"CLOSE-UP: U.S.A." — THE SOUTHWEST

VOL. 152, NO. 4 OCTOBER 1977

NATIONAL GEOGRAPHIC

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

TELEVISION has come a long way since the chairman of the Federal Communications Commission, which is charged with overseeing the airwaves of America, felt it necessary some 15 years ago to dismiss TV programming as "a vast wasteland." Today many oases dot that onetime desert. Amid the soap operas and ancient movies, one can find drama, education, and entertainment of truly highest quality.

In the vanguard of this "new television" are the four programs produced each season by your Society in collaboration with WQED/Pittsburgh and underwritten by Gulf Oil Corporation for presentation on Public Broadcasting. This December we embark on another exciting series. Watch for the dates on the covers of NATIONAL GEOGRAPHIC.

"Yukon Passage" combines history with adventure. Four young men journey down the fabled Yukon River—by raft in the summer, by dogsled in winter—tracing the always perilous, sometimes fatal route that led gold seekers to Alaska in the late 1890's. Danger, tragedy, humor, and hope still stalk the river road to the Far North.

January will bring an account of the life and discoveries of one of the most protean scientists of our era—Dr. Louis S. B. Leakey. Born of British parents in East Africa, raised among Kikuyu tribesmen, Leakey revolutionized paleontology. His finds in East Africa first indicated that mankind flourished there nearly two million years ago.

In February, underwater cameras will bring you into intimate contact with the world's most massive inhabitants, whales. Warm-blooded, air-breathing creatures like ourselves, they opted in some distant epoch to roam the seas. Now we and our explosive harpoons and our flensing blades may be edging these masterpieces of nature to the ragged edge of extinction.

Our final production of the season, "The Living Sands of Namib," will focus upon the strange flora and fauna that have managed to adapt to the incredible ground temperatures —sometimes as high as 170°F—of Africa's cruel southwestern quadrant. A classic wasteland, the Namib Desert still manages to support a fascinating variety of life forms. Thanks in good part to PBS, WQED, Gulf, and your Society, the once "vast wasteland" of television is now able to do the same.

Gilbert M. Grosvenor

NATIONAL GEOGRAPHIC

THE NATIONAL GEOGRAPHIC MAGAZINE, VOL. 152, NO. 4

October 1977

COVER: *Arizona's bountiful sunshine helped produce this armload of calendulas on a flower farm near Phoenix (pages 486-517). Photograph by H. Edward Kim.*

Oases of Life in the Cold Abyss

By JOHN B. CORLISS, Ph.D.
OREGON STATE UNIVERSITY, EXPEDITION LEADER
and ROBERT D. BALLARD, Ph.D.
WOODS HOLE OCEANOGRAPHIC INSTITUTION

SHIMMERING WATER streams up past giant tube worms, never before seen by man. A crab scuttles over lava encrusted with limpets, while a pink fish basks in the warmth.

Inside the research submersible *Alvin* we watch in amazement. We have dived a mile and a half (2.5 kilometers) into the near-freezing depths of the Pacific, yet our temperature probe now registers 63°F (17°C) as we hover over an incredible community living around a warm sea-floor spring.

Our group has come as geochemists and geologists to the Galapagos Rift west of Ecuador to investigate for the first time active hydrothermal vents in the deep sea.* While gaining invaluable basic data for understanding earth processes, we also make history for marine biology. The unknown creatures and dense communities of life we have discovered living at these vents, like lush oases in a sunless desert, are a phenomenon totally new to science.

---

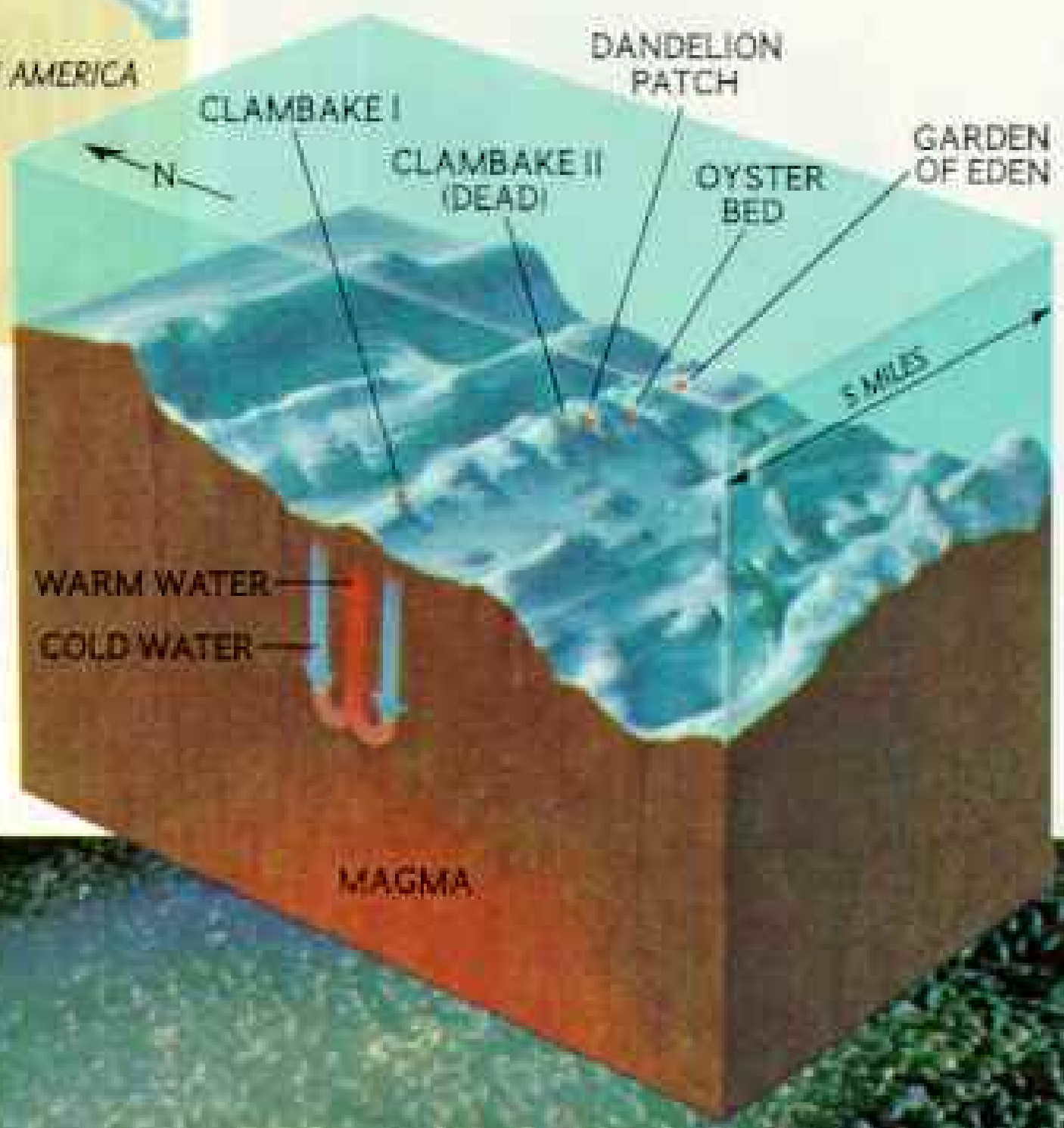
*Other principal investigators were Dr. Jack R. Dymond and Dr. Louis I. Gordon, Oregon State University; Dr. John M. Edmond, Massachusetts Institute of Technology; Dr. Tjeerd H. van Andel, Stanford University; Dr. Richard P. Von Herzen, Woods Hole Oceanographic Institution; and Dr. David L. Williams, U. S. Geological Survey.

TUBE WORMS, PRESENTLY ASSIGNED TO THE PHYLUM VESTIMENTIFERA, ARE OVER FIVE FEET LONG. CRUSTACEAN CRABS; BRISTLED FISH. JOHN W. EDMOND, MIT

A saltwater plumbing system

IN THE GALAPAGOS RIFT—a boundary between separating plates of oceanic crust—lava erupts, cools, and cracks. Cold seawater penetrates into fractures and, growing hot, drops off some elements while picking up others—manganese and silicon—from crustal rocks. Rising through fissures, the hot water flows from the seafloor, where the metal oxides precipitate, or separate out.

PAINTINGS AND SCALE MODEL (BELOW) BY WILLIAM H. BOND, NATIONAL GEOGRAPHIC ART DIVISION



Fanciful names distinguish five oases, each with its own fauna, found in the Galapagos Rift (**right**).

In a model (**below**), *Alvin* explores Clambake I, a 50-by-90-yard oasis fed by plumes of warm water. East-west cracks rend the floor as the oceanic plates pull apart.

We were drawn to this spot by evidence gathered earlier by the Scripps Institution of Oceanography, Oregon State University, and Woods Hole Oceanographic Institution. Towed instruments had picked up subtle temperature variations just above the seafloor. Sonar and photographs from towed cameras showed mounds that might be precipitated metal oxides related to hydrothermal vents. Water samples contained abnormal amounts of radon 222 and helium 3, isotopes that form deep within the earth.

So this past winter the Galapagos Hydrothermal Expedition got under way—three vessels carrying 25 scientists and 26 technicians—sponsored by the National Science Foundation as part of the International Decade of Ocean Exploration. From the research vessel *Knorr* we lowered a camera system called ANGUS to pinpoint the vents; an attached thermistor sensed temperature changes as small as 1/500 of a degree Celsius.

On February 15, during the first 12-hour run, the temperature line registered normal conditions—near freezing. Then, at 19:09, it showed a sudden spike. Within hours an onboard photo lab provided by the National Geographic Society had processed our film. Eagerly we ran the film to frame 19:09.

Clams! Hundreds of them covered the lava, in a dense blanket never before seen in the deep. We returned to the coordinates of that frame, and *Alvin* went diving (diagram, left).

In *Alvin* rotating pairs of scientists collected water and rock samples and pondered the animals: How did they get there?

Back aboard the *Knorr*, when we opened water samples, our noses crinkled at the rotten-egg odor of hydrogen sulfide. Yet this was the smell of success—pungent evidence supporting the theory that seawater journeys through the oceanic crust. There, under extreme heat and pressure, the sulfate in seawater converts to hydrogen sulfide.

In this smelly compound, microbiologists later explained, lies the secret of life in these oases. Certain bacteria metabolize hydrogen sulfide and multiply. The microbes, in turn, nourish larger organisms, even clams. Thus, in total darkness, an energy source other than sunlight—chemicals manufactured within oceanic crust—triggers a chain of life. Here the process, called chemosynthesis, is found for the first time in the abyss.

Discovery of giant clams, many of them larger than dinner plates, changed the diving routine. Now, in addition to picking up rock samples, *Alvin*'s mechanical arm harvested bivalves (**below**). "We were fascinated by the realization that these animals form a food chain based on energy from inside the earth, rather than from the sun," said co-author and expedition leader Dr. John B. Corliss (**bottom**). The abundant food at the vents probably contributed to this giantism.

CLAMS, VESICOMYIDAE, 30 TO 40 CM. (12 TO 16 IN.), ROBERT D. BALLARD, WHOI (ABOVE); NATIONAL GEOGRAPHIC PHOTOGRAPHER EMORY KRISTOF

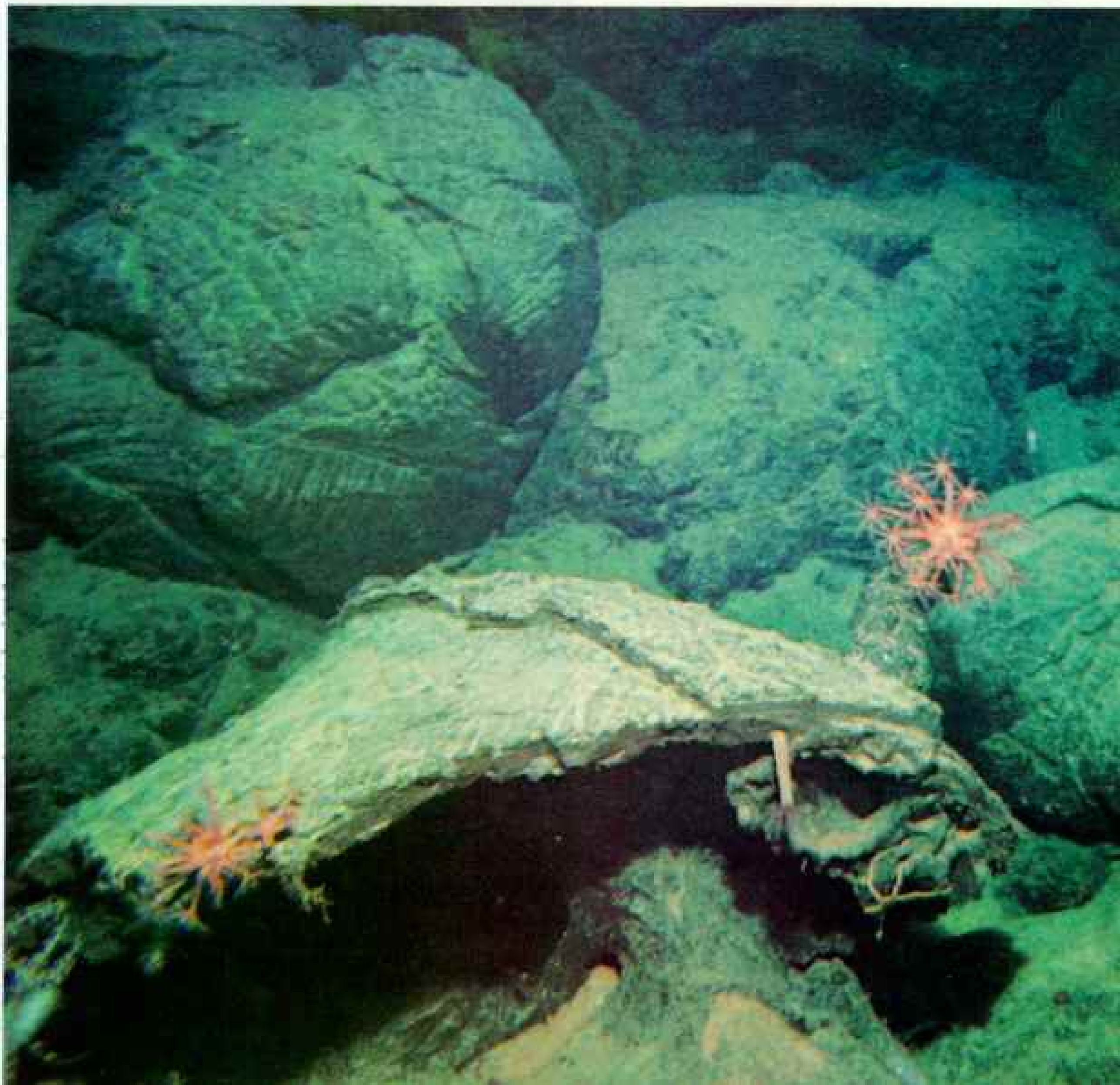
TORTUOUS volcanic terrain looms outside the five-inch view ports as we glide within our pod of light toward Clambake I. In the desert of the deep seafloor, only occasional invertebrates, like the reddish octocoral and the brittle star (**below**), enliven the barren basalt.

These pillow-shaped lavas formed during volcanic eruptions when molten rock squeezed up through fissures like toothpaste. As icy seawater pressed down with two tons per square inch, the lava congealed into these shapes.

As the lava cooled, the surface split, opening new fissures where seawater could circulate into the newly formed crust—such as this yard-wide crack (**lower right**) with an anemone perched on its rim.

These pillows—centuries old but young in geologic time—often have black, glassy surfaces. Sediment drifting down from the surface has scarcely had time to accumulate. The Galapagos seafloor is even fresher than the one explored during an expedition to the Cayman Trough (NATIONAL GEOGRAPHIC, August 1976).

Everywhere in the depths, except at the Galapagos oases, life becomes scarcer the deeper one dives. But marine biologists have nonetheless found great diversity on the ocean floor; deepwater,



or benthic, species of almost every animal phylum have adapted to the pressure, the cold, and the darkness. The animals subsist on one another and on leftovers, the remains of dead organisms that drift down from the productive layers of ocean near the surface—a journey that may take from a few days to many years.

After a five-hour bottom traverse, *Alvin* releases weights to lift us up in an hour and a half. Here in the catamaran tender *Lulu* (**right**), divers position the sub in its cradle, while *Alvin* program manager Larry Shumaker sits atop the sail, recently painted red for better visibility in rough seas.

EMORY KRISTOF

JACK R. DYMOND, OREGON STATE UNIVERSITY

ANGUS TOWED CAMERA, WOODS HOLE OCEANOGRAPHIC INSTITUTION

Startled congregation of crabs scurries away from *Alvin*'s instrument-packed sampling basket. Here in the oasis of Clambake I, fountains of milky blue

CANCROID AND MUNIDOPSIS CRABS, 10 CM (4 IN.); MUSSELS, MYTILIDAE; EXTERNAL ALVIN CAMERA, WHOI

warm water laden with bacteria and particles of sulfur glisten above vents almost overgrown with mussels, left. Water temperature is 54°F (12°C).

CHIMAERIDES ARMATUS, 13 CM (5 IN), MITCHELL LYLE, OREGON STATE UNIVERSITY

HANDLEDOME, 46 CM (18 IN), ROBERT D. BALLARD, WHOI

BENTHOCYTES, 20 CM (8 IN.), JOHN B. CORLISS, OSU

SOLITARY SOJOURNERS on the seafloor often flash by our ports as we move away from the oases. As *Alvin* pokes a water-sampling probe into a blanket of sediment, this curious rattail, or grenadier, investigates (**left**). Its eyes, among the most sensitive in the animal kingdom, may help the fish perceive bioluminescent prey. Above draperylike lava formations called pahoehoe (**right**), a skate skims by on billowing wings.

Startled by *Alvin*, a fuschia-colored holothurian, or sea cucumber (**below, near left**), contracts into a question mark during a pulsing escape. Ordinarily, sea cucumbers are seen creeping across the seafloor.

RAJA; 1.5 METERS (5 FT) ACROSS; ARGUS TUBED CAMERA, WHOI

OASIS DWELLERS thrive in the bacteria-filled water surrounding the lava of the vents. At Clambake I, a smooth rock suddenly extends arms and opens enormous eyes (**far left**): an octopus hunting crabs.

Crabs feast at each active oasis. We interrupt one (**right**) as it dines on feather-duster worms at a misnamed site, Oyster Bed; our "oysters" turn out to be mussels. *Alvin* doesn't need to sample crabs; they clamber into every corner of the exterior and come up with the vessel—dead from the temperature and pressure changes.

Some biologists suggest that the species of drifting larvae that arrives at a vent when it first becomes active will come to dominate the oasis. This concept, the founder principle, would explain why huge tube worms now monopolize the heart of the Garden of Eden, whereas bivalves prevail at Clambake I.

CANCROID CRAB, 13 CM (5 IN) AND SERPULID WORMS; JOHN B. CORLISS, DSU

UNKNOWN ORGANISM, DIAMETER OF BODY 3.8 CM (1.5 IN.), JOHN B. CORLISS, OSU

STRUCK by an energy crisis when their hot-water vents shut down, the bivalves of Clambake II died (**facing page**). Our thermistor shows no warm water, hence no life-supporting hydrogen sulfide. It is eerie, like seeing the charred remains of prehistoric campfires.

