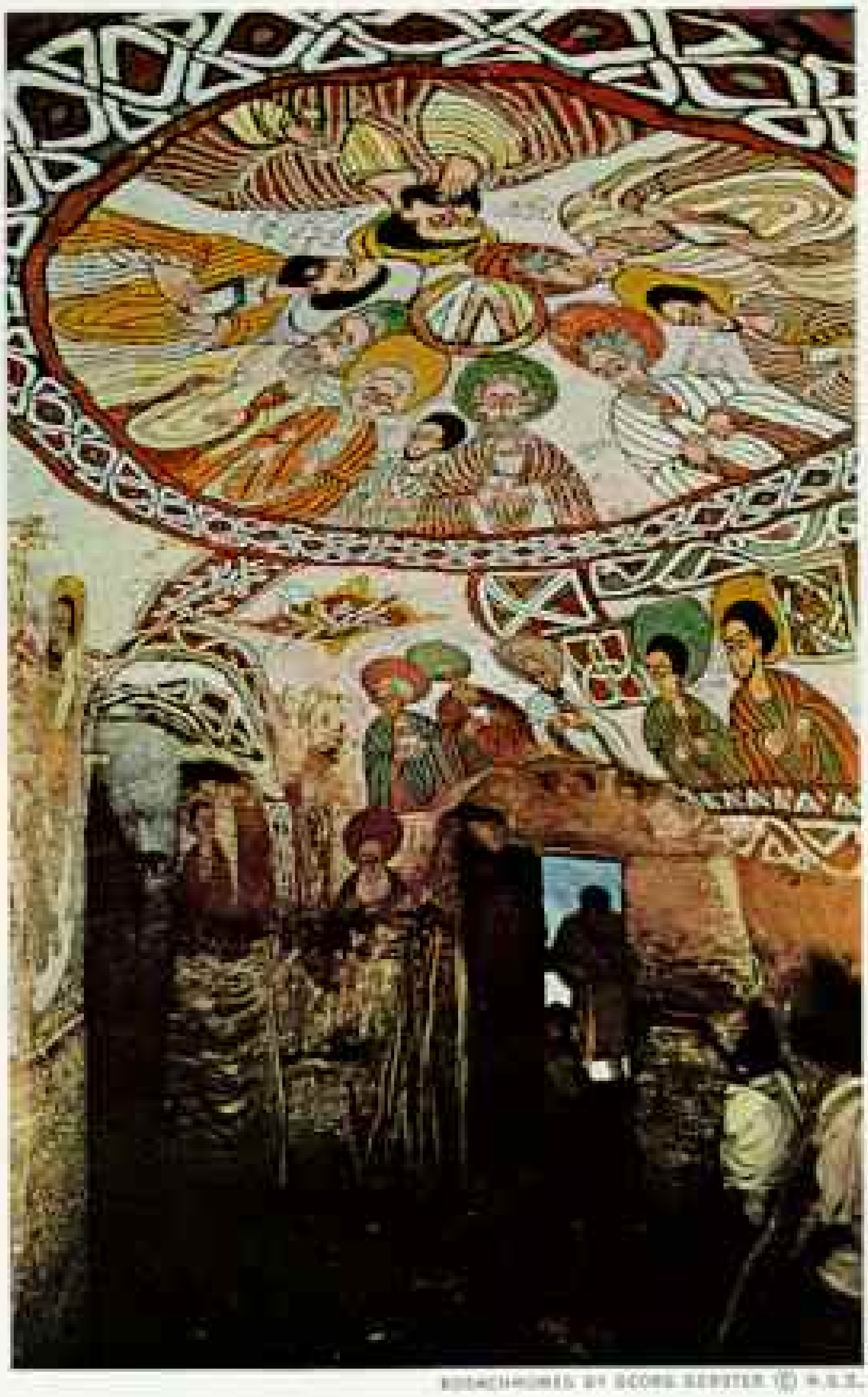
Grotto's gaping mouth frames the tiny church of Makina Madhane Alam north of Lalibala. Celebrants visit the church to honor a local saint.

REPRODUCTION © N.G.S.

Pinnacles of Guh guard a treasure

SOARING like the spires of a cathedral, the majestic stone towers of Guh rise from a plain in Tegre Province; a farmer (below) guides his primitive plow nearby. The rock church of Enda Abuna Yemata, named for one of nine saints who nurtured monasticism in Ethiopia about A.D. 500, appears at the center of the opposite page, nestled in the right side of the tallest pinnacle.

Visited by the author in 1966, Enda Abuna Yemata displays a wealth of well-preserved religious art, most of it 300 to 400 years old. The fresco on a dome of the church (right) depicts eight of the Apostles and James, Jesus' brother. Enoch and Elijah appear at left over the door and on the following page.



KODACHROMES BY GEORG GERSTER © N.G.S.

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Grandiose turbans worn by Enoch and Elijah in this fresco at Enda Abuna Yemata reveal an apparent Islamic influence—understandable, the author suggests, in a nation almost totally surrounded by countries adhering to the Moslem faith.

Turbans normally conceal a man's hair, but that of Enoch and other figures (page 867) can still be seen. Dr. Gerster speculates that the figures originally wore halos, later transformed into turbans.

Choirboys wear crosses of grass during Palm Sunday festivities at Lalibala. Many young Ethiopian boys enter church life as deacons and later join the priesthood. Others become *debteras*—laymen serving the church as musicians, poets, and teachers.

medium. Again, as at Aksum, they carved representations of the wood, sometimes including the monkeyheads, into their works in stone.

Why they turned to the difficult living rock is a mystery, but for me, and for the others who in our times seek out the medieval churches, it was a piece of luck. For non-Christian enemies fell upon Ethiopia and destroyed all but a handful of the erected places of worship. Those carved out of the mountains could not be pulled down, and so they remain for us to study.

Of Ethiopia's ravagers, the Moslem Ahmed ibn Ibrahim al-Gazi, known as Gran, or "the Left-handed," did the most thorough job. Leading a horde of Somali and Danakil tribesmen and supported by Turkish troops, he laid waste the highlands from 1527 until 1543, when Ethiopian and Portuguese soldiers killed him in battle.

Where churches had once stood by the hundreds, there remained only ashes and blackened stones.

"Most were rebuilt," I was told by Ato Kebbede Mikael, Ethiopian Minister of Antiquities and trustee of the Ethiopian Archeological Institute. "But strangely, they are in a new style that usually uses a circular ground plan, probably based on the *tukul*, the omnipresent Ethiopian rural house.

"Thus, in a nation where there are 14,000 churches, your task of finding the medieval ones will be somewhat simplified. Ignore the round ones. They are not what you seek."

Two men gave me selfless and invaluable aid. Roger Sauter, a Swiss and a teacher in Asmara, lent me a list of all rock churches he had compiled from literature and rumor over many years. And the late Ethiopian Catholic priest Abba Tawalda Yosef patiently questioned people in Tegre about rock-hewn churches and shared his findings with me.

A veritable army of a quarter of a million clergy serves Ethiopia's Orthodox churches. Where they dwell in lofty isolation, the ecclesiastics are suspicious of *ferengi*—foreigners.

Mistaken Identity Causes Crisis

There was the time, for example, when I undertook a seven-hour march, hauling my supplies and camera equipment unaided up a mountain, to see the grotto church of Gammadu Maryam. There I was turned back by a nun, who furiously incited the crowd around the church to "kill the foreigner." Later the chief priest apologized for the behavior of his flock and advised me against making another try.

"They thought you were a Moslem," he explained, "and since the days of Gran, that's as good as being the devil up here."

Frequently I found my bundle of permits, letters of introduction, and the like, even though written by high provincial authorities, worth nothing whatsoever 9,000 feet up in the mountains. Priests would read them, hand them back to me, pocket the keys to their churches, and leave me.

In such cases, I would hastily make an offer of a generous cash donation to the community's needy. Sometimes this worked. When it did not, I would seek out the highest ranking temporal official known personally to the local people and bring him with me to the forbidden church. His presence usually caused priestly resistance to crumble.

Fortunately, on the day I visited the monastery of Abba Yohanni in Tegre, I was accompanied by a sub-provincial governor, Shebeshi Agidew, and a sizable retinue. The governor's messengers preceded our procession on the trail. As we came in sight of the whitewashed façade glittering on the honey-toned amba escarpment, deacons struck stone bells (page 878) and beat drums. We saw a tent awaiting us in a field.

When we arrived, all the monks, led by the abbot, were on hand to greet us. They had donned their finest ceremonial robes, carried their ancient processional crosses, and waited under their huge umbrellas of many colors.

The monastery church, reached by an easy climb, is the most majestic, I think, in northern Ethiopia (pages 882-3). Ten fully preserved cupolas crown it. There used to be two more, but a landslide took them away, and the monks filled the gap with masonry sometime in the 1950's.

Less cordial was my reception at the seldom-visited grotto church of Makina Ledata

Tiny passageway, which may once have served as a water drain, leads to the Church of Emanuel at Lalibala (right). Main entrance to the massive shrine's courtyard lies at the end of labyrinthine trenches.

Throngs of pilgrims pack the courtyard of the Church of Emanuel during the Christmas season. Sculptured from a single block of tuff, the church's exterior imitates Ethiopia's ancient

Maryam on the heights overlooking Lalibala. I was remembered from an earlier visit, but Roger Schneider, the Luxembourg Orientalist who was with me at the time, was not allowed to enter, though he represented the Ethiopian Archeological Institute.

Normally a patient man but now somewhat unnerved, Roger walked around the little church tapping the walls and telling the priest they would collapse and destroy the precious paintings within. There then ensued this surrealistic conversation:

Priest: "There are no paintings here."

Roger: "Aha! You stripped them and sold them. My friend here has seen them. He's been inside."

Priest: "Naturally. After all, he's an archbishop."