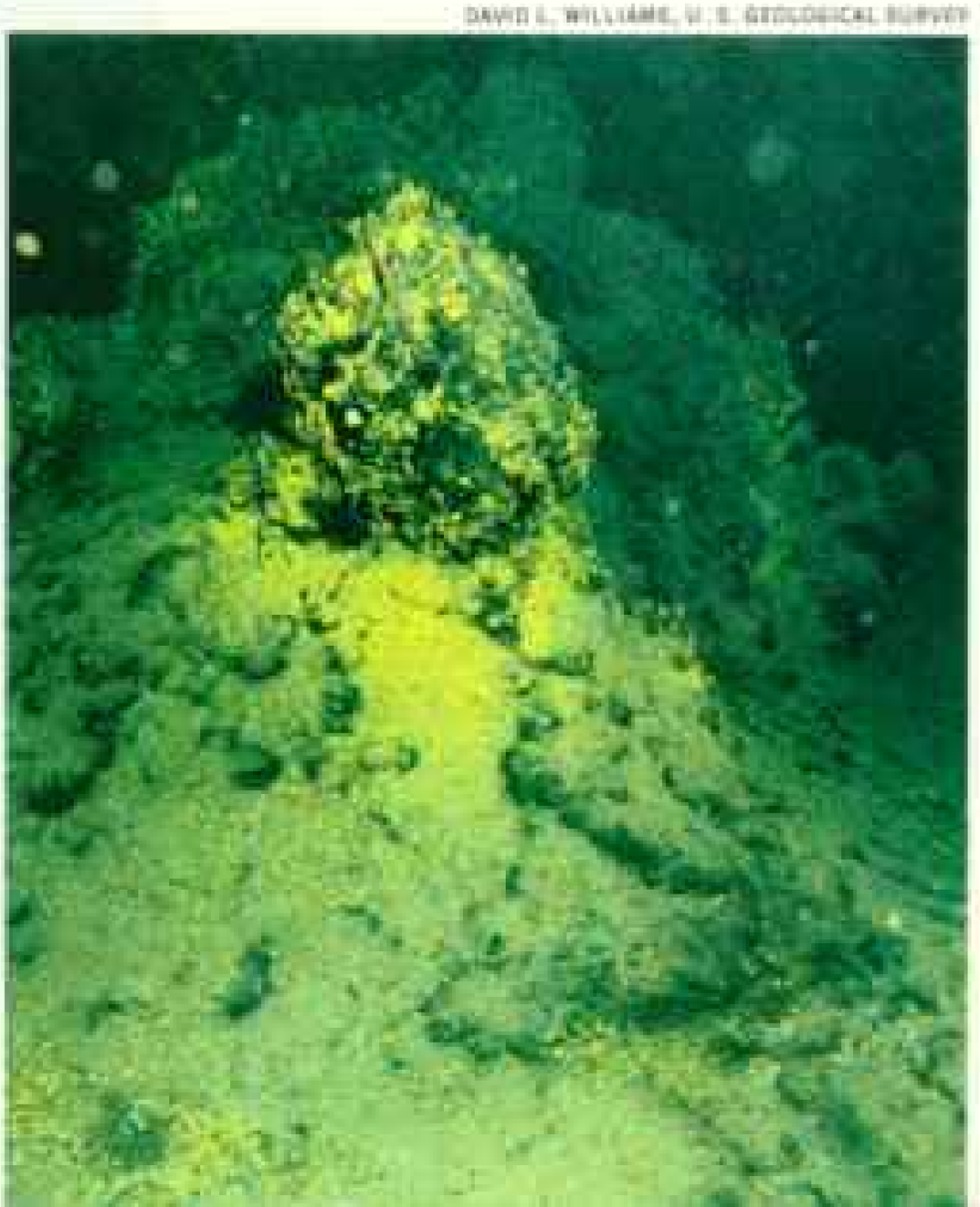
Resembling dandelions gone to seed, delicate animals (**above**)—perhaps a new form of protozoa—attach themselves to rocks with filaments.

Unidentified organisms draped like spaghetti beside a fissure (**left**) slipped away from our rock samples. Such mysteries may be solved after biologists dive in *Alvin* to the Galapagos Rift to sample and study its fauna in detail.

A three-foot mound bristling with black manganese and yellow iron oxides (**below**) marks a warm spring in a sedimented region about 12 miles south of Clambake I. The metals seeped from deep within the earth's crust in hot solution and precipitated as they hit cooler water.

EXTERNAL FLOOR CAMERA, WHOI

DAVID L. WILLIAMS, U. S. GEOLOGICAL SURVEY



KINGS TOWER CAMERA, NYC

JACK N. DYMOND, OSU

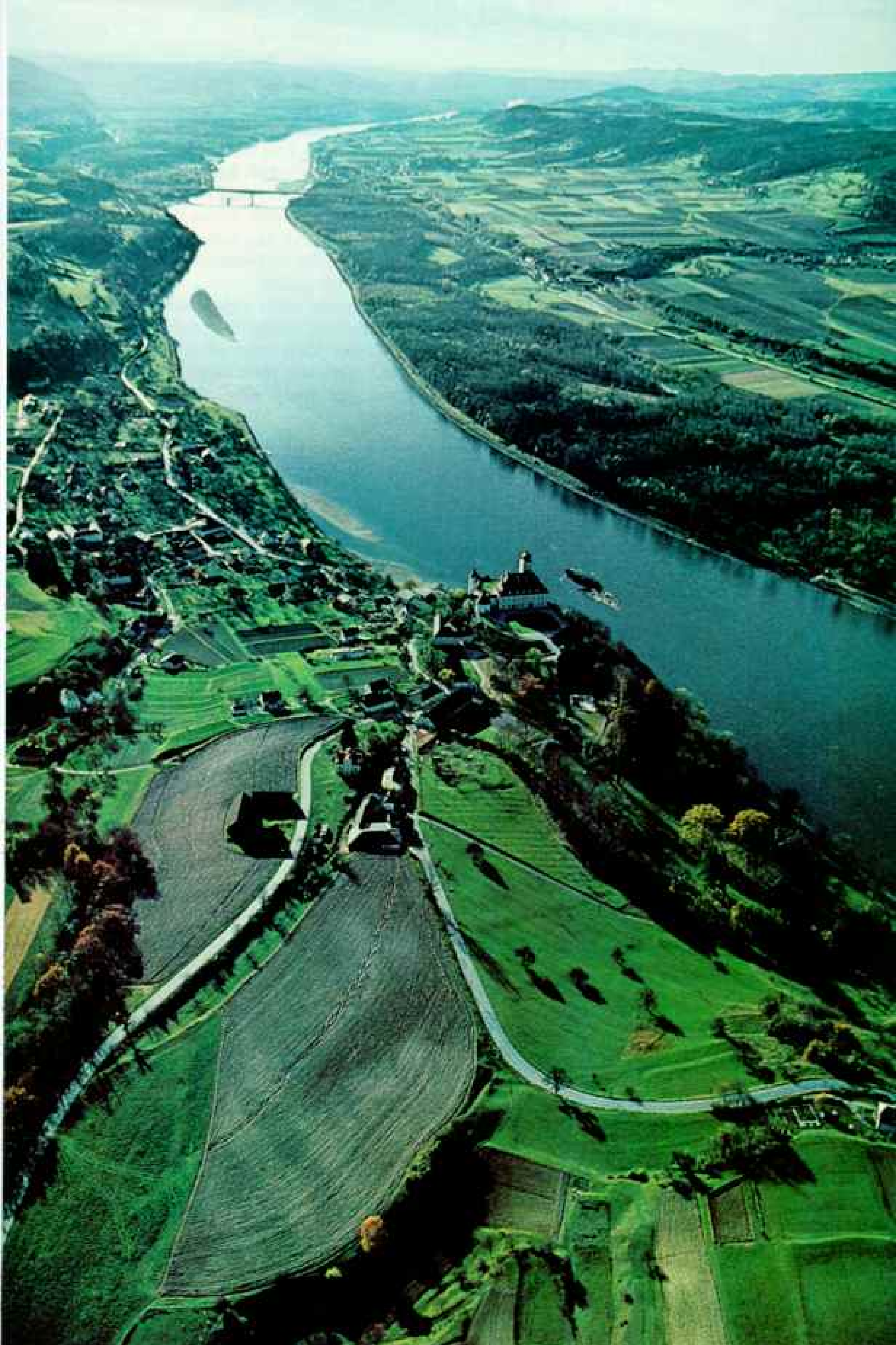
LAUNCHING A NEW TOOL for viewing deep-sea dwellers, one of its builders, Alvin M. Chandler of National Geographic, lowers an acoustically controlled camera and its baited basket. Such "creature cameras" were first developed by scientists at Scripps.

A team from National Geographic, Woods Hole, and Benthos, Inc., built this pressure-shielded system with high-speed flash units jutting from a cylindrical camera-carrying transponder. The navigational device signals position and receives orders to perform tasks. We could place the camera within 10 yards of any point (**lower left**), where, in minutes, the bait—mackerel and herring—drew fish.

At Clambake I (**below**) the camera attracts a rattail to its lens, while others feed at the bait basket below. Red numbers record March 13, 4:51 and 50 seconds p.m., seventh lowering. When the surface operator signals the transponder, it drops its weights and brings home the camera with its record.

How many more vents exist along the 40,000-mile-long system of oceanic rifts, we wonder? How many of these support life? And will their existence revolutionize our knowledge of life in the abyss? □

ALVIN M. CHANDLER AND EMORY KRISTOF (BELOW); AND EMORY KRISTOF (UPPER LEFT)



THE DANUBE

RIVER OF MANY NATIONS, MANY NAMES

By MIKE EDWARDS

Photographs by WINFIELD PARKS

BOTH NATIONAL GEOGRAPHIC STAFF

HE WAS A BOXY MAN in his shiny blue suit, and his face matched the nickname "Rada Tomato" that he had used as a Yugoslav partisan in World War II. I met him at a reunion of a partisan brigade, an affair as potent as the slivovitz his comrades were tossing down. They had been among the war's toughest guerrillas, these gray and sagging men, and now they reveled and remembered, wearing their medals on their lapels and their emotions on their sleeves.

Rada wore two decorations for bravery. I think he had to talk—*had* to talk—and I was a convenient audience. He told me of joining the partisans when he was 20, of his wife's then being forced to flee their village. Homeless in a time of terrible cruelty, she was dead of tuberculosis in a year. He spoke of his brother who fell in a skirmish in 1944. And, unashamed, he wept.

Then, struggling against memory, he gave me a thin smile and said, "I will sing you a song from my village." He began in a sweet voice, "People are so nice in Srem. . . ."

Rada and his comrades gathered in what had been a partisan hideout in a mountain range frowning down on the River Danube. I reflected that day on the triumphs and tragedies that have freighted this river in its almost 1,800-mile journey from Black Forest to Black Sea (map, following pages).

Rome fortified the Danube against barbarian tribes. For Ottoman Turks and Austrian Habsburgs the river was an avenue of conflict. World War II scarred the capitals on its banks: Vienna, Budapest, Belgrade.

Politically it is a divided river today, a high fence along the Czechoslovakian border symbolizing the rift. Upstream is West: Austria, West Germany. Downstream is Eastern Europe: Czechoslovakia, Hungary, Yugoslavia, Romania, Bulgaria, and a sliver of the Soviet Union.

Division, conflict, tears. They are valid aspects of the Danube, but not the one the

The Danube carves a valley unsurpassed in beauty at Schönbühel, Austria, where a castle stands sentry above river, village, and farms. Yet along its bucolic shores the legions of Augustus, Charlemagne, Napoleon, and Hitler marched, and for a time ruled. Now the Danube confronts a modern adversary—pollution.

From Black Forest to Black Sea, central Europe's longest river flows from West Germany and Austria through the Communist bloc, changing names as it changes nations.

The Danube assumes its name when two bright rivulets from the Black Forest, the Breg and Brigach, unite at the town of Donaueschingen. A nearby spring (**left**) that flows into the stream is unofficially honored as the river's source. People in neighboring villages frequently claim that *their* spring or stream is the true source.

Below Regensburg in West Germany the Danube becomes busy with barge traffic. With the completion of the Rhine-Main-Danube Canal in 1985, the river will become a link in a waterway permitting modern barges to navigate 2,130 miles across Europe, from the North Sea to the Black Sea.

world prefers. On a bluff on the Buda side of Budapest, I see the other. There stand Matthias Church, buttressed and spired in proper Gothic, and a crenellated rampart called the Fishermen's Bastion. Below, lights gleam as they do nowhere else on the river. It is a romantic place, a place for lovers. And there they are, in the niches and shadows, clinched and oblivious to passersby. I think of Rada. He too had loved.

The world's sentimental attachment to the Danube is vicarious, through a waltz that is lilting and haunting, sweet and bittersweet: in a word, enduring. There is no evidence that Johann Strauss the younger was under the spell of its waters. Facile and prolific, the Viennese Waltz King could find inspiration in almost anything—for "The Blue Danube," a line by a German poet.

"The river was never really blue," said a Hungarian environmentalist, a man concerned not with romance but pollutants, of which the Danube has its share.

"It is blue if you are in love," a Czech woman said.

I traveled along the Danube from source to sea by camper, barge, hydrofoil, launch. I saw the youthful river as crystal. Elsewhere it usually was gray or green. But sometimes when the sun is shining and the sky is azure overhead, the river does make Strauss an honest man.

"I must be known on every continent in the world," says 80-year-old Theres Biehringer (**above**). A retired cleaning woman in Ulm, she spends most days observing the passing scene, and passing tourists take her picture.

After her home was destroyed in World War II, Frau Biehringer moved into Das Schiefe Haus—The Crooked House (**facing page**)—built 400 years ago on a Danube tributary as a residence for fishermen and subsequently warped by time. A few years ago the floors were straightened, so furniture would stand reasonably upright.

An old Bulgarian song calls the Danube white, meaning "gentle." In commerce it is mostly red, dominated by Communist states.

RED, WHITE, OR BLUE, it drains a basin as large as two Californias and changes names as it changes nations: Donau, Dunaj, Duna, Dunav, Dunărea, Dunay. Celts who dwelt along the river in ancient times must have called it something similar, for the root of all of these names is the Indo-European *danu*, meaning "river" or "flowing."

Early on, the river toys with the notion of rejecting all this—rejecting destiny, politics, romance. It starts well enough, from the union of two small German streams, the Breg and Brigach, that tumble from the Black Forest and unite at the town of Donaueschingen. But after only 25 miles the river abruptly disappears underground, leaving a puddle that two hops will carry you across. But then, a little farther on, it overcomes its shyness and is on its way again, singing to medieval ruins on limestone bluffs.

I sought trout beneath those bluffs at dawn one August day. The fish did not oblige, but it didn't matter. I just wandered the foggy bank and munched windfall apples. Like the river, I was in no hurry that delicious morning.

But we did go on, the Danube and I, crossing fields fenced with geometric precision, inspecting antique cities. I saw Ulm long before I reached it. You can't miss the Ulmer Münster's spire, at 528 feet the tallest church tower in the world.

The first stones of this enormous edifice were laid in the 1300's. "Come look at the choir stalls," said Gerhard Lorenz, the *Münsterbaumeister*, or building supervisor. "You may see a few places where wood is missing, but not many, I think."

Allied bombers leveled more than half of Ulm in World War II, including Albert Einstein's birthplace. One bomb exploded in the cathedral, shattering carved oak choir stalls five centuries old. Three carpenters spent almost four years collecting and reuniting the splinters. "There is no new wood," Mr. Lorenz said, beaming behind his spectacles. "Only the old."

I wandered on down to Kelheim on a late summer Sunday. A riverside carnival vibrated to the oompahs of a band, and waitresses with arms like bridge cables swung between

With style and Gemütlichkeit, *a driver guides his team at the annual*

Volksfest in Kelheim, West Germany.

crowded tables clutching pitchers of beer, two or three to a hand. Youngsters polished off *Eiskrem* and *Zuckerwatte*—ice cream and cotton candy—while circling Fort Laramie on a little Union Pacific train. The riverside resounded with a last holiday fling.

TWENTY MILES DOWNSTREAM, at Regensburg, the Danube becomes a working river, a thing of muscle and smoke, servant of 35 principal ports. Laden with Austrian steel for the Soviet Union, Soviet cars for Bulgaria, Yugoslav fruit for Germany, Czech chemicals for Yugoslavia, ores from Canada and Brazil, the waterway hauls 70 million metric tons a year.

Regensburg will cease to be the head of navigation in 1985, when a new canal links the river upstream with the Main, a Rhine tributary, allowing large barges to navigate from Black Sea to North Sea. But for now at least, Regensburg remains a thriving port.

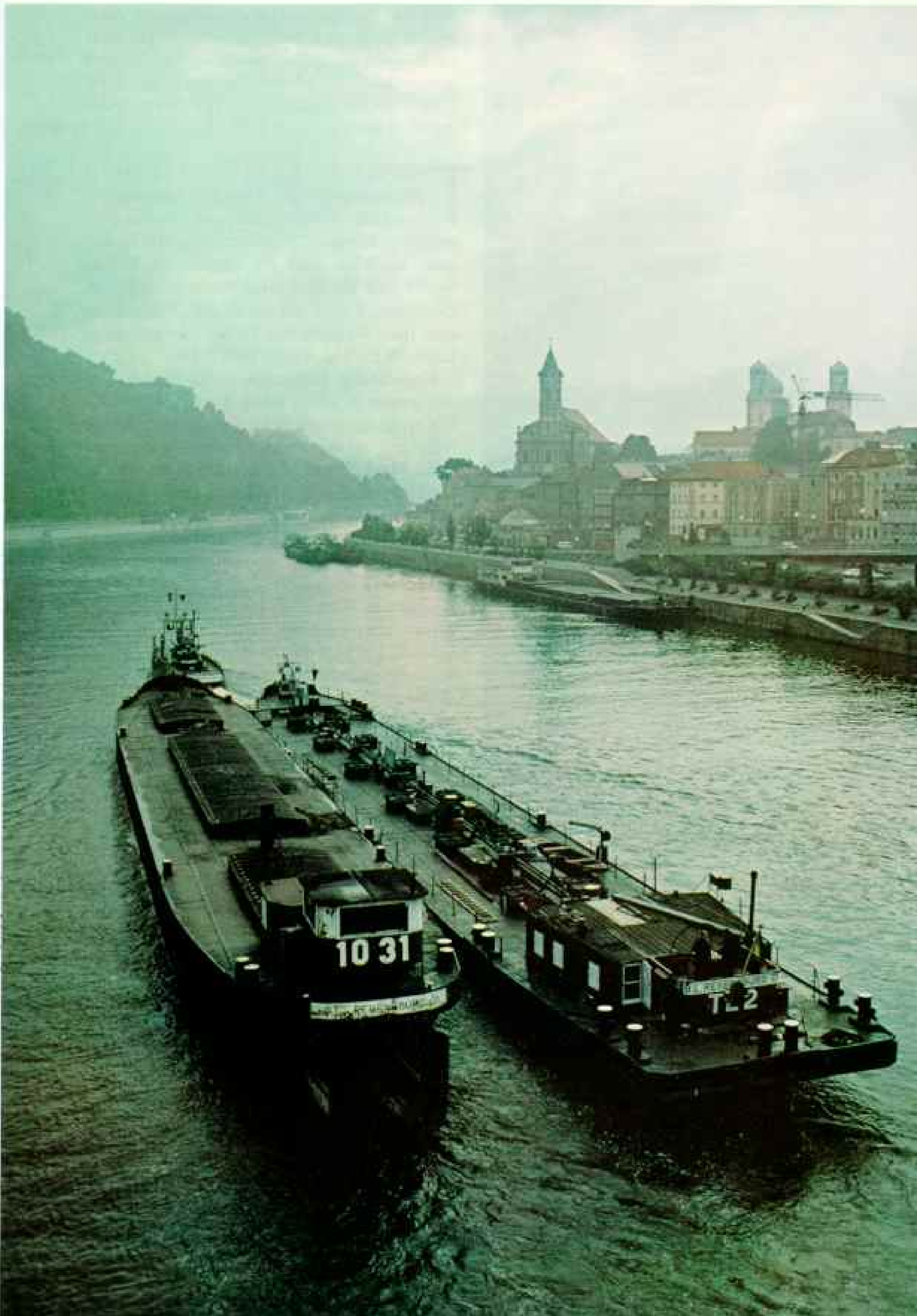
Barges at the quays flew the flags of the eight Danubian countries. The largest fleets on the river belong to Romania and Yugoslavia, each with more than 1,200 vessels; the smallest to West Germany with 67. A pact assures navigational rights for all, but the U.S.S.R. has become the leader among equals. It makes other nations dance to its tune on shipping charges, having refused to increase rates for 20 years despite inflation.

Why? Perhaps to drown the Western competition in red ink, one shipping official said. Or perhaps to attract foreign currency.

Regensburg was the end of the line for a Romanian named Mihail, who had delivered a cargo of chemicals. As I stood on a quay, I heard a sound like clucking. Chickens? Mihail answered my question with one of his few German words: *"Ja."*

And also aboard his barge I would find . . . find what? The word wouldn't come, so he wiggled his fingers above his ears. I went aboard to see his rabbits. And his ducks, chickens, and box gardens of tomatoes and onions—altogether, a perfect floating farm. Mihail smiled and patted his belly eloquently.

Freight craft on the Danube number some 4,400, and when I got to Vienna, I arranged with the Erste Donau-Dampfschiffahrts-Gesellschaft (First Danube Steamship Company) to travel a few days aboard one. The self-propelled barge *Greinburg* was bound


10 31
T-2

Fed by tributaries, the Danube flexes its muscles at Passau, where a coal barge and an oil barge (**left**) ride the river's broad back toward nearby Austria. In olden times "Ulm boxes," wooden rafts and rough-hewn canoes, lazed downstream to Vienna. There they became firewood, because rowing upstream was too difficult.

Looking as if he could tackle that task today, a brawny burgher at the Kelheim Volksfest inspects Black Sea mackerel charcoal-broiled for festival goers (**above**).

Ships of all Danubian nations use the river, but Communist countries dominate. On her barge at Regensburg (**right**), Anna, the wife of a Romanian skipper, cradles a rabbit. Their trip was interrupted when the Reichsbrücke, a major bridge spanning the Danube at Vienna, collapsed and fell into the river, tying up traffic for two months. "When they left," says photographer Parks, "I think they had a few more rabbits than when they arrived."

upriver for Linz, heavily laden with iron ore. In reservoirs behind hydroelectric dams we sped along at 12 miles an hour. Against the current we made three and a half; I could walk to Linz that fast.