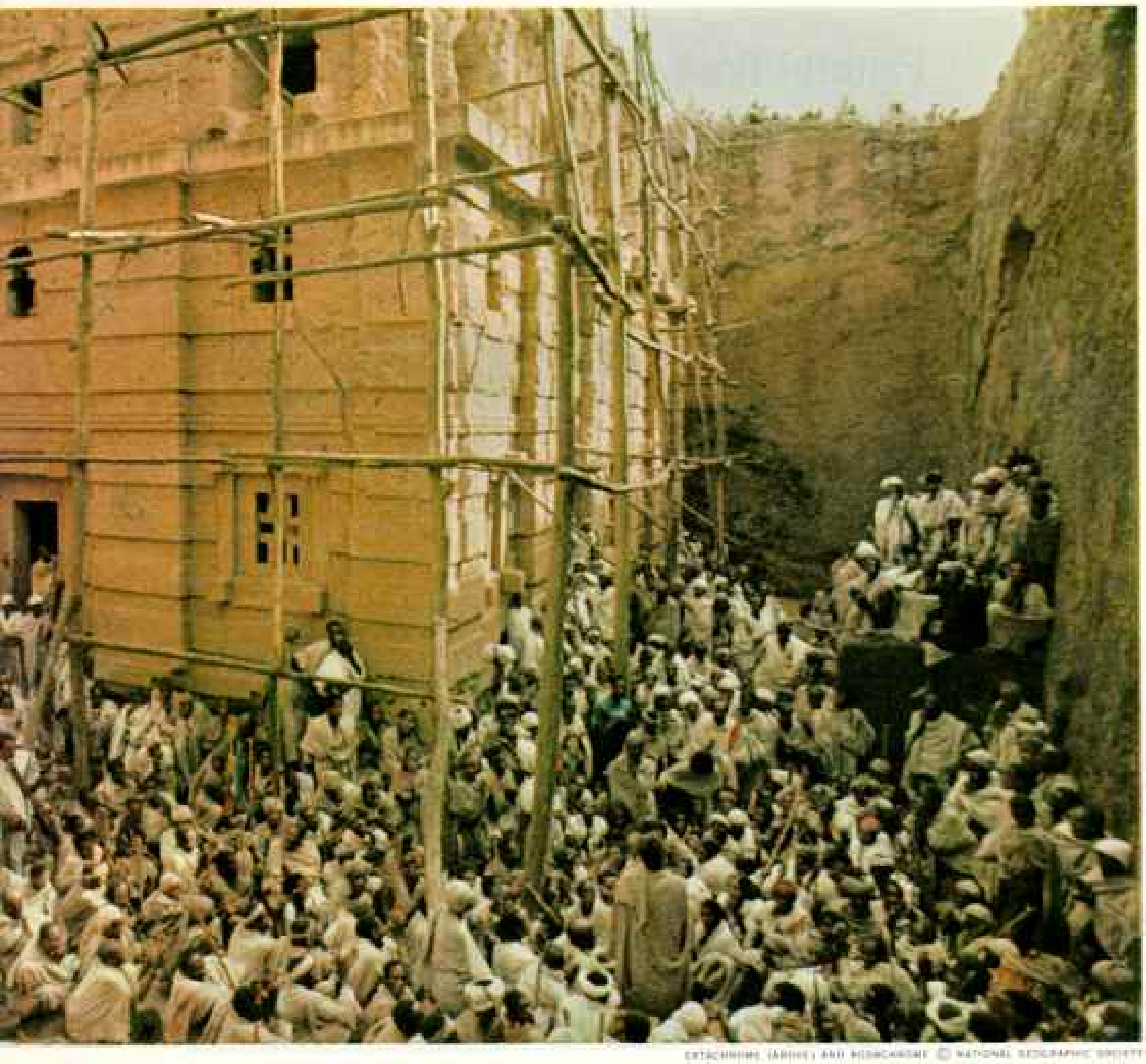
Gerster: "This news of my promotion from the laity is pleasing to me. Now will you open the church?"

Priest: "No, but I'll do so when you come bearing signs of your office."

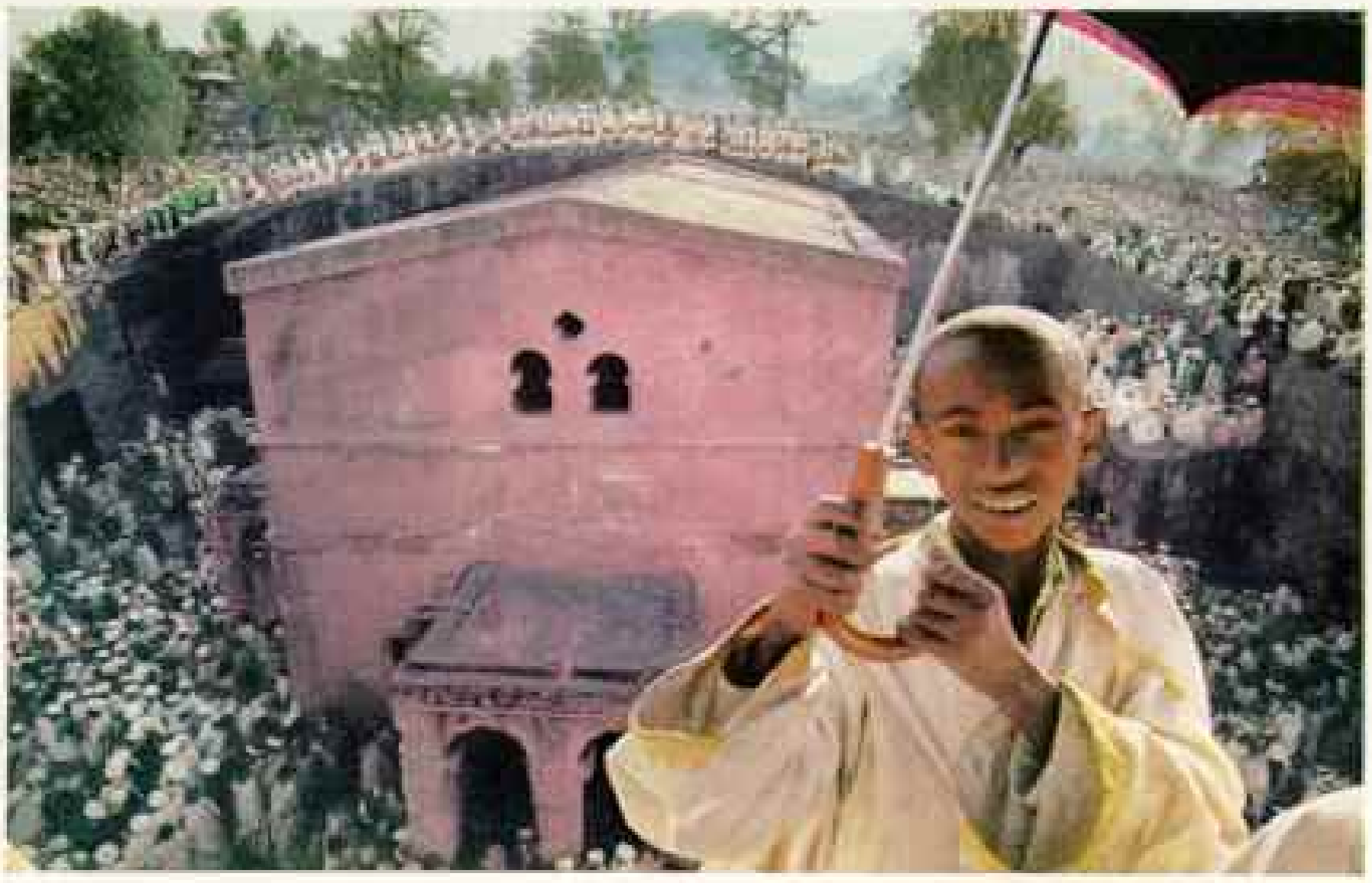
If sometimes I found frustration in the high country, and even danger, I also found beauty, and peace, and warm friends. Never did I tire of the landscape with its tangled ravines filled with inky shadows, gaping wounds torn in the land by once-roaring rivers; the windy plateaus checkered with green fields of young grain and yellow patches of *nug*, a relative of