The captain and mates were busy when we cast off or tied up, but otherwise a modern vessel like *Greinburg* largely takes care of itself. Capt. Heinrich Gruber, a wiry man with hair the color of the Danube at dawn—silver-gray—sat almost motionless at a console studded with buttons and switches. After he eased us into a lock, I complimented him. "Like driving a car," he said with a shrug.

Aft, in the quarters, I had the sensation of being on a rattling train. Put water on the stove for coffee and miraculously it appears to boil instantly. Touch the pot and you find the water is only vibrating.

One afternoon I watched half a dozen gray herons playing follow the leader: flapping determinedly, gliding, then alighting on a shingle beach. On the north bank the Bohemian Massif was a plunging jumble of contours. To

the south appeared the Dunkelsteiner Wald, a rolling hillscape of forest and farm. *Greinburg* passed villages and vineyards that reached for castle ruins. For me this region of Austria, the Wachau, is the Danube's most appealing union of land, water, and man's work (page 454).

It is, everywhere, very old work, as I found in the medieval village of Dürnstein. My hotel was a former castle, standing since the 1600's. "The newest building in town," innkeeper Hans Thiery said. Later he amended that: "The newest *old* building in town."

Vineyards are the Wachau's mainstay and its delight. "Old men say that if they are born again they want to be winegrowers," observed Heinrich Stöger, who at 71 knows the joys well. We met in his vineyard. Had I been to a *Heurigen*, he asked. "We have a saying: 'A man should have an hour of happiness every day. If he cannot get it, he can go to a Heurigen for a night of happiness.'"

The stock in trade of these unpretentious drinking places is new wine, barreled for a few months. Or, as another elder defined it, "the wine you start drinking when everything older has been drunk."

Traditional green branches over a doorway beckoned me into a Heurigen. Climbing to an arbored terrace, I took a seat at a wooden table and tried *grüner Veltliner*.

"It's a wine that goes down easily," vouched a tablemate. I agreed. Below and beyond, the Danube was hammered silver. The vines overhead were splashed with gold. I knew an hour of happiness and more.

EVERY SUMMER AFTERNOON they come to Vienna's Stadtpark (page 467). Older ones, like Josef and Wilma Polland, sit on benches in the sun. Young people stretch out on the grass. They come to listen, and some to dream. When the orchestra on the bandstand begins to play waltzes, Vienna is alive as of old.

"I learned to waltz when I was 10," said Frau Polland, who is 75 now. "When I was young, I liked an American couple in the movies. They sang and danced. *Wunderbar!* His name was, I think . . . Eddy Nelson?"

The orchestra began "The Blue Danube."

"That is the most important waltz," Frau Polland assured me. "They play it every day."

On a café terrace by the park, sad-eyed Josef Wojcik maneuvered scissors and a sheet

White-gloved formality graces Vienna's Willy Elmayer-Vestenbrugg dancing school, where young people learn to waltz, tango, and polka with poise and elegance. Boys learn how to greet a woman with a correct *Handkuss*—the lips come close to, but do not touch, the hand. The hand kiss is proper only with married women, and then, according to strict etiquette, only indoors.

of black plastic. "Nobody else in Vienna makes silhouettes now," he said. "There were three of us, but two are dead." As he compared his work to his subject, a young woman, he said, "I can show you the house where Beethoven wrote the *Eroica*." Then he talked of other composers who made Vienna the capital of the classics: Haydn, Mozart, Schubert, Brahms, Mahler.

But Johann Strauss always will enjoy a special place in Viennese hearts. He stands in bronze in the Stadtpark, playing his violin.

Strauss wrote "The Blue Danube" in 1867 for a men's choir. An amateur supplied clumsy words, and the music won no acclaim. But a few months later in Paris it caught Europe's fancy overnight, and for Austria it became virtually a national anthem.

THIRTY-FIVE MILES downstream from Vienna I drove through a checkpoint in the high fence, studded with guard towers, that is Czechoslovakia's version of the iron curtain.

Attitudes toward a Western journalist vary in the countries stretching from this border to the Black Sea. I was to find that in Hungary and Yugoslavia I could move about with near-total freedom, and largely so in Bulgaria. In Romania, which regiments its citizens more than most of the other Eastern European countries, it was difficult to wander off the established tourist track. This was also true to some extent in Bratislava, Czechoslovakia's biggest city on the Danube. Even a visit to a collective farm required several requests to pleasant but cautious officials. But once I had penetrated the numerous bureaucratic layers, I found Eastern Europeans invariably hospitable.

In Bratislava you can dine on caviar in a good hotel or go outside and see housewives standing in line to buy sausage. Signs hail the Communist Party while Gypsy musicians play American pop. Atop a high hill—a spur of the Little Carpathians—the earth holds the remains of 6,845 Soviet soldiers. A great marble shaft honors them for liberating Bratislava from the Nazis in 1945. There are always red flowers on the graves—geraniums, roses, or poinsettias. The effect of flowers, stone, and bronze, and of the history they convey, is powerful indeed.

Bratislava's skyline is singed by the gas flares of a sprawling petrochemical complex, and Danube fishermen sometimes complain that their catch has an oily taste. "Many of us are worried about pollution," said a man I met by the river. He voiced a frustration I have heard at home: "The big industries are more powerful than we are."

I wanted to tour the Slovnaft refinery but got only as far as the office of engineer Juraj Kuka, whose job is environmental protection. "We *are* strict," he insisted. "After all, we also use the Danube for drinking." The river arrives polluted from Austria and Germany, he reminded me, though he conceded that after it passes Slovnaft it is 18 percent dirtier.

To house 360,000 people, a population that has more than doubled in three decades, Bratislava is flinging up apartments at the rate of 5,000 a year. I had no appointment to visit one, but with my guide's doubtful aquiescence I knocked unannounced at a door.

Vendelin Trepáč was at the TV absorbed in a game of ice hockey—Czechoslovakia versus the Soviet Union. My visit startled him, but with good grace he made me welcome.

Mrs. Trepáč showed me through the tidy three-bedroom flat. The room of one of the three daughters was decorated with pictures of musicians, including John Lennon. The kitchen held two small refrigerators.

We sat down and the couple explained that they both worked, he as a manager of an apprentice program for a dressmaking enterprise, she as a trainer of seamstresses. "This apartment is very reasonable," she said. "We made a small down payment and pay 293 crowns a month" (about $30 U. S.).

Mr. Trepáč's eye had returned to the TV. "Goal!" he shouted as Czechoslovakia scored. It made me think of Sundays at home.

Downstream from Bratislava the Slovakian countryside spreads out a billiard-table

Blue in evening's faint glow, the Danube slips between Buda and distant Pest, dominated by the Hungarian capital's domed and spired Parliament Building. Divided like Paris by a beloved river, Budapest comes alive at night with opera, Gypsy music, and nightclubs. Eight spans, including the Chain Bridge, foreground, link the twin cities.

flatness, figured only by an occasional village or line of willows.

"Good land—black land!" exclaimed the mayor of Čičov, Julius Kosa. A great, friendly, dark-eyed bear of a man, he escorted me around his village of 2,000 and showed me the new community center.

I camped that night near a small lake in a wildlife refuge, a mile from the Danube and two miles from Čičov. After dinner the moon came up full and fat. The lake was luminous and still. Not a frog croaked. This tranquil water seemed far from the smokestacks and rumbling engines of the working river. I stripped and waded in.

At dawn I drove back to Čičov and pulled into the main yard of the United Cooperative Farm. Tractors rumbled by, pulling wagonloads of fodder. Workmen, all wearing blue fatigues, arrived on bicycles. Women boarded

Symbols of grief, bronze statues stand watch at a memorial to partisans in Bratislava (**left**), Czechoslovakia's only large city on the Danube. Atop Gellért Hill (**below**) in Budapest, Hungary, Soviet troops visit a monument honoring their countrymen who died in the World War II battle for that city.

a van to spend the day picking tomatoes.

It is a vast enterprise: 7,500 acres yielding grain, vegetables, fruit; 500 workers, 800 cows, 12,000 chickens in an automated henhouse. Workers receive a modest salary plus an annual bonus and numerous benefits.

Cooperative farms were founded in the postwar years as Communists remade Eastern Europe. Men in Čičov who had owned land before the war resisted collectivization. I was told about this by the cooperative's second chairman, 63-year-old Štefan Livinka. He had a ruddy face and irregular teeth. But he laughed easily, and when he held his cigarette breast-high between thumb and forefinger, he seemed almost regal.

"There was sabotage in the early days," he said. "Some cooperative members had to be expelled. In the first years we hardly received anything: some milk, very little money. But

"Where do you come from?" two black-garbed men asked photographer Parks in Bratislava (**left**).

"America," he replied.

"America!" they chuckled in amazement, then boarded a bus to go to work—cleaning chimneys.

In the Hall of Mirrors of an 18th-century palace in Bratislava (**right**), everybody pauses as the groom searches in his wallet for the marriage license. A civil ceremony will follow in an adjacent room.

after a time we began to buy machines and live better."

He drew on his cigarette. "There is no comparison between life today and before the war." In the prewar years he worked for a count, "a very rich man," who went about in a carriage. "I worked from sunrise to sunset—to the last breath."

He had the use of about an acre of land. "We could not have ducks or geese. You could only have an animal that would stay inside a fence, and of course ducks and geese must go to water. The count was very religious and wanted everything clean on Sunday."

Driving out of Čičov that afternoon, I noticed something: flocks of geese and ducks, wandering alongside the pavement.

DIVIDING Czechoslovakia from Hungary, the Danube takes sizable bites from both. Branches describe large islands; along the main channel the river creates backwaters and swamps. The river's favored companions here are willows—fat-trunked, stubby trees and low, clotting bushes.

Algernon Blackwood, master of ghost stories, wrote in "The Willows," one of his scary best, about camping here: "And the note of this willow-camp now became unmistakably plain to me: we were interlopers, trespassers; we were not welcomed. . . . *The willows were against us.*"

A steady breeze made the trees noisy as photographer Winfield Parks and I found a campsite about ten miles from Győr, on the Hungarian side of the main channel. I thought of Blackwood's forbidding scene: the "terrifying . . . ceaseless raging wind . . . shaking the willows round us like straws."

A farmer told me it blows all but 28 days of the year on the average. He didn't mind; he was thoroughly a man of the windswept plains. "Mountains, what are they good for? Nothing, except growing grapes."

In midafternoon a young soldier appeared. Patrolling the border with rifle and dog, he seemed confused when he came upon two foreigners with a tent. He extended a soft hand and made small talk: "It is better to be a tourist like you than a soldier, yes?" At last, embarrassed, he said, "I am not sure you are allowed to spend the night here. Would you mind coming to see my commandant?"

So presently we stood outside a building topped by a red star, talking to an officer. "Wait ten minutes," he said, disappearing.

Ten became thirty. I could almost hear the phone lines humming overhead. Then he came out smiling, wishing us a pleasant night.

After dark the wind increased. We huddled around our lantern. Our guide, Zsolt Havati, liked Glenn Miller, and I had a tape. I played it on my recorder, louder and louder. But the music only ran away with the wind. Blackwood had written of such a night: "The trees were swaying violently to and fro. . . . It was incredible, surely, but there, opposite and slightly above me, were shapes of some indeterminate sort among the willows. . . ." I slept poorly.

ALL HOTELS WERE FULL when I got to Budapest, and I am glad. Otherwise I would not have rented an apartment on Gellért Hill. Below, the river seemed a frozen slab streaked with the lights of bridges and buildings. I could see the city's great architecture: Matthias Church, the Parliament's filigreed facade, and Buda Castle, residence of Hungarian kings, and of Habsburg royalty when this was part of Austria-Hungary.*

It was hard to realize that not far beneath Gellért Hill the earth is eternally seething. Yet I saw the evidence daily; steam plumes escaping from the dome of the Rudas Baths, where the hill meets the river.

Hope of relief for numerous ailments lures citizens to ten public baths, fed by hot springs or wells. Temperatures and chemical properties vary, and one may bathe around to find the most suitable waters.

The Rudas Baths have something extra—a pedigree. Turks built them in the 16th century, when they occupied the city. I joined a line of waiting men there one morning. Attendants issued small aprons, like loincloths, and then forty or so bodies were splashing in a large steamy pool—nearly all of us, alas, looking rather paunchy.

Many citizens take mineral water home to drink. I saw a couple tying jugs on a motorbike. They had filled them at a fountain, rather like a soda shop, where any of three warm waters is available by the glass. *Hungária* tastes something like a rusty pipe but is said to be good for kidney disorders and nervous stomach. *Juventas*, mildly sulfurous, is recommended for high blood pressure and rheumatism. *Attila* tastes like rotten eggs and is recommended for almost everything. One small sip and I knew why Attila was the most dreaded Hun of all.

I drove south into the Hungarian countryside in mid-September. The Great Hungarian Plain stretched to willows and beeches by the river, and, in the opposite direction, toward windbreaks of yellow-mottled poplars.

Near the town of Kalocsa, fields turned red. Even the houses were red, dripping garlands of paprikas. The long-podded kind is merely piquant to the tongue; the small cherry paprikas are like a blowtorch. When dried, they flavor Hungarian family soups and goulashes —in fact, almost every dish—but most eventually are sold worldwide.

In the fields women and older men bent and picked, rolling down the long rows like waves. A vivacious young woman named Éva, with the gentle, dark green eyes common in Hungary, said: "Even if it is raining, you must pick. But the more you pick, the more you earn." On this collective farm 40 percent of the harvest belonged to the family.

Good-humored cackles floated across the field as I offered a helping hand. "Don't kneel," Éva scolded. "It's too slow that way. Bend from the waist. . . . Use both hands. . . . Give it a twist; we don't need the leaves."

JUST BEFORE the Danube drops into Yugoslavia, it passes a grassy sweep of plain. Here in 1526 the Hungarian army attacked 80,000 invading Turks led by Suleiman I, well named "the Magnificent." He slaughtered most of the 25,000 Hungarians and dumped their corpses into common graves. Continuing up the Danube, Suleiman reached Vienna in 1529—the high-water mark of the Ottoman Empire in Europe.

I didn't hear much of Suleiman in Yugoslavia. People talked instead of Austrian rulers. As the Ottoman Empire declined, Austria grew, installing her own subject peoples along the river. "My family came as border guards about 170 years ago," said an artist in Kovačica. They were Slovaks. In another town a man told me his forebears were Ruthenians, from what is now the Soviet Ukraine.

Austria also settled Germans in this region, called Vojvodina. Hungarians already were there, as were Serbs who had migrated north to escape the Turks. These peoples have

*Bart McDowell explored Hungary in NATIONAL GEOGRAPHIC, April 1971.

largely kept their own distinctive languages and customs in what is perhaps the most ethnically diverse region of Europe.

An old Slovak woman, whose face shone like a beacon from her black shawl, hiked her skirt to show me four petticoats. "This is what all Slovak women wore when I was a girl, always blue or black," she said. "Blue meant expensive." She looked me over. "Is it not the same with blue jeans?"

Much of the land that the resettled peoples got in Vojvodina was either too dry or too marshy. But hundreds of miles of drainage ditches and irrigation canals have remedied those problems. "We grow enough here to feed all Yugoslavia," an official bragged.

Yugoslavia toyed with collectivization but chose merely to limit the land a man may own to 25 acres. "I can do as I wish with my land," said Štefan Supek in Pivnice. "I don't have to grow anything if I don't want to."

I SPENT SEVERAL DAYS in and around Pivnice, among early-rising Slovaks. At dawn shapes materialized on the gravel roads—women floating by on bicycles, heading for the fields.

More than half of Pivnice's families own tractors; no doubt the Supeks could too. But, Mr. Supek said, "We *like* horses." Before riding me about town in a wagon, his son polished the hooves of the two fine mares as a man would polish his shoes.

I went with Mr. Supek at daybreak as he did chores: grinding corn for feed, cleaning stalls, feeding chickens and rabbits. Then he started a rabbit stew in an iron pot.

Meanwhile, his wife and daughter-in-law spread a breakfast of slivovitz, slices of ham, eggs, sweet rolls, and thick coffee. Lunch included not only the rabbit stew but fried chicken. "An everyday meal," Mrs. Supek said. "Slovaks work hard and eat good."

In the nearby town of Despotovo, a Serbian farmer named Spasoje Ubavin agreed that Slovaks are hard workers. "When they finish their own work, they come here to earn money from us," he said. "But Serbs," he added, tapping his temple, "use their heads." Mr. Ubavin uses his by growing cabbages the size of basketballs, weighing as much as ten pounds, on Danube-irrigated land.

A figure I remember from Pivnice: Farmers there own 27 makes of tractors, manufactured

Free to choose between America's dean of the clarinet and a prominent local ballad singer (**above**), citizens of Budapest enjoy varied nightlife fare.

Reality returns by day. While tourists armed with credit cards browse at showcase shops (**top**), one young student approached the author's wife on the street and asked to purchase her shoes.

in most of the industrial world. In Belgrade port director Curic Gojko remarked on this: "We are a free country, so we trade with everybody."

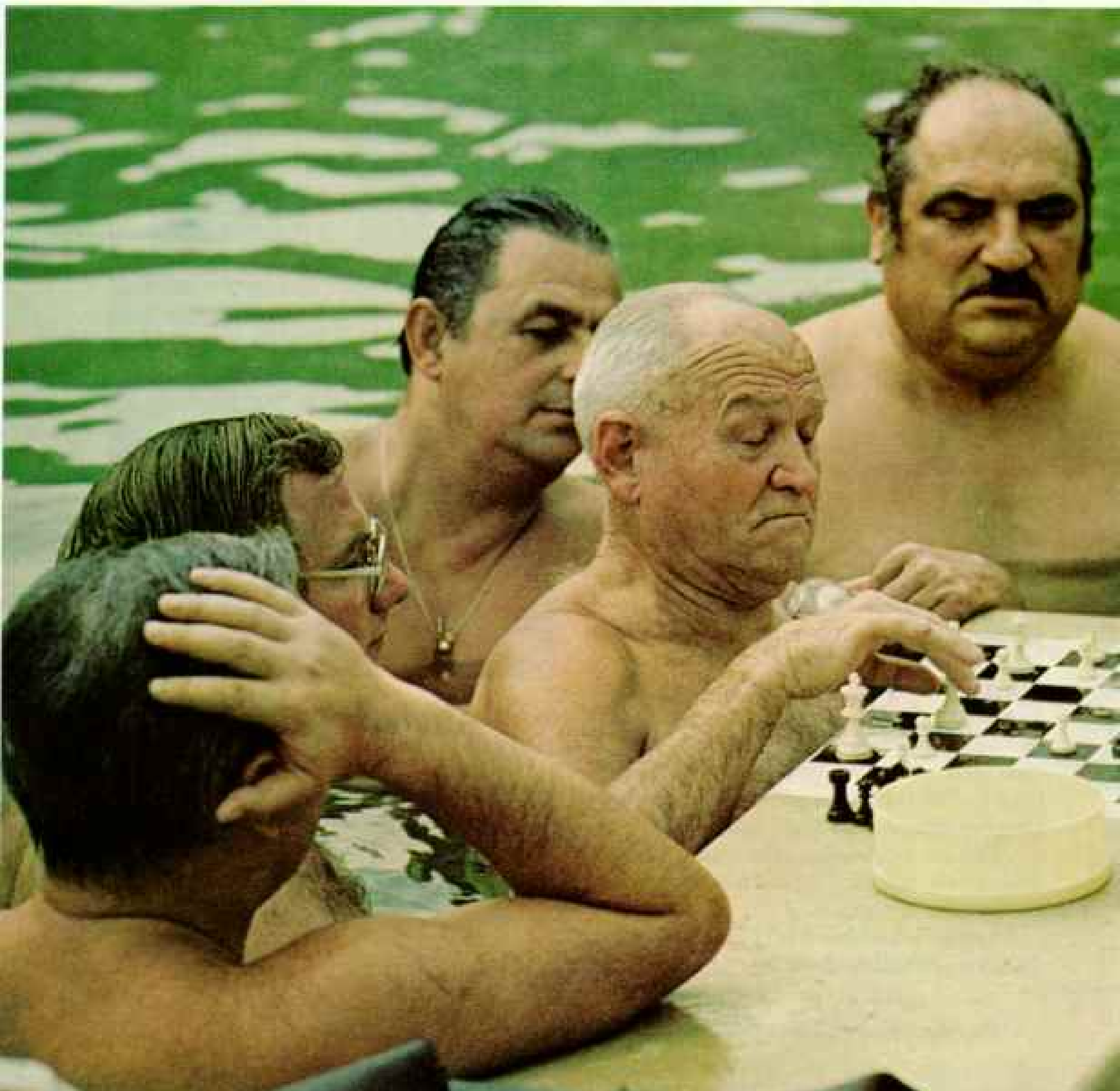
As we walked along the modern quays, he reminded me that Belgrade is about midway between Regensburg and the Danube's mouth —just as Yugoslavia lies somewhere between East and West in its blend of socialism and free enterprise. The quays held crates from Sweden and tires from Poland. A Soviet barge had arrived with machinery. We passed a hundred or so plastic drums. "What gentlemen we are," Mr. Gojko said. "Germany sends those down empty, and we fill them with cherry and apricot juice and ship them back."

The next morning, fog obscured Belgrade's skyline and absorbed the noise of traffic. But voices carried on the smoky water, and I heard Branko Stanković, a fisherman with a happy-go-lucky grin, moan as he raised his net: "Ah, mother, only two little ones."

Branko and his friend Bata, or "Boy," drifted with the current in two skiffs, each holding one end of a net. Other fishermen were drifting too, and the banter flowed.

"If I catch a big fish, I will buy everybody a drink at Jojkic's restaurant."

Good move or bad, everybody is in hot water during a lunchtime chess match at the Széchenyi thermal baths in Budapest. To cleanse and refresh its weary or arthritic citizens, the city offers more than a hundred mineral-laden pools, some



"You know he has been out of business for months, Branko."

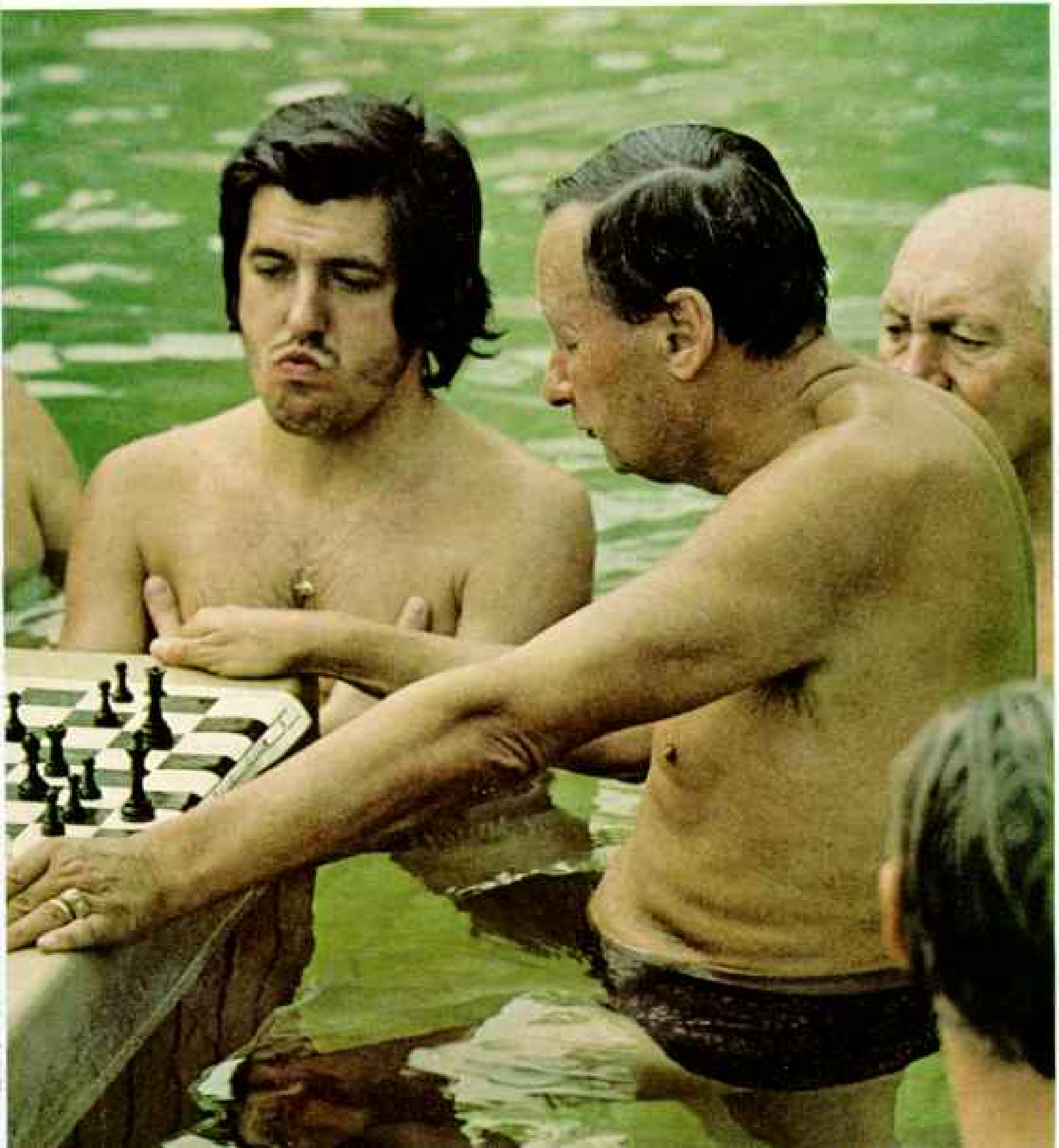
Sturgeon, catfish, and carp make commercial fishing important from Belgrade to the delta at the Black Sea—where, if you believe fishermen's tales, catfish grow large enough to swallow children.

As he tramped the dock, folding his net, Bata talked about the drawbacks of fishing, such as the winter cold that causes rheumatism, days when the catch is meager, days when the catch is good and fishermen spend too much on alcohol. "But I couldn't live without this river. It is a drug, like tobacco."

It is the same for Angelka and Aleksander, who live with their son and a cat named Miki on the barge that serves as the fishermen's dock. Angelka is a buxom woman with lustrous eyes, and if her dress strains at the seams, it does not matter. Angelka does not need fine clothes to have friends.

Someone is always visiting: fishermen who drop their catch into tanks in the hold of the barge, and an assortment of Belgrade citizens, including actors, artists, and civil servants. They come to have a tot of refreshment, to ask what's for lunch—sometimes, as a florid-faced bureaucrat did, to steal a kiss. "I love

built by Turkish conquerors 400 years ago. Bathing in the pollution-gray Danube is unwise, and in some places against the law. Accusing fingers generally point upstream—at somebody else's plant, in somebody else's country.



you because you are as crazy as I am," Angelka told him.

She cooked a carp that was heavy with roe and bade me enjoy it. Miki stretched to put his head in my lap. Such is the informality of life on a barge on the Danube.

One night as I dined in Belgrade, an American woman approached my table. Presently her mission became clear. She wanted a description of the river downstream, where it divides Romania from Yugoslavia. Her Romanian lover was going to attempt to swim across—unable, she said, to get out of the country any other way.

I have no idea whether he tried. I only know it would be difficult.

Memorial to bravery, the Bridge of the Slovak National Uprising (**above**) at Bratislava honors partisans who fought the Nazis —and offers diners in a tower-crowning restaurant a view of the land they fought over.

Windows of the new Hilton hotel in Budapest yield a crazy-quilt image of rebuilt Fishermen's Bastion, named for the guild charged with the original rampart's defense.

FOG SHROUDED BELGRADE as I took the early morning hydrofoil that runs toward the great Iron Gate Dam. Fog and rain, gloom and chill. They were to be near-constant companions for the rest of the autumn journey to the river's mouth. Opposite Romania by the time the visibility improved, I greeted the Carpathians again. Making a giant arc from Bratislava, they tumble down to the river like ducks headed for a swim. The military also reappeared. On the Romanian side green watchtowers stood on steel stilts every mile or so. Romania is extremely sensitive about its riverine border.*

The Danube widened into the dam's placid reservoir, a mile across. Then we entered the wasp waist of the Iron Gate, where the reservoir squeezes through a rock-walled passage only 500 feet wide.

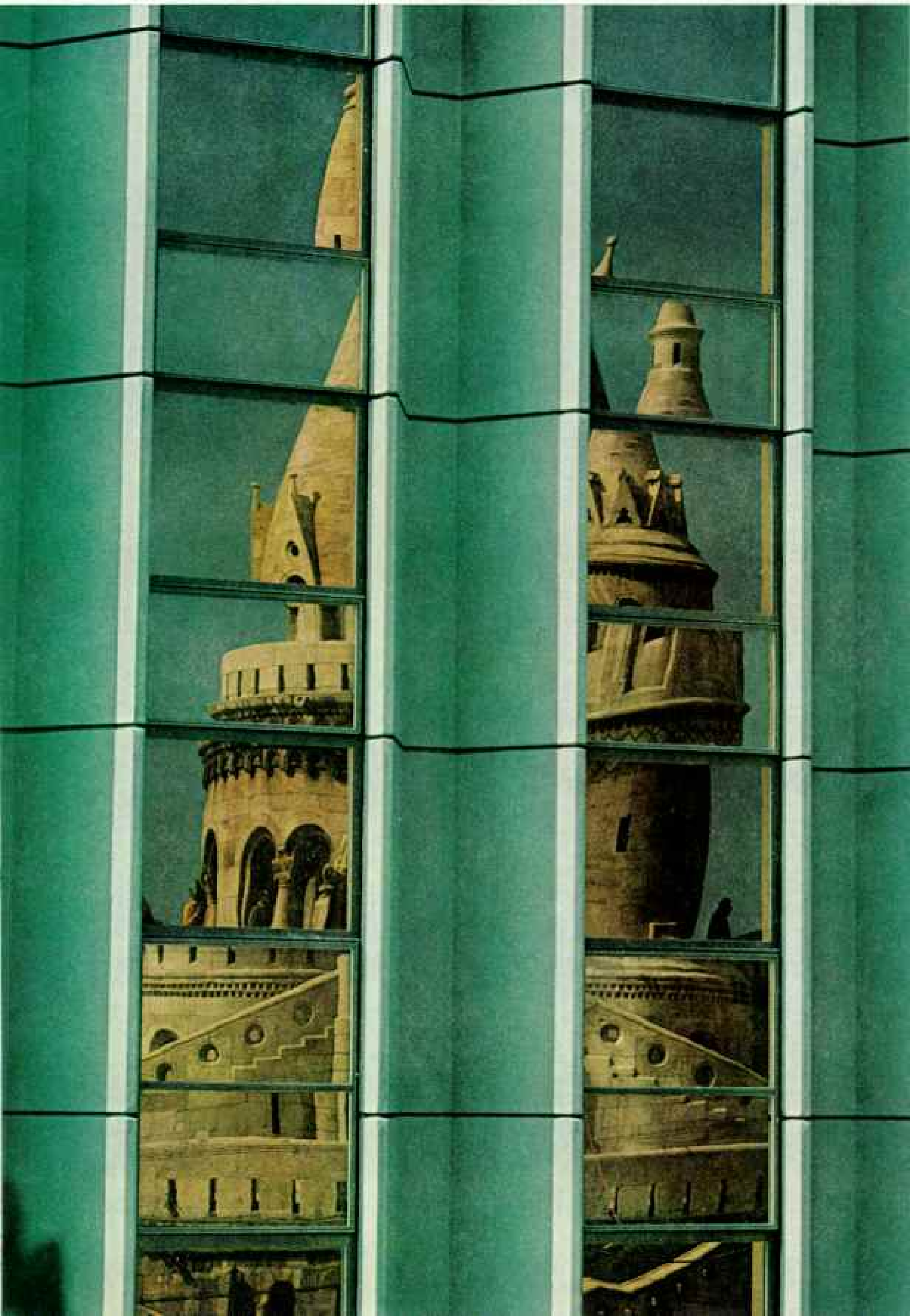
Before the 165-foot-high dam was completed in 1972, a former pilot told me, this stretch of the Danube boiled with rock-studded rapids. After 15 years of threading barges through the treacherous narrows, my pilot friend had been pensioned off in middle age, suffering from hypertension.

A government publication on the Iron Gate Dam exults, "Man's will has conquered the Danube." Not for the first time, actually. Crossing to Romania, I saw a stone pillar—one of twenty that supported a Roman bridge 3,724 feet long, built in the second century. Given the tools of their time, I think the will of the Romans was greater.

Now floodlights chase the night here, and hammers clang on steel; the city of Drobeta-Turnu Severin is a barge builder as well as an important port. By contrast, the city's streets are quiet, for there are few cars.

I went into a coffeehouse decorated with Turkish motifs. Behind the counter fez-topped Ahmet Halim ladled for a large crowd. The air was heavy with smoke. Incongruously, a patron's tape recorder spun U. S. country and western ballads. *(Continued on page 481)*

*See "Romania, Maverick on a Tightrope," by William S. Ellis, NATIONAL GEOGRAPHIC, November 1975.



Still rising from reclaimed marshland, New Belgrade, the Yugoslavian

capital's booming western suburb, thrusts concrete fingers skyward.

Scenes of everyday life inspire Yugoslavia's self-taught artists. A "naive," or primitive, painting (**left**) shows a heavily laden village couple walking home.

Looking as if they had just stepped out of the painting, citizens congregate in the town square at Pivnice (**below**). Leather-shoe style of a Pivnice harvester (**right**) hasn't changed much since the Middle Ages.

(Continued from page 476)

I sat and sipped, watched by two young men. One, who spoke a bit of English, eagerly accepted an American cigarette. He hoped to visit the United States. "But I have no money. I am not free." He made a gesture I saw more than once in Eastern Europe, crossing his wrists as if they were tied.

Romania gained independence from Turkey in 1878, after the Russo-Turkish War. But, as Ahmet told me, a Turkish community existed on an island until the dam was built. "My father had a coffeehouse there. My mother never learned Romanian. She never needed to."

I wandered the countryside downstream, my road flanked by sodden cornfields. I passed a cooperative's big new cattle barn. Men and women loaded a truck with tobacco. When I passed again later, a tractor was trying to drag the truck from the mud.

Fences dripped nets in a fishing village. Two armed soldiers strolled the main street. Fifty yards away, on the river's shingle, a woman washed clothes. Might I go down and talk to her? The soldiers shook their heads; I was as close to the Danube as I could go.

I SAW NO PATROLS on the Bulgarian shore of the Danube, which is the border with Romania for 290 miles. But as I drove into Svishtov, a small port, martial music rose from the city square. Several hundred troops stood before a speaker's platform decorated with photographs of Bulgarian and Soviet leaders—a reminder that Bulgaria is the U.S.S.R.'s best friend in Eastern Europe.

Conscripts who had just completed basic training, the soldiers goose-stepped forward as drums rolled, each stopping at a table to sign an oath of allegiance.

I remember that October day for another reason: The sun came out, glowing over farm tracts and villages where chrysanthemums and roses were blooming their last.

The fog came back. On a dour morning as I drove near the river, a shepherd materialized. A little man of 68 years, seeming all the shorter in his gum boots, Matej Peshev blamed the weather on the river—warm water meeting cold air. "Sometimes we have a month in the fall when we don't see the sun," he said. "But I am out every day with my sheep and goats."

I went down the highway to Archar, a town like most others in Danubian Bulgaria, with stucco houses and garden plots. A dozen citizens stood in front of the bakery. When the door was unlocked, the people bought one-kilo loaves for a few cents. Seeing me empty-handed, an old woman said, "If you do not have Bulgarian money, I will buy you a loaf."

From my hotel window in Ruse I looked out one morning on a barge that had just arrived, loaded with Soviet autos. More than half of Bulgaria's trade is with the Soviet Union, and much of it passes through this port.

I dined above Ruse one night in what had been a Turkish fortress, called the Leventa —"big fellow." Russian troops crossed the white Danube downstream from Ruse in the Russo-Turkish War, and the Leventa garrison surrendered without a fight. Eventually this invasion won Bulgaria's freedom after five centuries of Turkish occupation.

Still, signs of the Ottoman Empire survive. The state pays for the upkeep of two mosques and also pays the salary of the Turkish community's chairman, Isliam Redjelov Isakov, whom I met in an office decorated with inscriptions from the Koran. "The empire fell because it clung to feudal ways," he said. "It did not develop its people." As if to make a point, he told me of his children and their achievements: one son a physician, another an artist, two daughters who are teachers.

THIS RIVER HAD SEEMED in no hurry to start its journey, and now it seemed in no hurry to finish it. From the Bulgarian city of Silistra to the Black Sea is a straight-line distance of 65 miles. The Danube goes more than three times as far, swinging north from Silistra into Romania, then east, forming Romania's border with the Soviet Union and nurturing at its saltwater rendezvous a delta as large as Delaware.

Road's end comes finally at Tulcea, Romania's port at the delta's apex. To venture farther, you must go where water goes: into three main delta channels by which vessels reach Tulcea from the Black Sea, or into the spiderweb of waterways stretching out through lagoons and expanses of reed.

There are no provisions for a traveler to cross from Romania to the Soviet Union's strip of Danubian shore. I settled for an afternoon journey by hired launch past the Soviet port of Izmail.

I wondered if the men inside the Soviet guard towers were as cold as I was on the water. Where the willows parted, I saw a fence topped by barbed wire. Izmail spread a miles-long waterfront, punctuated by two score or more gantries. Barges, trawlers, and freighters hugged the quays and clustered at midstream. I saw mountains of coal and ore.

ELSEWHERE IN THE DELTA, Romania eagerly encourages tourism—the lagoons and islands are great for watching pelicans and other birds in the warmer months—and I had no trouble arranging a trip into the delta's interior.

Surely the delta people are the hardiest on the Danube, living with the water always, fishing or harvesting *stuf*, tall reeds that are made into paper. My host in the village of Crişan, Parfente Sava, had spent his life tending nets from a rowboat. His hands were massive. "My son-in-law says I should buy a motor," he remarked as his powerful arms propelled us. He laughed. "I can row six people and never get tired."

It was in Mila 23—a village at the twenty-third mile of an old channel—that Romania found Serghei Covaliov, who won Olympic medals for canoeing in 1968 and 1972.

"Serghei was rowing to school when he was 6 or 7," said his father, Simeon (facing page), whose own chest and arms bulged. "In his teens he would row 60 miles in a day."

Tears rolled down Mrs. Covaliov's cheeks as we talked. Serghei lives in Bucharest, and it is a mother's privilege to miss her son. She dried her eyes. "People ask me what I fed him to make him strong," she said. "Corn and fish." She began to weep again.

Bittersweet smiles crease the faces of Mr. and Mrs. Simeon Covaliov, whose son Serghei left the village of Mila 23 in Romania's Danube Delta to become an Olympic canoeing champion. "We get postcards," says his mother, "but we hardly ever see him." Her husband, a retired fisherman, recalls that he once caught a sturgeon so huge it threatened to burst the net. "I jumped into the water and lassoed it," he explained.

Wave of a weathered hand greets friends as workers disembark at Mila 23 for provisions (**above**). These Russian-speaking Romanians, who live in villages close to the U.S.S.R. border, will construct dikes for a fish farm in the Danube Delta.

Kissing a regimental flag, a young soldier in Svishtov, Bulgaria, professes allegiance to his homeland (**right**).

I went on down to Sulina, the last town on the channel. A bustling port before World War II, it made merchants of several nationalities wealthy. But most of its buildings were destroyed in the war, and Sulina today is a quiet town of small wooden houses.

The port captain, Mihai Ivenco, offered to take me on the last brief leg of my Danube journey in his launch. After six miles we left the last willow behind. The launch bucked, and spray flew into my face, tasting of salt. After 1,776 miles, the Black Sea.

On the way back to Sulina the captain told me that his father and grandfather also had been captains of the port. He himself had

been offered a good job in Bucharest. "But I can't get away from that sound," he said as a freighter's whistle blew. "I could never follow the rules of land."

He pointed out a cemetery at the edge of town. "All my family is buried there. For a mariner of Sulina there is no place else."