(Continued on page 877)

wood-and-stone "sandwich" style of construction (page 881); scaffolding aids restoration. Lalibala's population of 9,000 triples on religious holidays, when trade and gossip intersperse the festivities. The church is one of 11 rock sanctuaries built by 12th-century King Lalibala in response—says local legend—to a divine command and with the aid of angels.



CRTACHROME (ABOVE) AND KODACHROME © NATIONAL GEOGRAPHIC SOCIETY



Faithful flock to sunken shrines

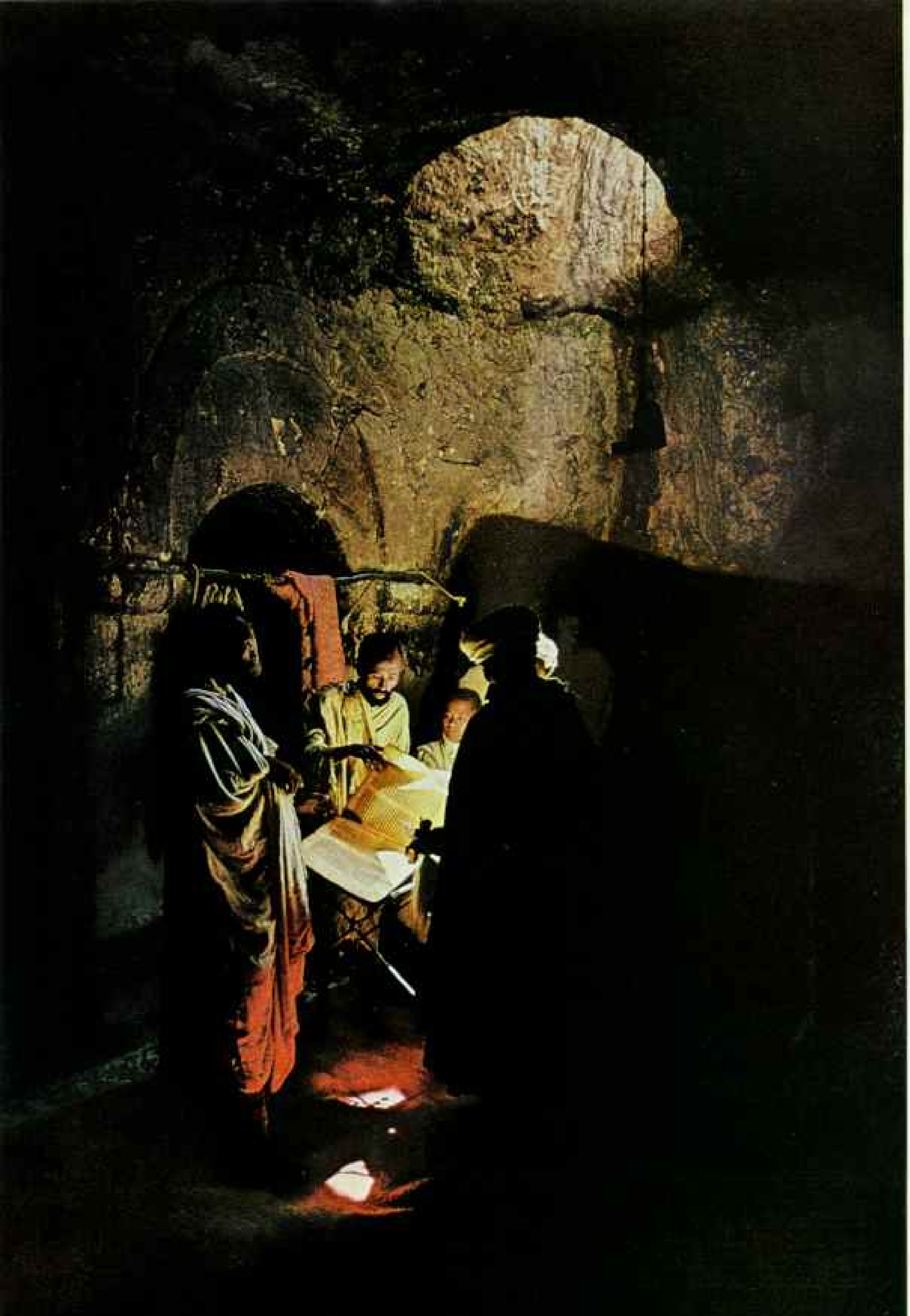
LARGEST of Lalibala's churches, the Church of the World's Redeemer (right) may have been copied from the old coronation church at Aksum. The monolithic shrine dwarfs the neighboring Church of St. Mary, King Lalibala's favorite. Debteras perform a Christmas dance (above) on St. Mary's walls.