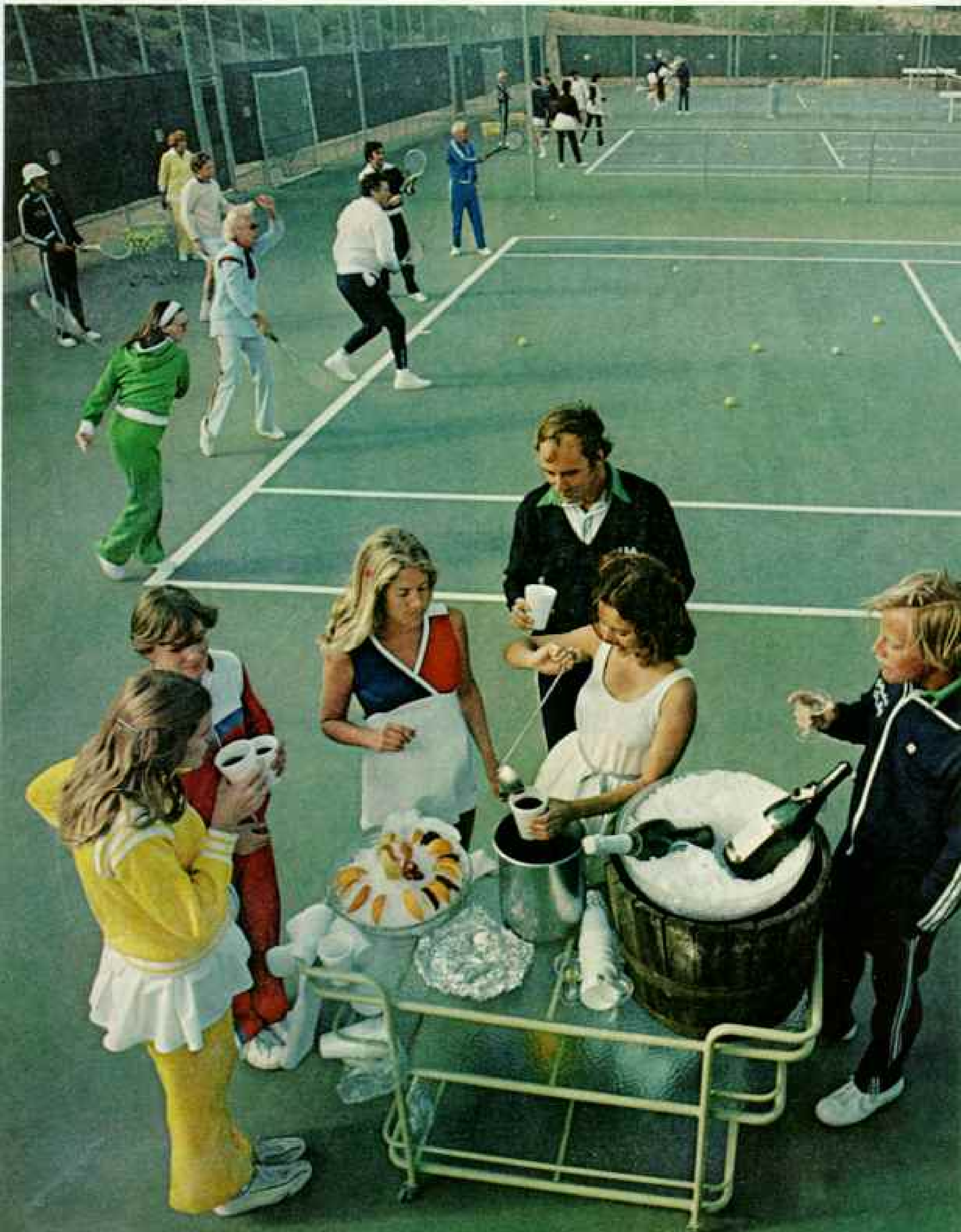
Later I walked down the dirt street to that repository of Sulina's past. There were Jewish and Turkish sections and stones carved in Greek, German, Italian, English. It seemed to me that bleak afternoon that Sulina did not have much else left.

Back in the hotel I heard an accordion and a drum and ran down to the street as a crowd passed. "Jon and Maria will be married today," a woman said. The music was loud and good. Someone offered me wine.

Soon Jon and Maria stood before an altar in a Greek Orthodox church. A priest placed crowns upon their heads. Suspended from a chandelier was a silhouette of a boat. It was Sulina's symbol, the Danube's symbol. The priest tied their hands with a kerchief. I looked at the faces: Jon, confident; Maria, innocent. Dancing followed, more wine, toasts, a feast, laughter, stolen kisses.

I knew that night that the Danube, no matter what its color, is still a lovers' river—and that Sulina is more than a graveyard. □

Arizona's Suburbs



of the Sun

By DAVID JEFFERY
Photographs by
H. EDWARD KIM
BOTH NATIONAL GEOGRAPHIC STAFF

FROM WHAT I CAN TELL, the epidemic is still spreading through the states bordering the Great Lakes, with outbreaks scattered from Oregon to Colorado to Maine.

Among its causes, falling mercury; among its symptoms, an aversion to mittens and galoshes. Medical experts might diagnose it as "heliophilia"—a consuming desire for sunshine. Thousands upon thousands are prescribing their own cures: Phoenix or Tucson with daily dosages of 86 percent chance of sun.

Some say the prescription produces bad side effects—housing tracts that metastasize across the desert, sinking water tables, congestion of arteries, galloping malls, and smudging of the skies.

All this began about thirty years ago, well before the term "sun belt" was trussed upon the nation. In the past ten years alone, more than half a million new people have shown up in the heart of Arizona's Sonoran Desert. (See "**Close-Up: U.S.A.**"—**The Southwest**, a supplement to this issue.)

And unlike traditional cities clustered about some port or industrial core, Phoenix and Tucson, about a hundred miles apart, spread low and wide, suburbs of the sun. Between them and around them a distinct culture has sprouted like the desert in bloom —splashes of color amid the thorns.

Clarence Conrad came from Spokane. His dream was to build dirigibles, and there is no hangar cheaper than sunshine. He and his son Darwin spent 18 months on a field outside Phoenix, welding together an aluminum airframe longer than a Goodyear blimp. Then, as if to balance accounts for all the

Champagne break refreshes baseline greenhorns at John Gardiner's Tennis Ranch near Phoenix. From there to Tucson, new residents and winter visitors—called "snowbirds" in Arizona—have flocked to desert areas of the fastest growing state. But the joys of boom prosperity are already tempered by problems of runaway growth.

Surf's up! Every 90 seconds Big Surf of Tempe opens 15

floodgates to activate the 4.5-million-gallon ocean in the desert.

"**I owe Arizona my life.** When I came out here as a kid, I had rheumatic fever and couldn't walk 20 feet without turning blue from asthma." Now Herb Drinkwater (**right**) and his family enjoy riding their horses to the distant McDowell Mountains.

After eight years on the Scottsdale City Council—"I'm not running again"—he hopes to devote more time to volunteer work. And he hopes to see his town grow in an orderly way with the kind of friendly people and relaxed style he has known.

good weather, a windstorm smashed it from its moorings. Tenacious, Conrad is building another, this time in the shape of a flying saucer, an oval 80 by 27 feet.

"We could sell fifty of them like that," he said with a finger snap, and he showed me letters of serious inquiry to back it up.

Beyond the saucer stood a corral where one melancholy horse scuffed in the dust. With the horse for company, I watched the setting sun ignite the saucer's skeleton from a dull aluminum to fiery red—a phoenix for this time and place.

Misfit Melons Find a Use

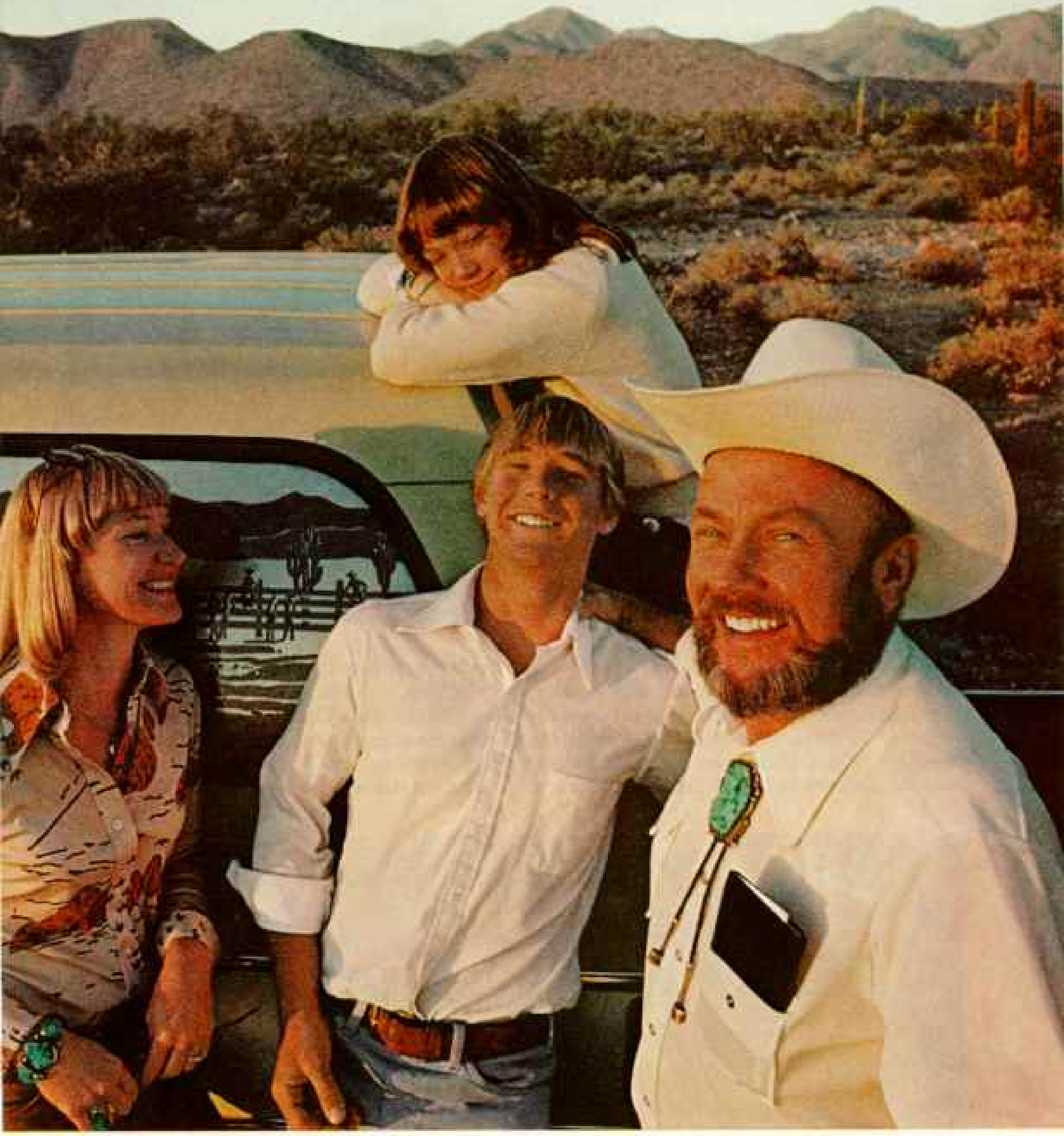
In his plain Phoenix office where the phone keeps ringing, John Van Hengel made a carton in the air with his hands. I was to visualize 36 compartments, each for a melon of identical size. Then here is a melon—firm, ripe, unbruised—the finest fruit of irrigated desert agriculture. But it is too large to fit in a compartment. Out it goes to rot untasted.

"What is thrown away is unbelievable," Van Hengel said. "I'd guess 25 percent of the food grown doesn't make it to market."

So Van Hengel started a food bank, and now almost two million pounds of salvaged food yearly reaches the tables of the hungry poor of Phoenix. Van Hengel didn't come to Arizona to start a food bank. He came 11 years ago because poor health dictated a therapeutic climate. He looks just fine.

For health, for sun, for jobs, people have kept coming until Arizona has become the fastest growing state in the Union and 80 percent urban by population. The Hohokam would hardly recognize the place—except for the irrigation canals. These Indian people diverted water from the Salt and Gila Rivers into a complex system of canals all dug by hand. For well over a thousand years they flourished in the desert. Their culture declined about the time Christopher Columbus was taken with the notion of profit to be had by sailing west.

After the conquest of Mexico, Spaniards made forays into what is now Arizona to search for the Seven Cities of Cibola, wrought of gold and daubed with jewels. What they



found were some Indian settlements. But the myth died hard.

Not until the late 17th century, when the tireless Jesuit Father Eusebio Francisco Kino began to franchise the faith through a string of missions, were the tenuous outposts of European civilization made permanent. In 1775 Tucson was established as a presidio to protect the faithful and strengthen Spain's colonial position in western America.

Then, in less than eighty years, the region passed from Spain to Mexico to the United States. After the Civil War, Tucson was a rough trail town of 3,000, where, an observer reported, directions were given with reference to manure piles, a dead burro, and a corral dog—"a salivated son ov a gun."

About the same time, and some hundred miles north, a few settlers hunkered down by the Salt River, *(Continued on page 495)*

Crescendo and diminuendo—of symphonies and waistlines—catch the upbeat mood of Phoenix. Guest conductor Izler Solomon (**above**) leads the respected Phoenix Symphony Orchestra in the new Civic Plaza, while Anne Kinnerup (**below**) leads an exercise class at the Arizona Biltmore, a landmark among the area's plush resort hotels.

Turning sun into gold and silver, the forty-story Valley Bank Center (**right**), tallest building in the state, houses Arizona's largest bank. In the past decade the state has been among the nation's leaders in economic growth.

where remnants of Hohokam canals promised a reborn agriculture. An Englishman among them, Darrel Duppa, reached for a classical allusion and called the place Phoenix.

If Tucson swaggered like an old Indian fighter turned gunslinger, Phoenix worked up the earnest calluses of a sodbuster. Those images have faded, yet the cities remain distinctive in outlook, especially on the question of growth. While Phoenix spirals outward unchecked, Tucson struggles to define and control its future.

Ringed by mountains, Phoenix and its satellite cities have grown to the tempo: new, newer, newest. Extravagant. New high rises sprout downtown. New houses wind like tendrils, smothering cotton fields and citrus groves. Then the desert with its tempo: old, and older, and oldest. Miserly. Saguaro cactuses hoard water by the molecule and by the century. Lizards scuttle dryly beneath chollas. A blur springs into fossil flight—roadrunner. The middle distance fades into a brown wash. Abruptly, mountains. Looking east, the Superstitions: mute, glowering, lunar. In that direction growth must end. Yet the compass rose of growth has other points.

Charles Sargent, who teaches urban geography at Arizona State University, showed me a series of maps he had made to document the development of the Phoenix area. As the decades roll by from 1915, black speckles of settlement grow, spread, and explode. The most recent map resembles a sodden blotter.

Good Life Breeds Complacency

"I'm afraid," Sargent said, "that we're going to repeat all of California's mistakes. We're growing without effective controls. We're paying for it in increased pollution, and in costs of transportation and public services. And we're going to get bigger and bigger because no one is going to slow it down."

Vernon Swaback, architect and planner at the Frank Lloyd Wright Foundation, agreed.

"Part of the problem," he said, "is that most newcomers never had it so good in terms of clean air, climate, and mobility. The idyllic circumstances create complacency. Based on present trends, the future promises an environmental breakdown. We're on a collision course with very little interest being paid to warning signs along the way."

Sprawl Has Its Defenders

Where others see runaway urban sprawl, Gary Driggs sees in Phoenix "a prototype for the new American city," and seems quite cheerful about it. It cannot be wholly discounted that, as president of the giant Western Savings, Driggs has a financial interest in growth. Clearly, though, his enthusiasm owes much to his days as lecturer in economics.

"Sprawl," he said, "is in many ways a positive thing. People can live in lower-density communities with less social friction, and urban facilities can be regionalized.

"You can see the same trend in the rest of the country, but many cities are held back by trying to support the old downtown core."

Then Driggs spoke what to many urban planners may be the ultimate heresy:

"There's no heart of Phoenix, and there's little reason for a downtown in most cities. Why have masses of people commuting daily when there's no functional reason for commerce to be concentrated?"

From the middle of Phoenix, Indian School Road arrows west, past small businesses, fast fooderies, gas stations, and shopping centers. Then a residential section shoulders up to the road: Maryvale, one of the largest and oldest of the many area developments. Prefabricated modules are trucked to lots carved from cotton fields and put together in stages. The assembly line moves, the product stays in place.

Sam Coleman was leaning on the exterior of his house, which was stacked on the curb with the siding already affixed: "We sold almost everything we had, packed the rest in two cars, and just came."

"It was scary," Joyce Coleman remembered, the day they backed out of their driveway in Marshall, Missouri. "We'd heard about people who had tried it two or three times, then went broke and had to go back home.

Happy to go native, Massachusetts transplant Lillian Porterie wears part of her collection of Indian jewelry on the job. Her employer, Honeywell, found an added bonus in the desert. Tiny specks of solder are best removed from delicate computer components by using the spines of the abundant cholla cactus.

Blooming crop of new homes sprouts southeast of Phoenix along a canal of the Salt River Project, first of the West's giant reclamation systems based on dams, reservoirs, and canals. Around both Phoenix and Tucson, leapfrogging subdivisions have turned

farms into scattered suburbs. Yet a quarter of Phoenix proper lies undeveloped, much of it in small plots. Housing sprawl has been called wasteful of water and energy. But it still appeals to those who make the final decisions—the home buyers.

"At first, I got homesick," she said. "But when I went back to visit, we had two snowstorms, the temperature got down to nine degrees, and Phoenix looked awful good."

More than 80 percent of Arizona is occupied by Indian reservations and public lands such as national parks, monuments, forests, and wildlife refuges—a whole lot of empty countryside to explore. People tell of swimming in Phoenix in the morning and skiing near Flagstaff in the afternoon. They imply that folks back home must be slightly cracked not to join the station-wagon trains heading west.

A few blocks from the Colemans' place, Sandra Aehlert was aggressively watering her carnations. Didn't she like the increasingly popular cactus-and-gravel landscaping?

"I can go out in the desert and see that junk," she shot back.

A native of Chicago's South Side, she misses the city, the Loop, the excitement.

"People who have been west awhile don't seem to care anymore. They get into a slow-paced life, and that's it."

She tossed her head toward the farmland that begins where development, for the moment, stops. "They've got sheep over there. All night we hear them, and some nights we smell them. Country living is not for me."

Hers was a minority report. The slow-paced life, the "Arizona life-style," a much exercised phrase, attracts many.

Lives Change in Western Ways

North of Camelback Mountain in dude-country-become-development, I visited the home of old friends from Chicago, Len and Karyl Drefs, and their daughter, Lisa. We caught up on family news and reminisced, sitting in a room filled with western touches: tile, rough beams, massive furniture, colors and patterns of Mexico and the Navajos. When evening balanced on the pivot between day's heat and night's chill, we moved to the patio, where reflections from the swimming pool spattered us with wavelets of light.

I asked Len if he would like to return north sometime. The look on his face began around his eyes and nose and spread into a grimace, as he raised his hand to ward off the demon of that possibility.

Our talk and laughter mingled with chatter from thousands of patios and vanished with the mountains into night. Later we went back inside to a room I hadn't noticed before, where the furniture, upholstered, blue, and formal, seemed lonely, a museum set piece from an old life left behind.

Business Seeks the Sun Belt

A newcomer might arrive on a Greyhound bus, stay in a Ramada Inn, charge it to an American Express card, and watch a Motorola television while planning to visit a development of the Del E. Webb company, perhaps Sun City. Each name is a service or product of a company that has its national headquarters, or a major regional facility, in central Arizona. They typify the service-oriented, minimally polluting industries the state solicits and attracts.

Of these, the ultimate symbol may be the 20-story Greyhound Tower, home office of the conglomerate Greyhound Corporation. With 207 subsidiaries—only one runs the familiar intercity buses—it is among the nation's hundred largest companies. Nothing is manufactured inside the tower, but as board chairman Gerald Trautman explained, just the first wave of executives to occupy it poured 21 million dollars into the Phoenix-area housing market.

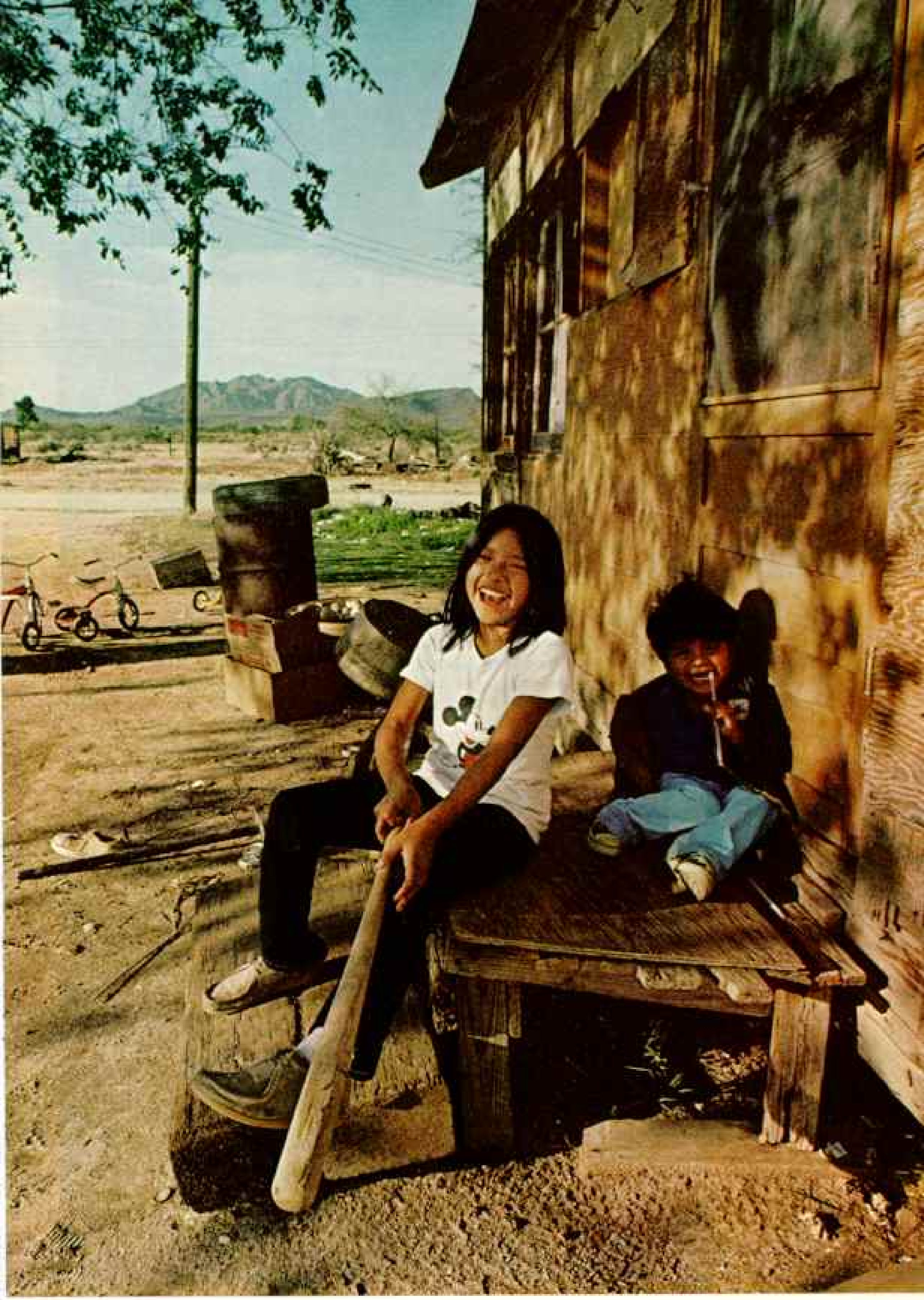
But why did Greyhound come to Phoenix?