Religious fervor almost costs a pilgrim his life (below). He plunged into a pond in St. Mary's courtyard, forgetting that he could not swim. Bystanders saved him.

Food grows on mile-high tables in Ethiopia's tumbled heartland. Green fields of grain patched with yellow plots of *nug*, an oil-bearing relative of the sunflower, create a mosaic of color among the plateau's cliffs and valleys. Ethiopians trace their empire to the days of King Solomon. Their lore—consistent in part with Biblical writ—says Queen

PHOTOGRAPH BY ALDEN ERSTER © N.G.S.

Makeda of Sheba traveled to Jerusalem from Aksum, then her capital city, to visit the renowned King Solomon. On the long journey home she bore him a son. When the boy reached manhood, he became Menelik I, King of Ethiopia and first of the Solomonic sovereigns. Emperor Haile Selassie I counts himself the 225th ruler of the line.



EXTERIOR (ABOVE) AND DETAIL © N.G.S.

Out of darkness, the light of faith

FOR ONLY A FEW MINUTES each day, when the sun is at its zenith, a golden shaft of light pierces the gloom of the underground church of Dabra Abuna Aaron (left). Priests of the church, located southwest of Lalibala, use the transient illumination to read from the Scriptures. The monks claim that for some mysterious reason no water enters the hole during the rainy season.

The cleric above cradles one of Dabra Abuna Aaron's most cherished possessions—a large ornately carved crucifix of wood, rarely seen in a country where metal processional crosses predominate. The three figures on the base represent the Holy Trinity.

the sunflower cultivated for its oil; flat-topped ambas scattered like giant stepping stones amid the highlands' saw-toothed peaks (pages 874-5).

Trekking with mule caravans from forests of lichen-festooned junipers down to sorghum fields, I watched girls on wooden towers whirl slings to drive foraging baboons out of the grain. Above a bamboo-covered world, cloud shadows raced across fields of *teff*, the staple grain used by highland peasants for bread and beer. In the biting cold of the 12,000-foot heights a perpetual wind whipped head-size globe thistles back and forth.

I spent weeks, even months, far from Ethiopia's modern centers, where battle is being waged to tie the past to the future. I lived among people who still cling to an Old Testament way of life, sharing their feasts and fasts. I sat in straw huts with candidates for the priesthood, as they listened to priests teaching them Ge'ez, the liturgical language.

Shoes Must Stay Outside the Door

Some days I stood through hours-long services with the *debteras* and, like them, held a sort of crutch clamped under my arm as a support.

The debteras are a class of non-priests unique to the Ethiopian church. They are experts in reading and liturgical song and are administrators of the church's traditional wisdom. Once, when with aching feet I wondered aloud why the faithful must remove their shoes before entering an Ethiopian church, an elderly debtera with the look of a Biblical patriarch countered with the question, "And would you tread on the toes of the angels who crowd a church during services?"

His turbanlike *temtem*, the standard headpiece of debteras and married priests, shadowed his face; I could not see his eyes well enough to know whether he winked.

The highland folk, incredibly hospitable people, invited me to share their meals in their huts. But I preferred spending my nights under the open sky to sleeping in the round thatch-roofed, mud-walled tukuls, often filled with acrid smoke and populated with bloodthirsty insects. In the outdoors I enjoyed the stars, the demoniac music of jackals, even the dawn serenades of the ubiquitous mules.

The braying awakened thousands of birds, and they awakened the villagers. Then the people came to me, crowding near, fingering with disbelief the thin nylon sleeping bag which could keep the ferengi comfortable at an altitude of 11,000 feet.

They also marveled at other technological wonders I apparently introduced. Admittedly it makes a great effect to land in a helicopter, like an angel from heaven, as I did several times. But among people who boast of centuries of familiarity with angels, one is soon assailed by aspiring hitchhikers.

"My sick uncle lives just across the ravine. I'll pay you a chicken for the gasoline."

I had to refuse such offers, but the ensuing night-long palavering around a campfire, while the horn beakers of *talla*, the local beer, passed from mouth to mouth, robbed me of much-needed sleep.

Hidden Treasure Comes to Light

Nine times in six years I returned to the mountainous inner sanctum of Haile Selassie's wondrous empire. If Abba Salama's burial mountain, for its historical associations, was the most valuable prize of my long, lonely quest for Ethiopia's wealth of Christian churches, then Enda Mikael—St. Michael's—was a close runner-up because of architectural uniqueness.

A place name—Dabra Salam—had been mentioned to me repeatedly as the site of an important church. As usual, no one I met had ever been there, nor could anyone locate it more precisely than "somewhere on the other side of Asbi," a village in northeastern Tegre (map, page 865).

I found an area known as Dabra Salam half an hour's drive and an hour's hike northwest of Asbi. I found its church, too, huddled beneath an overhang, perched on a rocky outcropping. But it was a disappointment. Its exterior was crude, and doubtless of reasonably recent construction (page 880).

The priest with the keys failed to show up on time. I was about to leave when he arrived. He opened the door of Enda Mikael. I stepped inside—and shouted with joy.

Beyond the unprepossessing façade, like a pearl in an oyster, shone a tiny ancient shrine with every architectural feature of old Aksum; it is, I am assured by all who have since seen it, the most spectacular example of its style yet known.

It is almost perfectly preserved. Gran's hordes overlooked it, and the overhanging rock had kept the elements at bay. Even the wood is as sound as when first placed there.

The old church is used today as the inner sanctuary of the enlarged Enda Mikael. Because all Ethiopian church sanctuaries are holy secret places, Gabra Giyorgis, chief priest and keeper of the keys, at first allowed me only a tantalizing glimpse into the medieval shrine.

"*Basta,*" he kept repeating. It is the Italian word for "enough"; he had learned something of the language during the Fascist occupation of the 1930's and '40's. He mellowed, however, when he learned that my name, like his, honored St. George. Briskly he pushed out the people who, at news of a foreigner's arrival, had abandoned their plows and cattle to come and gape. Now I could study the miniature basilica in peace.

Built on a square some 22 by 22 feet, it blends with its Aksumite heritage most of the features of an architecture taken over from Byzantine Christianity—arches, vaults, and dome. St. Michael's is actually a hybrid, partly erected and partly carved out of the amba's rocky side. It was hard to tell where construction ended and carving began, so skillfully had the carvers emulated the forms of structural architecture (page 881).

I noticed with pleasure a wall fresco that depicted a caparisoned elephant bearing

two saintly riders (next page). To me it suggested Frumentius and his comrade Aedesius. History records that, following their capture, the young men became favorites of Aksum's royal family and even helped the queen rule after the king's death.

When I urged Gabra Giyorgis to clean the cobwebs from another fresco, he hauled out a huge crude broom. I gave an anguished cry of "Stop!" Perhaps the plaster and picture might not have crumbled away, but I dared not be responsible for making the test.

Of Lalibala, much has been learned in the past few years, thanks mainly to another of the emperor's progressive granddaughters, the Princess Hirut Desta. She helped organize the Ethiopian Committee for the Restoration and Preservation of the Churches of Lalibala, which set to work in 1966 to repair the ravages of 800 years of pelting summer rains.

About half the needed financing and much of the effort came from the New York-based International Fund for Monuments. The work was completed last spring, under the direction of Dr. Sandro Angelini, an Italian architect and expert on restoration.

"We had to remove sheet iron that had been laid down to protect the roofs," he told me. "Then from both roofs and walls we chipped away the cement and, inch by inch, scratched off oil paint—remnants of earlier, unsuccessful efforts at preservation.

"When we were down to bare rock again, we applied a newly developed erosion-preventing liquid. All along, of course, we were also clearing silted-up ditches and partly

Folding book (left), with 34 parchment panels, portrays patriarchs, prophets, an archangel, St. James, and—here concealed by creasing—Mary and the Child. This prized wheel picture belongs to the church of St. Mary at Dabra Seyon.

Tinkling twilight music: Ethiopian monks (lower left) often greet the quiet highland dusk and welcome strangers by tossing pebbles at bells made of stone slabs.

Crowns of ostrich eggs (right) decorate crosses atop many churches. Ethiopian Christians consider them symbolic of both the Resurrection and the Virgin birth, since it was once thought that the ostrich left its eggs in the sand for the sun—representing the Creator—to hatch. Tradition calls for seven eggs; here one has broken. Each weighed about three pounds before being emptied. As wild ostriches disappear, churches turn to artificial eggs.

Commonplace

WITHIN THE CLIFFSIDE CHURCH of St. Michael of Dabra Salam stands an earlier church—a 22-foot-square structure (opposite page) that now serves as the sanctuary of the larger building. The author, who was welcomed by priests in processional finery (left), learned that the original St. Michael's—probably built in the late Middle Ages—represents a survival of the ancient Aksumite style of wood-and-stone construction. The design, of alternating layers of wood and dressed masonry

KODACHROMES © N.G.S.

Fallen giant of yesteryear, one of the huge steles of Aksum lies shattered on the ground. Erected by pre-Christian Ethiopians more than 1,600 years ago, probably as a memorial to a sovereign, the monolith simulates in granite the layered wood-and-stone architecture of the time. Another Aksum stele, 65 feet tall, still stands.

façade hides a rare architectural gem

with the distinctive protruding beams called "monkeyheads," dates from before the dawn of Christianity. Ethiopian architects used the style for more than 1,000 years.

Builders of the original Church of St. Michael, which the author considers one of his most important finds, created a structural hybrid—part excavated, part erected. The floor and ceiling were carved from the rocky interior of the cave, and the walls were built up between.