"When Greyhound acquired Armour and Company, we studied a number of sun-belt cities. We were looking for a favorable business climate and good living conditions."

Phoenix jumped to the top of the list. Yet skeptics raised some doubts about the move from Chicago, Trautman recalled.

"Some of our people thought we would be out of the mainstream of finance. But in the first two years after we moved here, so many bankers and investment bankers came by that I jokingly said we *(Continued on page 503)*

On deck for fun, Karen Peters and her cousin take time out from softball on the Gila River reservation, home to Pima and Maricopa Indians. The Hohokam Indians, first to irrigate this desert, had settlements nearby until about 500 years ago. They left an agricultural tradition the tribes of desert Arizona still follow.



Switched-on Tucson rolls to the foothills of the Santa Catalina Mountains (**above**). Despite appearances, outdoor lighting is regulated to minimize sky glow, which handicaps astronomers at four observatories within a 50-mile radius.

A darker problem is water. All of Tucson's supply is pumped from wells, and, with growth, the city now controls some 11,000 acres of former cropland (**below**). These "tumbleweed farms and dust factories" serve as underground reservoirs. But rain does not refill them at anything like the rate Tucson depletes them.

Near Casa Grande, Pinal County agent Jim Little (**right**) examines land that collapsed after severe lowering of the water table. "Our agriculture," says Little, "is like the cartoon man crawling across the desert crying, 'Water! Water!' "

(Continued from page 498) would have to hire a vice-president for entertainment.

"That got reported in the papers, and we had a hundred applications for the job."

Any thorns on the rose, I wondered?

"Crime has been a problem," Trautman said. "There have been a lot of dope-related minor crimes." But, he added, "I think the legislature is waking up to the problem."

Crime. Phoenix has been choked by publicity on that subject, following the assassination of Don Bolles, reporter for the *Arizona Republic*. Allegations of rampant corruption and collusion, both public and private, have blanketed Phoenix like a rush-hour dust storm.

Lawmen Face a Thorny Problem

One kind of crime may be less serious, but is no less prickly. I climbed into the cab of an unmarked pickup truck. With a 350-cubic-inch engine under the hood and two transceivers on the dash, it clearly meant business.

So did law-enforcement officer Richard Countryman, sitting behind the wheel dressed in work clothes. Between us lay a holstered pistol, and under the seat a 12-gauge shotgun, as we rolled out into the light traffic of an early Saturday morning.

"Oh, I've had threats on my life," Countryman said. "A fella pulled a gun once. I talked *very* carefully, and talked him out of it."

We cruised down a main drag and saw something being sold out of the back of a truck. Countryman dismounted to check it out, walking with the heavy set and talking with a cagey friendliness worthy of a southern sheriff. One of the men, tall and tanned under a straw cowboy hat, seemed to be smiling too much. "We're all legal here," he said.

Countryman checked the tags. Sure enough, all the cactuses had proper licenses. Good thing for the tall man. Under Arizona's Native Plant Law, someone caught with illicit cactuses can be fined $100 to $1,000 per plant or get up to a year in jail, or both.

Cactuses are being rustled, maybe a third of a million dollars' worth a year (page 506), because more people are planting them. "Tucson gardens" they're called in Phoenix. Since you don't water a cactus, you can help save a precious commodity.

"We are using underground water almost twice as fast as it is being replenished," Wesley Steiner of the state's water commission told me. "In Pima County, where Tucson is, the rate is five times. In some remote areas, the rate is a hundred times."

The problem must be solved. On that there is general agreement. And perhaps on one other point: Nobody knows—despite various calculations—nobody really knows how much usable water can be recovered.

There agreement ends. The most spectacular object of disagreement is the Central Arizona Project, called CAP. Envisioned for more than forty years, CAP, now being constructed, is designed to pump Colorado River water up through a giant pipe—an inverted waterfall going at 90 tons a second—right through the Buckskin Mountains.*

The water will be pumped via open aqueduct to Phoenix, and from there to Tucson—a total of more than 2,000 feet of vertical lift from the Colorado, and 307 miles. Cost, if everything runs on schedule, is estimated to be about two billion dollars, more than 75 percent to be repaid by water users.

Water: How Much Is Enough?

Optimistic projections suggest that CAP will slow the rate of water-table decline by two-thirds. So even with CAP, central Arizonans will still be pumping more water out of the ground than nature puts in.

The Carter Administration has questioned the value of CAP, but not alone.

"The question," Phoenix engineer and law graduate Frank Welsh said, "is how much money we are going to waste before we stop the CAP."

Unthinkable? Not to Welsh, who is the entire staff of Citizens Concerned About the Project. "Arizona's real water problem," he said, "is that (Continued on page 507)

*Rowe Findley explored "The Bittersweet Waters of the Lower Colorado" in the October 1973 GEOGRAPHIC.

Legacy of a master builder flourishes at Taliesin West in Scottsdale, winter home of the Frank Lloyd Wright Foundation. Olgivanna Wright, the architect's widow, stands in a room where massive desert-inspired forms are accented by geometric designs. The foundation community includes a school, an architectural firm, and living quarters.

With lots for sale since 1959, the development called Arizona City—complete with tennis courts, pool, park, and lake, but far from employment centers—is now home to only about 1,300 of a projected 25,000 residents. Here in the "golden corridor" between

Phoenix and Tucson, other developments have failed totally. Some never delivered amenities promised; some were hurt by publicity on land fraud; and some had too little water. Like played-out mines, they have been abandoned to the desert.

water, now delivered to Phoenix for less than one cent a ton, is cheaper than dirt. There's no incentive to conserve it."

Welsh thinks enough surface water is available to support twice, maybe five times, central Arizona's current population. That is if water is used wisely and if agriculture, which now consumes 89 percent, can be dispersed. In essence, move the farms to the Colorado, rather than the Colorado to the farms.

Clifford Pugh has heard it all. When I talked with him, he was rounding out his career as project manager for the Bureau of Reclamation in Arizona. His job was to build CAP and to catch the flak.

He reviewed the project's outlook. By its scheduled completion in 1987 the area's water table will have fallen about another hundred feet. Was the shortfall, I asked, serious enough to arrest the great influx of people?

Pugh laughed. "We've had the problem for forty years, and it's never stopped anyone from moving to Arizona."

CAP might forestall that day if it can meet its expected yearly average of 1,200,000 acre-feet of water. (An acre-foot measures a volume equivalent to one acre of water one foot deep.) But, as Pugh said, a drought upstream, increased withdrawals by upstream states, or a combination of both would leave CAP with a relative trickle of perhaps 500,000 acre-feet to draw in a given year. And CAP stands lowest on the priority list for drawing water from the lower Colorado.

Indians' Water Rights Cloudy

For each of the first twenty years of CAP's operation, or until 2005, the five central Arizona Indian tribes are guaranteed 257,000 acre-feet of water—at least on paper. However, they lack the capital now to build proper irrigation canals.

Furthermore, their claims to water rights have not been finally settled either by legislation or by litigation. Until then, Arizona's water future will be dammed by a great question mark.

The first skirmish in what could be a protracted uprising has involved a small Indian reservation and a large dam. Once isolated, the Fort McDowell Indian Reservation northeast of Phoenix is on its way to being encircled by subdivisions.

Through the reservation winds the Verde River, one of the last sections of free-flowing stream in central Arizona. Along its banks cottonwoods nod above a tumult of green, home to wild pigs and bald eagles—a swash of oasis in dust country.

If Orme Dam is ever built below the confluence of the Verde and Salt Rivers, an arm of the reservoir will inundate 70 percent of the reservation at high water. At low water the reservoir will shrink, exposing broad, desolate beaches. The Indians would be compensated, somewhere around $75,000 for each man, woman, and child.

"I got some money before, and I don't have it now," said tribal elder John Williams (page 509). In his 70's, he has a long memory of how his Yavapai people were slaughtered, then repeatedly uprooted. They were compensated, of course.

"We had nine million acres in Arizona and got 55 cents an acre." Now, he said, the tribe has 24,000 acres left and wants to keep it.

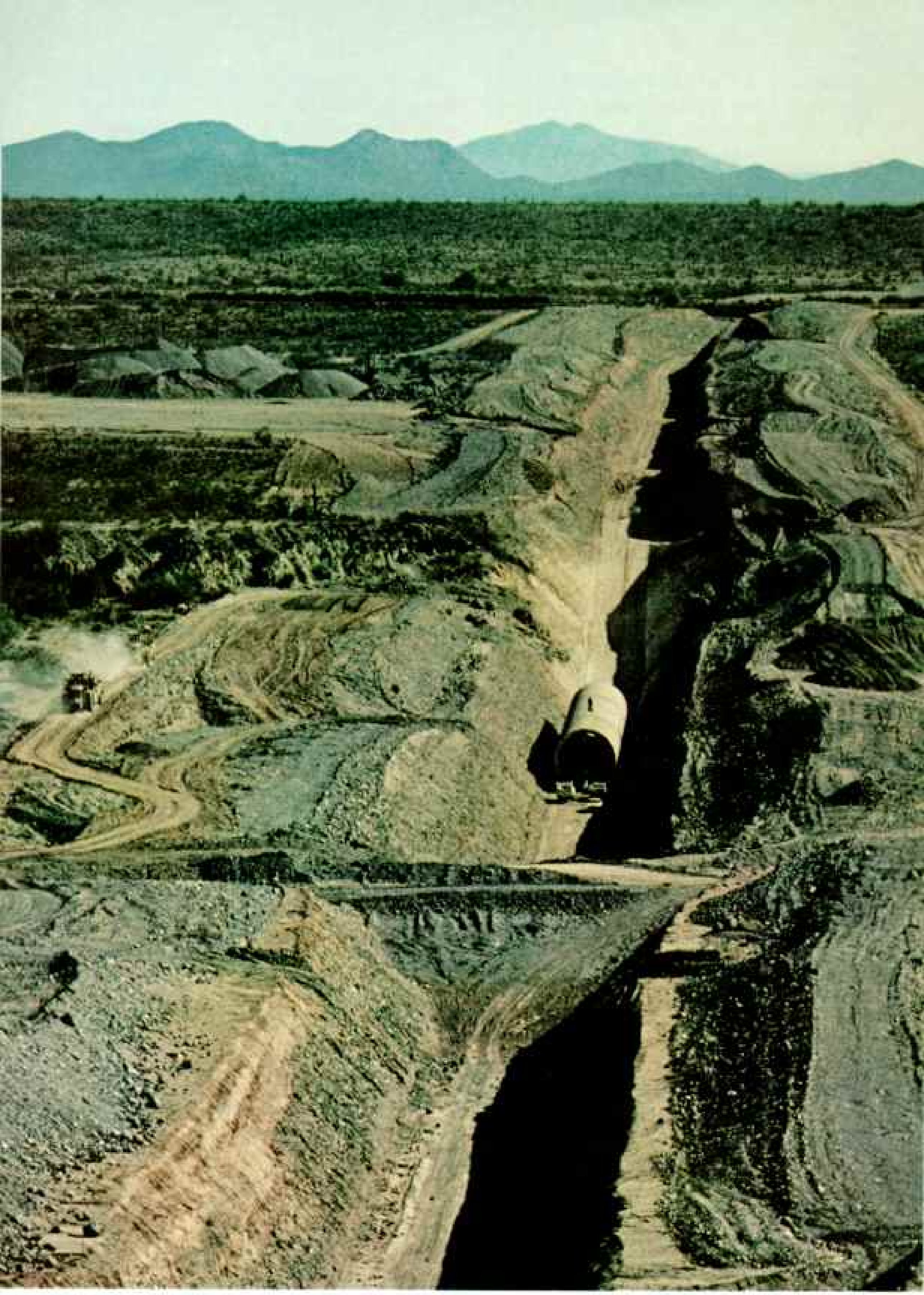
"If we get that money, where are we going to spend it in the right way? We'll lose the land and the money both."

On the evening Fort McDowell adopted a resolution to hold onto the land, the tribal council asked for guidance from the thirty or so Yavapais attending. One older man stood up and said, "The council should provide a big dinner, so we can all celebrate and be happy. That's what white people do."

Not far away on that same evening, the council of Scottsdale, "the West's most western town," approved development plans that could increase its population by 50,000, making it as big as Youngstown, Ohio.

Although Scottsdale will certainly grow, the Yavapais may have already won their battle. Recently, Orme Dam has been eliminated

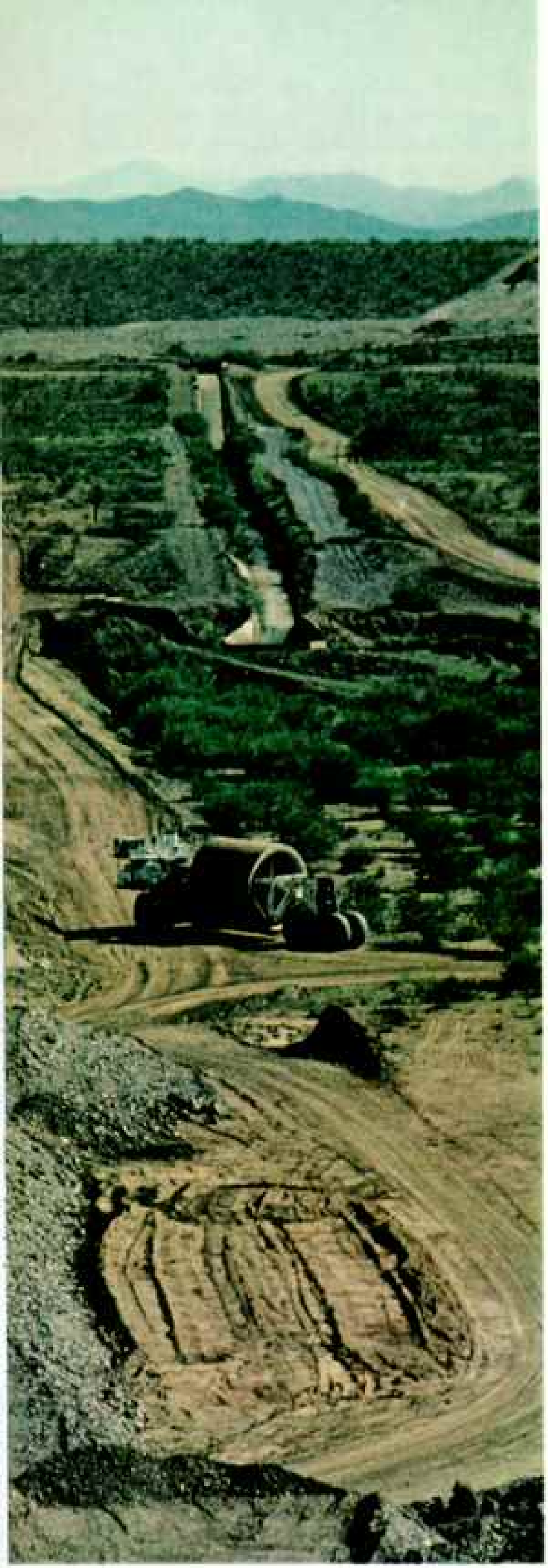
Scene of the crime: One of Arizona's five "cactus cops" checks out a fallen saguaro, probably abandoned by skittish cactus rustlers. Despite the threat of fines and prison, thieves make off with perhaps 25,000 of the majestic plants annually, selling them to landscapers for as much as $400 apiece. To combat the problem, state authorities push for more enforcement officers and stiffer penalties



Boon or boondoggle? The plan called the Central Arizona Project, designed to pump vast amounts of water into the desert area from the already heavily tapped Colorado River, has avid defenders and opponents.

Near Sun City, the world's largest precast concrete pipes are being laid in trenches (**left**) to carry CAP water beneath the usually dry Agua Fria and New Rivers.

Most disputed feature of CAP, Orme Dam would provide a reservoir and flood control for Phoenix; it would also inundate most of the Fort McDowell Indian Reservation. Tribal elder John Williams (**below**) scorns compensation. "I don't want the money; I want to keep the land," he says. As of now, he seems to have won. Orme and two other dams have been deleted from CAP.



from CAP by Presidential directive. Based on their past experiences, the Indians will believe it when they don't see it.

If any group of newcomers can ignore the long-term future of Arizona's growth or water—or energy, which many think a potentially worse problem—it is probably the retirees who have come flocking to sun country for their sunset years.

Out east of Mesa at Leisure World, a retirement community, Glenn Crane was hand-sanding a nearly flawless mahogany table in the carpentry shop. A retired Army colonel and engineer, at 57 he was among the new wave of under-65 retirees.

"The interests and attitudes of the 80-year-olds here are different from mine," he said. "I don't hang out with them."

Besides carpentry, Crane has "become carried away by the Phoenix Zoo education program," and spends many volunteer hours teaching natural history to schoolchildren.

Northwest of Phoenix at Sun City, largest of the retirement communities, some 40,000 have settled into neat bungalows in the sunshine—but not to bask. The activities calender for one month listed 561 organized events, plus what residents could do on their own.

Golf carts and bicycles whiz every which way in an atmosphere closer to recess than retirement. Prepare yourself for retirement is standard advice. From what I saw at Sun City, I would add: Go into training for it.

Entertainers out to Pasture

Some retirees do take it easy. I met Rodney, a refugee from the nightclub circuit; Sigmund, an artist; Anne and Pedro, onetime circus performers. They were relaxing in one of the desert's most exclusive communities under the loving care of Jo and Paul Fritz.

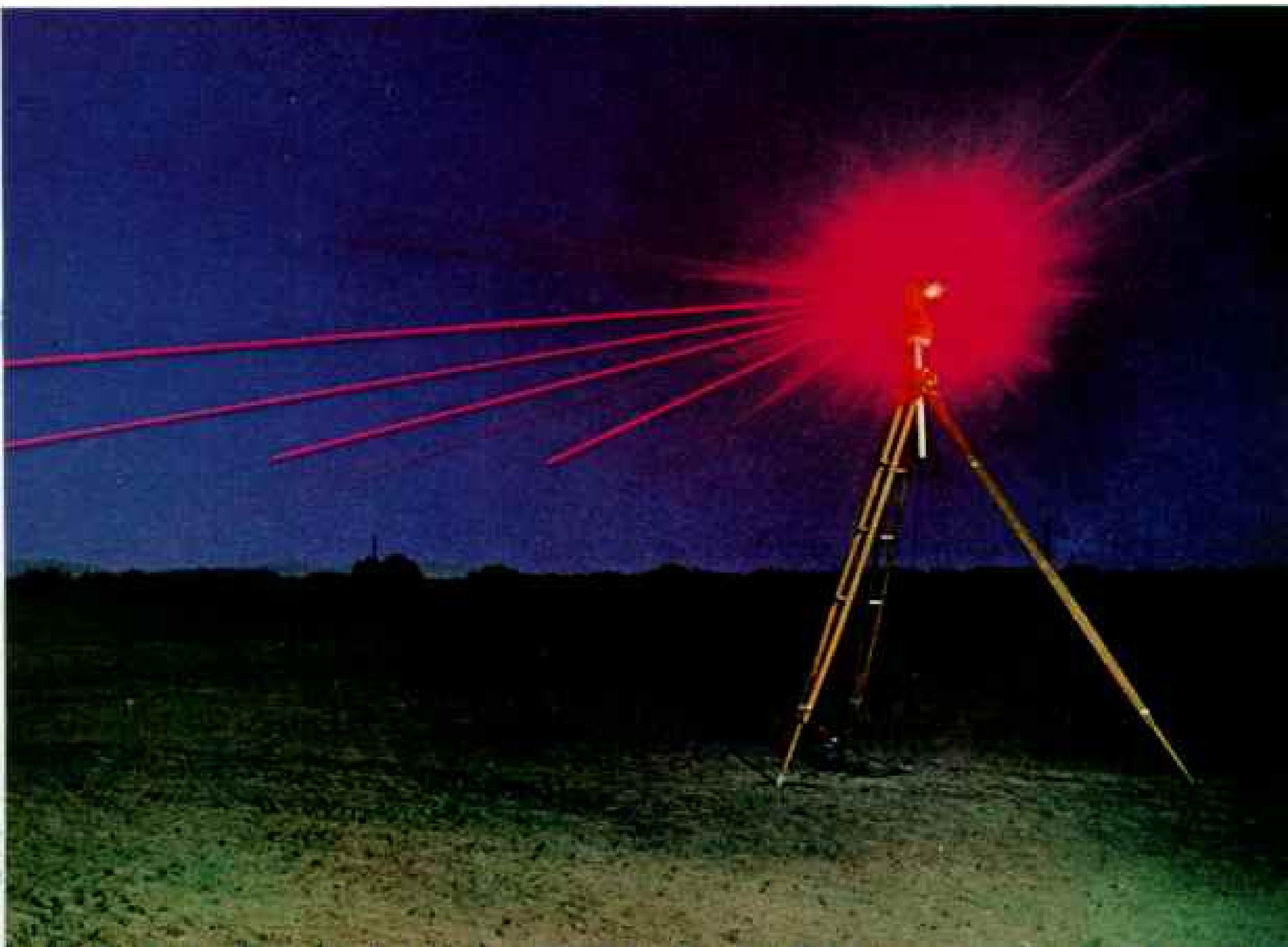
The Fritzes were sheltering them because, over the hill as entertainers or household companions, most chimpanzees have no futures. So the Fritzes founded the Primate Foundation of Arizona to save what chimps they could and to establish family groups against the threat of chimpanzee extinction in the wild.

If 35 chimps have ended up lucky in the desert, thousands of people were left with nothing. They dreamed of a place in the sun, fell in love at a distance with the very *idea* of Arizona, only to wake to a nightmare

Salad days in the lettuce fields can bring young workers as much as $55 a day. Unionized harvesters (**right**) take a break from the laborious piecework of cutting heads from stalks in a field near Picacho Peak, site of the only Civil War skirmish in Arizona. With their fertile soils and long growing seasons, desert farms yield prodigious crops.

On the beam, as seen in a time exposure, a laser-guided land scraper operated by Floyd Spar levels a field billiard-table flat. This technique helps prevent runoff of irrigation water, typically reducing consumption by a third.

With the water table falling and wells increasingly expensive to run, laser planing has been deployed in the technological battle to conserve water.



reality. Between Phoenix and Tucson, I saw the carcasses of the dreams, ghost towns that never were. At one, a grid of asphalt streets, and nothing else, lay precisely in the middle of nowhere. At another, street signs, their names obliterated, canted out over dusty ruts through scrub desert.

A sign advertised lots at $4,295. I called the phone number given. It had been changed. I called the new number. A sleepy-voiced woman said no, no, she didn't know anything about it, and hung up.

"The era of the big land rip-off peaked in the early '70's," Anthony Ching, chief counsel for the state attorney general's economic protection division, told me. He said that news stories, the economic downturn, and new laws have sharply curtailed high-pressure sales of dubious land to out-of-staters.

"The real crooks," Ching said, "took the money and skipped town. Some bad actors used bankruptcy to avoid responsibility." But others, he said, whose developments were more legitimate, "have made serious efforts to keep their promises."

At the height of the sales frenzy even some promoters came to grief. Ching showed me a four-page ad featuring an imaginary boat sailing a nonexistent lake west of Phoenix. Despite columns of glowing gush, the promoter didn't sell a single lot. The sales pitch had been run in a Honolulu paper!

Abandoned Lots Scar Landscape

From a light plane climbing in a slack spiral, the streets and cul-de-sacs of abandoned land developments took on the mysterious geometry of some ancient, unrecorded civilization. Jim Little, extension agent for Pinal County, cataloged the rest of the landscape that surrounded the town of Casa Grande.

To the north spread a Pima reservation, threaded by a double strand of interstate highway suturing Phoenix to Tucson. To the south, mountains rose to a Papago reservation. Below, an open-pit copper mine—Arizona is the nation's leading producer—looked like an inverted gelatin mold. Where the water table had dropped too far to pump, scrub followed old furrow lines. Where the water had dropped farther, and the ground had collapsed, great cracks ran perpendicular to the natural lines of drainage (page 501).

Across broad expanses, machines divided fields into two colors—green where cotton had been picked, gauzy gray where bolls yet hung on the plants like popcorn.

Jim Little told me that farms of high-quality cotton ran upwards of 2,000 acres. "The guys who own those farms are sitting on boards of directors," he said. "They're not the kind of farmers who come to town on Saturday night in bib overalls."

Growth War Rages in Tucson

Farther south lay Tucson, a city in the farmland business. Since the mid-'50's it has been acquiring farmland and now controls 11,000 acres outside the municipal borders. No cotton, alfalfa, or wheat is planted in this phantom Tucson. Nothing much grows but tumbleweed. Yet the city harvests a vital crop from under the land—water. Wholly dependent on groundwater, Tucson has a mighty, growing thirst and pumps water that seeped under the desert tens of thousands of years before the first Hohokam dug the first canal.

Like Phoenix, Tucson has been growing prodigiously, its mellow core of tile and stucco, reds and tans, arches and courtyards corralled by the sharp edges of the up-to-date. Unlike Phoenix, Tucson has been arguing the consequences and future of growth at length, in public, and at the top of its collective lungs.

Like all good range wars, this one involves a land dispute, with each side trying to put black hats on the other. One faction, whose leadership has come from business people, including members of the activist Chamber of Commerce, has fought for traditional growth. The basic credo: Let people by their individual choices decide for themselves where they want to build and live, and let growth follow the dictates of the free market.

No! says the other side, a loose coalition of

Drifting along with the tumbleweed, Texan Ray Averi, with his dog, Buddy, hopes for a job at the end of a lonely road. In a tight employment market, many have turned back or passed on through desert Arizona. Still others have been eager to take a step down in salary to take a step up in living, with sun and climate as fringe benefits.

conservationists, reformers, and educated novices adept at the politics of doorbell ringing. Leapfrog sprawl costs too much—in terms of the environment, public utilities and services, and the quality of life people came to Tucson for in the first place. Redirect growth back toward the center of Tucson.

City Divided by Power Politics

In 1975, controlled-growth advocates won a majority of Tucson's City Council seats, defeating the traditionalists. Tucson, which had grown from 50,000 to 300,000 in the past 25 years, seemed determined to slow down.

"Don't call us 'no-growthers,'" said Vice Mayor and City Council member Barbara Weymann. "It's so inaccurate. We're not the kind of people who want to build a wall around the city. But we are concerned about where the growth is going."

What, I asked, about the charge that those who favored controlled growth for Tucson were antibusiness and ruining the economy?

"We would like to see more industry come here. We need it to broaden the area's economic base."

Since that was also what the business interests wanted, what was the problem?

"There are no lines of communication, no lessening of the polarization. It is very disheartening to be blasted in the business press. In the past those people ran Tucson. They could pick up the phone and make things happen. Purely and simply, they'd like to have the power back."

Banker, Chamber of Commerce president, member of the Good Government League, the business community's political arm, Jack D. Davis agreed with Weymann on one point.

"It's a crime that Tucson has become so split on the growth issue," he said. "I would love to have Tucson stay the way it is. But it's either grow or die—we can't stand still."

Davis told me the question of residential

GEIR KEYES, IDA DOCUMERICA

Dust blizzard, churned by high winds and aggravated by loose soil from plowed and bulldozed land, moves in on Phoenix (**above**). Dust storms sometimes paralyze traffic and choke roads, but most are only eye-stinging nuisances (**right**).

Pollution from dust, pollen, and auto emissions has risen with expanding populations in Phoenix and Tucson. Still, most days offer up the tonic that brings people to the area —dry, sunny days ending in flaming sunsets, followed by cool, star-strewn nights.

Half-time jubilee crowns homecoming royalty Norbert Peters and Mary Avilés of Maricopa High School. In small towns beyond the frantic growth surrounding Phoenix and Tucson, people go about their living unaffected by "sunbeltomania." But if the pattern continues, they may find an army of newcomers galloping over their desert horizons.

development remained the central issue. "People coming to Phoenix and Tucson don't want to move into an inner city. They've come to get away from that."

It was water bills, not arguments about the philosophy of growth, that wrote the next chapter in Tucson's rodeo politics. The new council made what proved to be a serious political mistake—it raised the city's water rates substantially.

Outraged citizens mobilized and collected enough petition signatures to force a recall election. The controlled-growth advocates, Barbara Weymann included, were bucked off their City Council seats.

Progress for Mexican-Americans

Another group of citizens, the quarter of the population that gives Tucson its distinctive architecture and ambience, has also jumped into the city's lively public arena.

"We Mexican-Americans have been paying taxes for generations, but still our streets are not repaired," said Alberto Sanchez, director of the El Rio Neighborhood Center.

"Ninety-nine percent of us are Catholic. We want to know why, if we are such good material for God to save, we are not good material to be helped.

"In the old way of thinking, we wondered: Why do the Anglos discriminate against us? Why don't they like us?"

That way of thinking changed in 1970, Sanchez said, when his community made itself heard by speechmaking, demonstrations, and confrontation. Out of that turmoil grew the neighborhood center, "a place of beauty, services, and help," with day care, legal aid, and—top priority—programs for education and employment.

"The demonstrations were one lesson we'll never forget. We're learning some of the tricks of Anglo society. Now we have a greater opinion of ourselves. We're improving, and we know it."

For other Arizonans the outlook is hazier. One day I entered a model home in a medium-priced subdivision on the far-eastern border of Tucson. Inside, salesman Kurt Riechers was going through tissues like so many potato chips.

"If you didn't have an allergy before, you'll have it now," he sneezed, railing at the Bermuda grass newcomers had planted in remembrance of lawns past—part of the reason Tucson's pollen count has risen a hundredfold in thirty years.

Riechers had come for the expanding opportunities in Arizona, struck by what a professor had told him—that someday a megalopolis would stretch from Nogales to Tucson to Phoenix to Las Vegas.

"With this climate, I don't know how you can stop it," Riechers said. He had once ridden horses right here, where he was now selling houses. Growth was good for his business, but what did he think about it as a resident instead of a salesman?

"I have mixed emotions. It all depends on what day you talk to me."

He pointed out a window to the distance, where the Santa Catalina Mountains lay against the sky like a sleeping dinosaur, mountains where you can ascend from the desert and lose yourself at the summit in the deep green and silence of a Canadian forest.

"Do you call that clear?" he said, meaning the desert air between us and the mountains.

I did.

"People see that and say how crystal clear it is. It used to be much clearer."

A Golden Age Ahead?

So, how are Arizona's suburbs of the sun going to turn out? Vanish like the Hohokam, perhaps. Or as people keep voting with their mortgages, flourish like some Athens or Sparta of a new golden age. Will the CAP do the job, or will Clarence Conrad's giant dirigibles be ferrying water across the desert?

Though speculation is harmless and free, I remember the advice an elderly Arizona lady gave her neighbors at a hearing on water rates in Tucson:

"Dig your own wells, pay your own bills, and shut up." □

Where Can the Wolf Survive?

By L. DAVID MECH, Ph.D.

FROM MY "BALCONY" SEAT atop a barren skyline ridge I watched intently as an ancient drama unfolded in the sprawling Arctic valley below. The scene was Bathurst Inlet in Canada's Northwest Territories, and a great white wolf was making its way over the tundra straight toward a herd of caribou.

It was a mixed herd of about a hundred, with bulls in velvet, a high proportion of ragged, shedding cows, and several calves perhaps a month old. They were all passing along a parallel series of animal trails, stopping every few strides to nibble choice pieces of dwarf birch or willow.

Then suddenly the herd, sensing the wolf, was drawn together as if by some giant biological magnet. The tightly pressed group flowed quickly forward. Four or five caribou on a nearby slope also sensed the danger and bolted downward to join the dense nucleus of their kind.

The white wolf made its decision. Instantly it sprang forward. While the stragglers gravitated toward the herd, the wolf began closing the 200-yard gap.

As the wolf pressed closer, the caribou increased their speed. Straight toward them the white wolf shot, with long legs alternately stretching out then pulling together in 15-foot bounds. And directly away from the wolf the caribou sped. The chase covered a quarter of a mile, and the wolf tried its best all the way. Still the wild hunter was unable to come closer than about 200 feet to its intended prey. It chased the caribou at this distance for about fifty yards. Then all of a sudden the wolf slowed, and less than a minute after the chase had begun, it was over.

As the straggling caribou joined the safety of their tightened herd, the wolf trotted off along a boulder-strewn slope and picked its way up the valley and eventually out of sight. It would have to find some other caribou on which to dine.

Such dramas, with the same unsuccessful climax, are enacted often on the Arctic stage. I witnessed only a few chases—all failures—during my short trip to Bathurst Inlet, but the pattern was the same as I have seen many times elsewhere with moose and deer, the largest and the smallest of the wolf's hoofed prey: a very low percentage of success. The wolf as scientists know it is quite different from the public's image of the creature as a heinous super-killer.

Hounded by man from time immemorial, wolves still hang on by tooth and nail in North America's diminishing wilderness. Peering cautiously from Alaskan scrub, this animal seems like a big, friendly specimen of its descendant, the domestic dog.

ROLLIE GEISSMICK

The wolf is the ancestor of the dog, and looks like a large, lean, and shaggy version of a German shepherd. It is most often colored a mottled gray, but may be snow-white or pure black or any shade between.

It is probably best known for its howling. A wolf howling alone produces a low, drawn-out, mournful call "like a very lonesome, sentimental fire siren," as one writer put it. But add to this the howls of an entire pack, and the result is incredible. Some wolves yip; some yowl. Others moan, whine, bark, or wail. The woods resound with wild chords and discords and an undercurrent of quavering ululations.

Myths Create a "Monster Image"

It is this eerie howling that has probably inspired the tales that have arisen about the wolf. The animal is thought capable of choosing any prey and running it down with impunity. Its weight, usually 60 to 120 pounds, is often grossly exaggerated, and so is the size of its packs, rarely more than twenty members and usually fewer than ten.

Wolves are even accused of adopting and raising human children upon occasion. Romulus and Remus, the legendary founders of Rome, are of course the most famous examples.

No doubt the monster image of the wolf helps account for the zeal with which the animal was wiped out in most of the United States during the early decades of this century, though it is also true that wolves were a serious liability to man. In those days they killed plenty of his livestock, and man retaliated with private and official control programs. These involved poisons, bounties, den digging, and many other methods that exterminated wolves even in areas unsuitable for livestock.

Today in the U.S. the gray wolf remains in significant numbers only in Alaska and

Pack tracking in Minnesota's north woods, a plane surveys resting wolves, collared with radio transmitters by author L. David Mech. A biologist with the U.S. Fish and Wildlife Service and one of the world's foremost authorities on the animals, Dr. Mech has radio tagged 150 of them and logged more than 2,000 hours in the air while monitoring their movements and observing their behavior.

DAVID HISER

Minnesota, although a small population may yet survive in the Rocky Mountains (map, below). Between 5,000 and 15,000 inhabit Alaska, and as many as 1,200 range northern Minnesota. Perhaps a dozen wolves hang on in Michigan, plus some 30 on Isle Royale, a national park in Lake Superior. The Secretary of the Interior has placed three subspecies on the endangered list: the eastern timber wolf, the northern Rocky Mountain wolf, and the Mexican wolf, a rare wanderer of the Southwest. The red wolf, a separate species, is found in parts of Texas and Louisiana.

Elsewhere in the world, the gray wolf is also in trouble. In Mexico, biologists consider it endangered. The animal is gone from most of Western Europe, though some populations remain in remote areas and in Eastern Europe. Large numbers of wolves still inhabit Asia, though in the U.S.S.R., the official government policy is to exterminate them from most cultivated regions while easing control in wilderness areas.

Fortunately the world is awakening to its environmental problems, and the old myths about the wolf are being reexamined and replaced by scientifically established facts.

I have spent at least 15 of the past 20 years studying wolves. Most of my research has centered on Isle Royale and several areas of northern Minnesota, although I have also worked with wolves in Michigan and Alaska, as well as Italy, Manitoba, and the Northwest Territories.

Now, after nearly 2,000 hours of flying, some 1,400 miles of hiking on Isle Royale alone, and untold thousands of miles in boats and vehicles, all in quest of information about the wolf, I am beginning to know the animal.

A Moose That Didn't Get Away

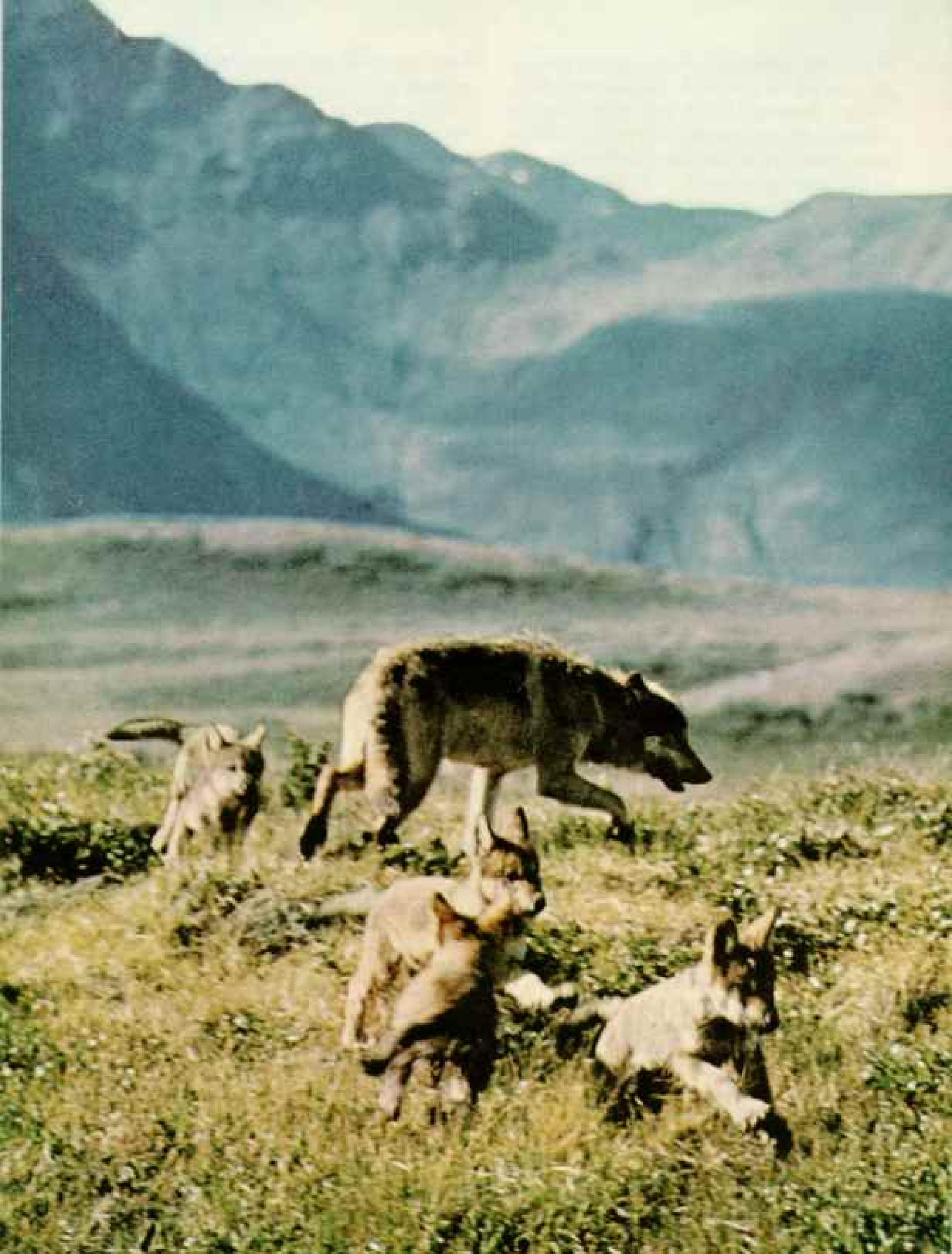
The first wolf investigation I undertook was on Isle Royale. There, accompanied by Dr. Durward L. Allen of Purdue University, I followed a pack of 15 wolves for three winters.* I spent some 400 hours studying the wolves from a light ski-plane, and 65 hours

*See "Wolves Versus Moose on Isle Royale," by Durward L. Allen and L. David Mech, NATIONAL GEOGRAPHIC, February 1963.

Soothing shot of tranquilizer and muscle relaxant from the end of a long stick enables Dr. Mech to attach a radio transmitter to a she-wolf captured in Minnesota's Superior National Forest (**left**).