A flaking fresco on a wall inside the old church depicts two men astride a caparisoned elephant (left), the beast's right foreleg raised as a rider whips him forward. No inscription identifies the men, but the author thinks the painting may show Frumentius and his companion, Aedesius, in India on a visit that preceded their capture. Another interpretation holds that the figures represent Thomas, the Apostle of India, and a disciple who, like the saint, wears a halo.

PHOTOGRAPH BY KENN BROWN © NATIONAL GEOGRAPHIC SOCIETY

PHOTOCHROME (OPPOSITE) AND SUBSCRIPTIONS © N.G.S.

Gleaming igloo-white, the church of Abba Yohanni in Tegre Province stands out against its tan mountain setting. Newly constructed whitewashed walls replace a part of the building lost in a landslide centuries ago. The church bears the name of its founder, believed to have been killed at that time. Legend blames the mother of Abba Yohanni for bringing him bad luck. She unexpectedly appeared at his retreat, disregarding his vow never to look again on the face of a woman.

Majestic Abba Yohanni boasts an interior height of thirty feet and ten well-preserved cupolas carved into the cave roof. Two can be glimpsed above the front arches; two others collapsed when the mountainside fell.

Of recent origin, paintings on cloth decorate the pillar at left, reflecting the traditional style of early Ethiopian religious art.

buried walls to unmask the original contours of the holy city."

The newly revealed Lalibala is something of an embarrassment to those Ethiopian clergymen who have insisted on the site's purely religious significance. The excavations have shown that there was a military side to it as well. They have yielded remnants of fortifications, and at least two of the rock-hewn structures, later used as churches, are believed now to have first served as royal palace and reception hall.

The place is named for King Lalibala, who may have ruled toward the end of the 12th century. He is something of an embarrassment too. He was a usurper, a Zagwe mountain war lord who seized the reins of power from Aksum at a time of the old kingdom's weakness.

Usurper or not, Lalibala was canonized by the Ethiopian Church for his Christian zeal and pious life. When the Solomonic line eventually retrieved the throne from the Zagwes about 1270, it could hardly erase the saint from the history books. It solved the dilemma by eradicating all signs of the profane from Lalibala, the Zagwe capital, and by turning it into a purely religious place. A local brook was renamed in the process. It was known thereafter as the Jordan.

Churches Cut From Single Blocks of Rock

Today's Lalibala is as incredible as when the Portuguese Chaplain Francisco Alvares visited it in the 1520's and despaired of his report's being greeted with anything but disbelief.

The complex of churches and chapels is carved into a bank of pink tuff on the shoulder of a mountain. Four of the shrines enmeshed in Lalibala's maze of tunnels, galleries, shafts, and alleyways are literally monolithic.

Workers freed massive rectangular blocks of stone by trenching straight down into the tuff. Artists then sculptured these blocks into houses of worship, fashioning them after conventional churches. Yet each is a single chunk of rock from base to highest gargoyle, from altar to choir loft—and each has its own character.

The solemn Church of the World's Redeemer, Ethiopia's largest rock-hewn monument, has five arched aisles, and on its roof the carvers picked up the arch motif as sheer exuberant ornamentation (page 873). The intimate Church of St. Mary features luxuriant flowerlike designs painted on its ceilings. Emanuel's Church painstakingly emulates sandwich-wall technique, and in its zeal to copy the ancient tradition, is more Aksumitic than the Aksumites (pages 870-71).

Finally, the elegant Church of St. George,

"**He only is my rock and my salvation. . . .**" Framed by a cruciform window, a debtera chants from the 62nd Psalm in the liturgical language, Ge'ez. One of the quarter of a million clerics of Ethiopia's 14,000 churches, he serves in Wallo Province.

in its cruciform shape, is to me the towering triumph of a people who chose to rally round the symbol of the Cross.

On major religious holidays pilgrims triple Lalibala's population of some 9,000 (pages 870-71). Residents and visitors happily trade goods, exchange gossip, and cram the sunken courtyards of the churches, which reverberate with chants and the beating of drums.

At the Christmas celebration on January 7, I watched debteras, in gorgeous garb, dance on the walls around St. Mary's (page 872). They swayed to the throb of long drums, stomped, chanted, and shook their rattles.

Eager to wash their sins away with a dip in the pond in St. Mary's courtyard, some pilgrims joyfully jumped into the deep water without giving a thought to the fact that they could not swim. Quite a few clearly began to drown and were rescued only by the frantic efforts of bystanders.

Once-remote Wonders Now Within Reach

I first visited Lalibala in 1964 when I was collecting material for my recently published book, *Churches in Rock*. I flew there then in a chartered plane because I couldn't face an eight-day mule trip. And the best place I could find to sleep was under a small table in a priest's garden.

Today Lalibala has a comfortable hotel and, except during the heavy summer rains, scheduled daily air service from Addis Ababa. There is even a kind of access road—pioneered by the dauntless Princess Hirut herself—passable in dry weather by four-wheel-drive vehicles only.

Speculating on how the monolithic churches were built, I hold with the majority—that artisans chiseled the interiors from top to bottom, forming first the vaulted ceilings, then the arches, capitals, pillars, and bases. Thus, they would, at the start, have used the uppermost row of windows both for access and for removal of debris.

Swedish architect Bernhard Lindahl, who has studied the shrines intensively, believes, however, that the interior work proceeded from the bottom up. He thinks that the stonemasons usually chiseled from the main entrance to the holy of holies, probably first cutting the nave to its full height and then going on to the aisles.

What sort of men were the builders? "The angels," I have been told by a very old priest. More-sophisticated Ethiopians have speculated they might have been foreigners, particularly Egyptian Copts. Undoubtedly there are similarities between Aksumite rock shrines and such rock-cut sanctuaries as Egypt's Abu Simbel,* even resemblances to certain ancient constructions in central Anatolia and India.

But I think that recent discoveries, including my own, which have been made quite near the old town of Aksum, point to a widespread, unquestionably Ethiopian tradition. The men who carved the Christian churches of Ethiopia in the cool medium of the mountains looked, I am sure, like those who dwell there today.

THE END

*See, in the GEOGRAPHIC: "Abu Simbel's Ancient Temples Reborn," May 1969; and "Saving the Ancient Temples at Abu Simbel," May 1966, both by Georg Gerster.

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Ethiopia: The Hidden Empire

SEE IT IN COLOR, WEDNESDAY, DECEMBER 2

SPEAR AT THE READY, A MEMBER OF THE EMPEROR'S GUARD PARTICIPATES IN MOCK COMBAT. EXTRAORDINARY BY JAMES P. BLAIR © N.G.S.

Ethiopian odyssey

A SEARCHING LOOK at a land seeking to shed its centuries-old isolation for a meaningful role in modern-day Africa will come to CBS television screens on Wednesday, December 2, when National Geographic presents "Ethiopia: The Hidden Empire," second in its 1970-71 series of color programs.

The camera will spirit you to this remote realm of peaks and desert lowlands, where Christians coexist with Moslems and animists. Gentle monks and fierce nomads mingle in marketplaces. Rock-hewn medieval churches dot the rugged highlands; gleaming new buildings rise in the capital, Addis Ababa. Emperor Haile Selassie I pauses for prayer on Liberation Day, May 5; leads a parade, greets diplomats—solemn duties for the Conquering Lion of Judah.

The National Geographic Society produced this hour-long documentary, narrated by Joseph Campanella, in association with Metromedia Producers Corporation (MPC). Sponsors are the Foundation for Full Service Banks and Timex Watches.

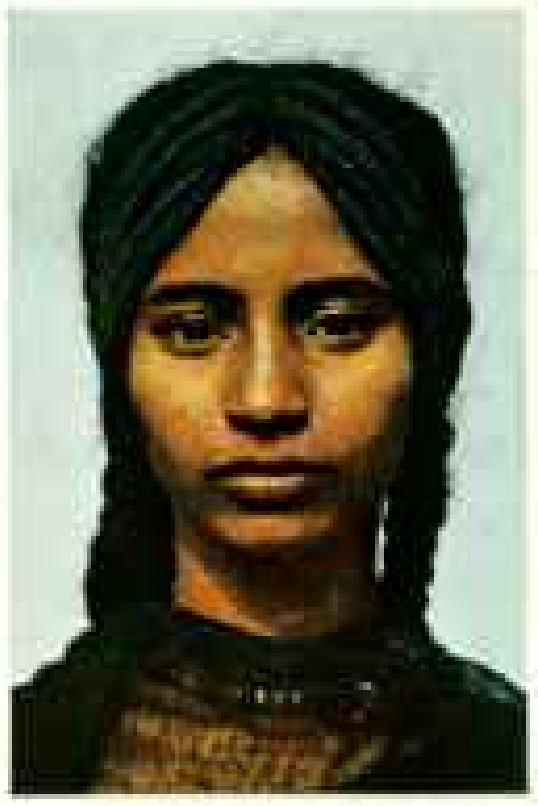
Tear out this page and keep it near your TV set as a reminder

KODACHROME BY GEORG GERSTER © N.G.S.

Natural fortress of chasms and cliffs, the landscape helps explain Ethiopia's centuries of isolation.

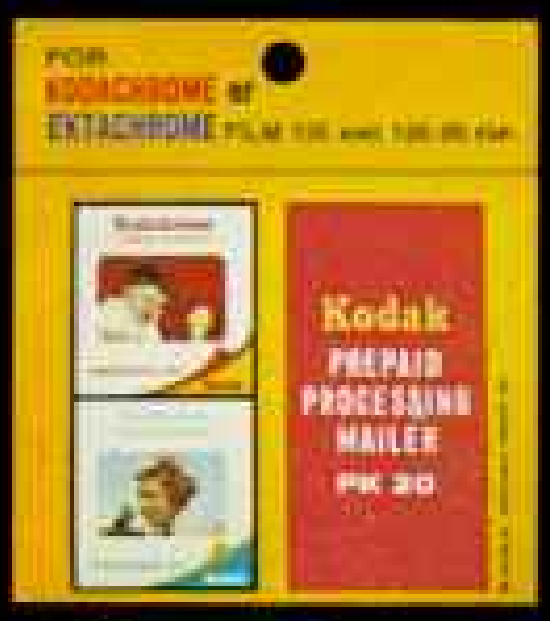
Salt traders load camels with blocks pried from a dry lake bed in the Danakil Depression, much of which lies 200 feet or more below sea level.

Sistrum and song tell the joy of Christian clerics on a holy day.



Bronzed beauty will age fast in one of earth's hottest, harshest climates.

Omo River men beach a crocodile killed by hunters for its hide. Natives will eat the meat.



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