Once ranging over most of North America (map, **right**), the gray wolf, *Canis lupus*, has been almost eliminated in the contiguous United States; the 1,200 or so in Minnesota remain the only sizable group. Estimates for Canada range from 17,000 to 28,000; Alaska may harbor as many as 15,000.

Conservation groups would like to see wolves reintroduced to selected wilderness areas in the U.S.—such as the Great Smoky Mountains and the Adirondacks. Others, chiefly farmers fearing for their livestock and hunters for their game, fight such proposals.



watching the pack hunt moose, the wolf's most formidable prey.

These hunts made the famed killers look like amateurs. Of the 131 moose that I saw the wolves detect, all but seven escaped through alertness, speed, endurance, or sheer pugnacity.

When the wolves finally did zero in on one of the less canny moose, the results were spectacular. I recall especially an attack on a nine-month-old calf of some 300 pounds that the pack managed to separate from its mother. I asked my pilot, Don Murray, to nose the Aeronca "Champ" down to about 400 feet for a closer look.

Most of the wolves were worrying the cow, while two pursued its bolting offspring. After about 150 yards, one wolf lunged at the rump of the calf and held on; the other clamped onto its throat. The calf stopped and began trampling the front wolf into the snow. Still the wolf managed to hold on for two minutes before relinquishing its throat hold. It then stood on its hind legs, placed its forefeet on the moose, and tore at the side of the animal's neck. The calf brushed the wolf off against a tree.

The other wolf, however, remained tugging at the calf's rump. The front wolf then dived under the running moose and again fastened to its throat. Continuing to run, the moose straddled the wolf, which brazenly ran right along under it, fangs still hooked into its throat.

Then two more wolves reinforced the attack. One grasped the calf by the nose, and the other by its right flank. The struggling moose dragged all four wolves through the snow, then finally collapsed in a heap. A few minutes later the moose calf's flesh was being converted into wolf meat.

Law of the Wild Is Still in Force

In Minnesota, where the wolves' primary prey is deer, the predators are dealing with an animal of great speed and alertness. Thus their hunting success is not much better than with the powerful moose. The pack usually ends up with the misfits: the immature, old, crippled, sick, or otherwise inferior individuals. It's the old story of the survival of the fittest. The wolf's culling out of inferior prey ensures that only the healthiest, most vigorous members of the prey population survive. And those that do survive, having a better share of the food supply, will probably grow healthier, live longer, and so produce a greater number of superior offspring.

Hungry as a Wolf: An Apt Analogy

Of course, all this useful culling is just what comes naturally to the wolf. It is superbly adapted to that role. It can survive for two weeks without eating, and thus can hunt and chase great numbers of animals until it finally finds one it can kill.

Once wolves make a kill, they can consume impressive amounts of it. One clear, crisp afternoon, pilot Murray and I watched 15 wolves bring down a cow moose at the base of a steep ridge on Isle Royale. The wolves surrounded the carcass and tugged in every direction. In less than three hours they had eaten half of the 600-pound carcass— about 20 pounds for each animal.

Usually it's a feast-or-famine proposition with the wolf, but, on the average, a wolf consumes five to ten pounds of food a day when hunting is best, usually in winter.

While hunting, wolves journey far and wide, traveling single file at their tireless rate of five miles an hour along frozen waterways, windswept ridges, and old roads and trails. On Isle Royale I once found a pack covering as much as 45 miles in a day. Between kills this pack traveled an average of 31 miles a day, bearing out the old Russian proverb, "The wolf is kept fed by his feet."

Further testimony to the wolf's wandering ways is the size of its range. In Minnesota most packs inhabit territories of from 50 to 125 square miles, and in Alaska much larger ones. There one biologist followed a pack of ten wolves by aircraft for 45 days. They roamed an area some 50 miles wide by 100 miles long, a total of 5,000 square miles.

Wolves can also be tracked by transmitter.

Doting baby-sitters, all wolves love pups—their own or another's. This wolf, raised in the Alaskan wild by naturalists Herb and Lois Crisler, guards a litter the couple entrusted to it. All members of wolf packs share in the upbringing of the young. Strong emotional bonds, formed early between pups and adults, become the cement of pack unity.

The first animal I tracked in this way was wolf number 1051, a denizen of Minnesota's Superior National Forest. Designated by the number on his ear tag, 1051 was a lone wolf, a young male weighing 75 pounds. I caught him in a special trap. Then after anesthetizing, examining, measuring, and ear-tagging him, I outfitted him with a radio collar, which put out a long-range signal that could be picked up from an aircraft.

I have since radio tagged some 150 wolves in Minnesota, and tracked them by air, but 1051 still holds the record. He wandered a straight-line distance of 129 miles between the most distant points in his journey, covering about 500 miles in two months.

The range that animals like 1051 cover may be ten times greater than that of packs in their area, and loners generally travel along the edges of the packs' ranges. When a loner does wander into the middle of a pack's territory, it runs the risk of being mauled or killed by its own kind.

In a natural population of wolves, where man has not interfered, all the available

Fangs flashing, captive wolves in Utah resolve who is top dog in highly structured wolf society. Body language normally keeps the peace. Seemingly vicious disputes (**right**) are usually settled without bloodshed as the subordinate animal rolls over in a gesture of submission (**above**). Pack members that try to improve their position and fail may be the ones that leave to become lone wolves.

BOTH BY ERWIN BAUER

WITH BY WILLIE HENDRICK

How to woo a wolf: Assume a submissive posture, and the storied "man-eater" may deign to give you a sniff, as illustrated here by two naturalists in Alaska. Ordinarily wolves will flee at first sight of a human. Not one case of healthy wolves attacking people has been recorded in North America. Old accounts of marauding "beasts" in Europe—probably embellished by legend—are now interpreted as attacks by rabid wolves or wolf-dog hybrids. Nonetheless, wolves have been pursued through the ages with poisons, barbed bait, traps, and guns.

space will be taken up by packs. Each occupies a territory of its own, overlapping little with neighboring packs, except possibly on the tundra. There during much of the year the need for migration seems to result in greater tolerance among groups.

Exclusive spacing of pack territories may be maintained by howling and by scent marking—a ritualistic practice very much akin to a dog's usual treatment of a fire hydrant. Whatever the means of marking territories, lone wolves are left with no real areas of their own, and most are doomed to a nomadic life of trying to avoid packs.

Thunder Bests Lightning in Stormy Scene

But where do lone wolves come from? To answer that question, we must understand the social organization of the pack. Packs are family groups, and every wolf is born into one. The most basic pack will include an adult pair and a litter of pups. The adult male is the leader of the group, and the adult female is next in social status. The young are subordinate to the adults, but a social ladder or "dominance hierarchy" also develops among the pups.

The social ranking of wolf pups is probably chiefly determined through play fighting within the pack, since adults usually break up any severe fighting. A pair of zoo-born wolf pups that I raised in my home demonstrated that I was no match for an adult wolf in keeping them under control and that their need to settle their social status was of prime importance.

When they were a month old, looking like cuddly teddy bears, they began to fight so intensely I decided to give one up. Before doing so, I placed the pups together to photograph them. Immediately the two tiny creatures, the male named Thunder and the female, Lightning, pitched into each other with baby tooth and nail. This time Thunder got the best of Lightning. The diminutive victor stood stiff-leggedly over his vanquished sister, with tiny tail erected straight into the air. From that instant on, peace returned to the Mech household.

In a simple pack with a pair of adults and their pups, the social hierarchy is a linear one. Some packs, however, contain as many as 36 members, including several adults. In such cases both a male and a female social

ladder develops. Nevertheless, the male leader guides the activities of the pack and initiates attacks against trespassers.

Pack underlings can, however, sometimes effectively protest their leader's actions. One clear winter day when the Isle Royale pack I was studying headed out single file beyond the northern tip of the island and across the treacherous ice toward Ontario some twenty miles away, most of the members became reluctant to follow their leader. This animal then returned to the group and appeared to urge his subjects on toward the mainland. After starting out again and having to return several times, the leader finally capitulated and led his pack back to the homeland. As a graduate student whose Ph.D. depended upon this pack's remaining on Isle Royale, I must admit to having cheered the touch of wolf democracy I witnessed that day.

"Scapewolf" Leads a Dog's Life

At the bottom end of the wolf hierarchy are the peripheral animals or social outcasts. Most large packs have at least one individual on whom the other members take out their frustrations, a "scapewolf" so to speak. This low-ranking creature is subject to sudden attacks and may have to depend on leftovers for its sustenance.

Such an arrangement is actually beneficial to the survival of the pack. Instead of all members suffering malnutrition during a shortage of prey, or because of overpopulation in the pack, the bottom members go on short rations, leaving the dominant individuals in good health.

Here then is one of the possible sources of lone wolves. Being a scapewolf may not be too unbearable in a pack of five wolves with a good food supply. But if the pack grows to eight or ten, or a food shortage develops, life may become so grim for the lowest-ranking wolf that it just leaves.

Another factor *(Continued on page 534)*

Opportunist eaters, wolves gorge in Alaska's salmon-choked streams during spawning season. More commonly, they prey on such animals as caribou and moose, especially the young or infirm. Accustomed to feast or famine, wolves can go for two weeks or more without food.

WILLIE GEORGE

Timeless drama of predation unfolds as photographer Doran Whitledge records a moose kill in Superior National Forest. The prey, a calf with a broken leg, rests (**left**) while its mother stands guard —as she had all through the night before. Off and on, as the wolves closed in, the calf would hobble on its three good legs, followed by its mother, to the safety of a pond (**above**). Trembling with cold, it would always lead her back to shore. Death came under cover of night, accompanied by terrible bellowing. The next day Whitledge found the pack tearing at the carcass (**below**), already stripped of the large muscles. The cow, exhausted from innumerable charges at the advancing wolves, may have lowered her guard to feed before the fatal attack—some 24 hours after the showdown began.

The future of wolves in this Minnesota refuge is by no means secure. Now on the endangered species list, they are on the increase and have begun to encroach on surrounding farmlands, killing cattle and causing furor among some farmers. Dr. Mech sympathizes with local apprehensions and proposes the regulated killing of wolves in areas where they conflict with humans. His proposals have not endeared him to some staunch wolf lovers. But without such measures he fears even more wolves may succumb to the wrath of an irate citizenry.

in the making of loners might be their own aggressiveness. When offspring mature at the age of 2 or 3 years, they may not be able to endure the discipline of the dominant animals. Instead of living in the shadow of their parents and being subordinated by them, perhaps they just strike out on their own.

Loners do worst where wolves are least pursued by man and the packs grow large. The packs allow the loners no area of their own to hunt, thus weakening the loners and making them easy victims of the packs when they trespass. The loners are extras, and in a saturated population are expendable; their mortality rate is high. But where wolves are exploited by man, or perhaps where some natural disaster such as rabies or distemper wipes out part of the population, lone wolves suddenly play an important role. By wandering endlessly, they eventually locate any unoccupied area, and if they find a loner of the opposite sex there, they may mate, settle, and form their own pack.

Pack Life Breeds Strong Bonds

Within established packs the original pair probably continues mating each year until one of them dies. All mature members in breeding condition will exhibit a certain amount of sexual activity, but the dominance system applies especially to courtship, and usually only the dominant female produces pups. Her mate is most often the dominant male, but in especially large packs, it may be the second-ranking male.

The pups average six to a litter and are born in late April or May in a sheltered spot, usually a hole in the ground, a rock cave, or a hollow log. There all the pack members feed and care for them, and through such intimate interactions the pups and adults form strong bonds.

The pups are weaned when about seven weeks old, with the adults regurgitating partly digested food to them for the next several months. When the pups are about two months old, the adults move them to a succession of ground nests, called "rendezvous sites," where they may remain for weeks. At each successive site, the pups play over an area of increasing size, while the adults hunt for miles around and haul the food back in their stomachs or jaws.

One rainy September morning three students and I watched from a hundred yards away as an adult wolf returned to a litter of five at a rendezvous site in Minnesota. As the adult approached the half-grown young, they swarmed around her, jumping and licking her mouth in a typical food-begging behavior pattern. But that morning the adult apparently was empty and exhausted. It indulged the pups for a few seconds but did not regurgitate. Then it strode beyond them, turned around in a circle once, and lay down.

Two hours later, while the adult was still sleeping, one of the pups, weighing perhaps 30 pounds, spotted us and approached cautiously to within ten feet. There it stood, head low, scrutinizing us for ten minutes. Each time we clicked a picture, the puzzled pup jumped a few inches. It then circled us 180 degrees at about 15 feet and was joined by another. Then with their curiosity finally satisfied, they scampered off to play with their littermates.

"Do you fellows realize what a close call we just had?" I asked the students solemnly.

"Truly a narrow escape," one of them replied, just as solemnly.

Wolves Don't Eat People . . . Very Often

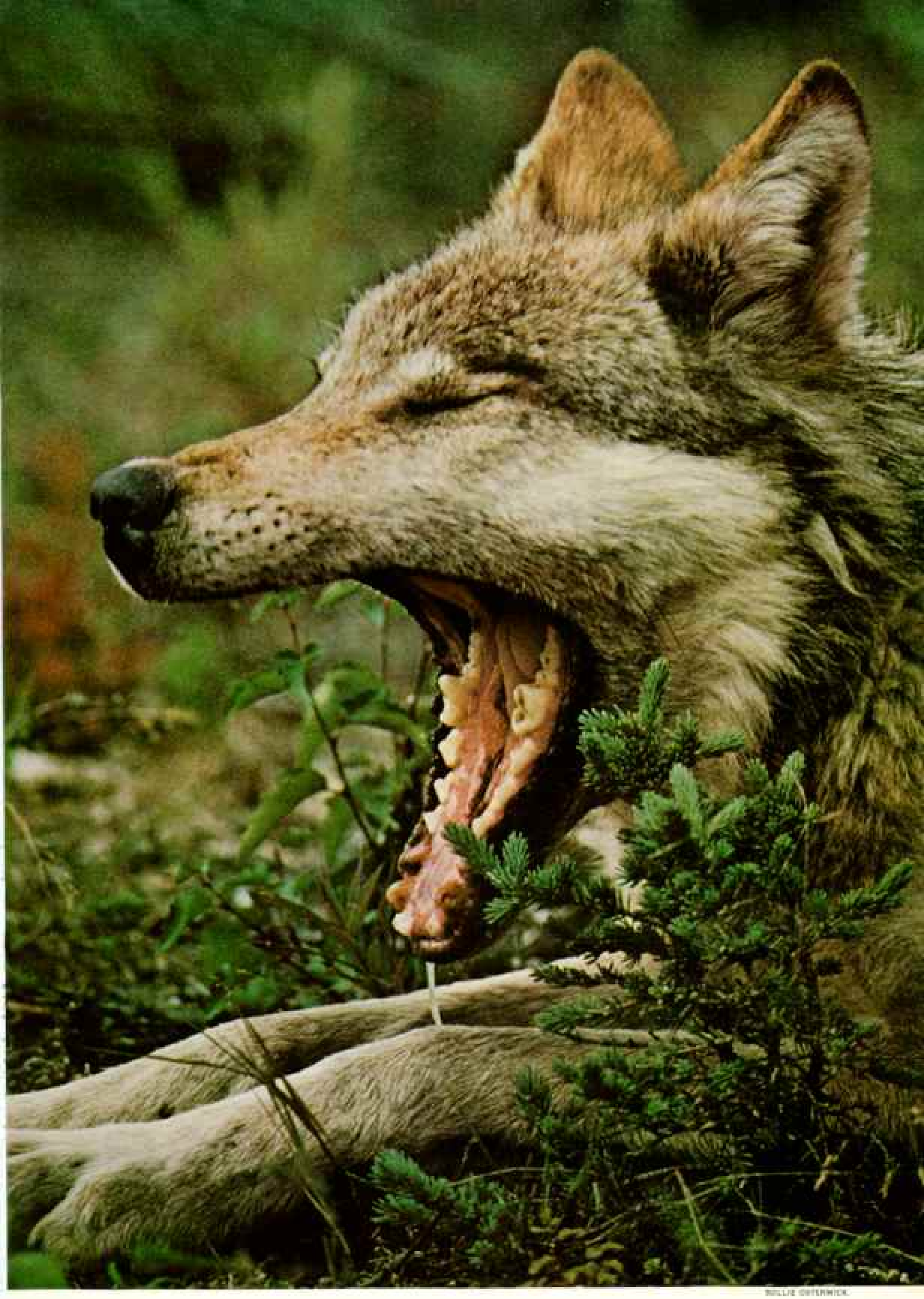
We were referring, of course, to the wolf's reputation as a people killer. According to myths, fairy tales, legends, and the sincere beliefs of some present-day backwoods dwellers, the wolf is dangerous to man.

One Minnesota logging contractor wrote me that he risked freezing to death one night in his snowplow, which had broken down, rather than walk eight miles home through wolf-infested country.

"What would you have done?" he asked me.

Since I have often walked through wolf country—near their kills, around their dens, among their pups—I would naturally have

Blunted by time, the teeth of this Alaskan wolf—the dominant female in her pack, and mother of two pups—mark her as a veteran of many hunts. In her prime she could tear through the rump of a fast-moving moose and hang on till the animal was downed. Now she will have to rely increasingly on the kills of other pack members for food.



BILLIE OSTERWICK

walked home. A healthy wolf is not likely to attack humans.

One seemingly reliable report of wolves attacking and killing people is the tale of the beasts of Gévaudan. In the Gévaudan region in southern France, between 1764 and 1767, wolves allegedly attacked more than a hundred persons, killing many, and eating parts of most. The attacks apparently are fully documented. The destruction of two huge nonrabid, wolflike animals put an end to the killings.

Dr. C. H. D. Clarke of Ontario, who has studied the writings on the mysterious beasts, concluded from descriptions of the creatures that they "were really unique in the history of their kind—natural first-generation dog-wolf crosses with hybrid vigor." Wolves and dogs can cross, and the results are highly unpredictable. Perhaps Clarke is correct. Whatever the case, it certainly is true that any attacks by nonrabid wolves on human beings are extremely rare.

An Ancient Enemy Turns Protector

When it comes to man's livestock, however, wolf attacks are far from rare. To the wolf, all livestock falls into the category of easy pickings when compared to wild prey. The wolf therefore cannot be allowed to thrive in intensively farmed areas.

But in wilderness areas, where the wolf feeds only on its natural prey, there is no reason it cannot be allowed to remain. As man has become concerned about his environment, he is realizing that the wolf belongs in the natural scheme of things and he is taking steps to preserve it in the wilderness. The animal is legally protected throughout the United States and in Canadian national parks. And research efforts continue.

Periodically my pilot and I climb into our aircraft and head out over the Minnesota wilderness, following a succession of electronic beeps that lead to some of the last remaining wolves in the lower 48 states. We hope that the data we collect will provide a better understanding of the wolf. We especially hope that our work will help guide authorities into a management program that will ensure the perpetuation of the species in the last vestiges of its former range.

It seems to me that that's the least we can do. □

As if running from its bad

DAVID HISER

reputation, a timber wolf bounds across a frozen Minnesota lake.

The Dominican Republic: Caribbean Comeback

By JAMES CERRUTI
SENIOR ASSISTANT EDITOR

Photographs by
MARTIN ROGERS

Keeping the music going, a San Cristóbal youth carries on after his school band has finished practice. With similar resolution his Caribbean nation marshals its endowments of fertile land, rich mineral deposits, and natural beauty to build a new stability after three repressive decades under dictator Rafael Trujillo and the civil strife that followed his assassination.

"HELLO, *yanqui!* How are *you!*"

The shoeshine boys in Santo Domingo's Plaza Colón were grinning, patting my shoulder, shaking my hand—an astonishment to me, since I was wearing unshineable suede shoes.

In country towns, laughing, jumping school kids tried their English on me. "Meeter, Meeter!"—the closest they could get to Mister—"*Good* to see you!" Where was the battle cry, "Yanqui, go home!"? In seven weeks and 3,000 miles of driving in the Dominican Republic, I heard it not once.

It was good to know that Dominicans felt close to us yanquis, for the United States has always felt close to the Dominican Republic—in some Dominicans' opinion, too close. The U. S. Marines occupied the Republic from 1916 to 1924, to forestall possible German intrusion, end fiscal chaos, and protect investments. In 1965 President Johnson put troops ashore for nine months to quell a revolution he feared might open the door to the Communists. On the cheerier side, in the decade since moderate Joaquín Balaguer won the presidency, the United States has poured at least half a billion dollars in loans and investments into the Dominican economy.

Opposition politicians and students still decry yanqui interventions and dollar diplomacy, but the man in the street goes on admiring Tío (Uncle) Sam. Many told me with wistful innocence, "It is my dream to live in the States."

If it had not been for ten votes in the United States Senate in 1870, they *would* have been living in the States. Dominican President Buenaventura Báez, for self-serving reasons, tried to sell the Republic for $1,500,000 to United States President Ulysses S. Grant, who particularly coveted Samaná Bay for a naval base. The treaty of annexation then went to the Senate and was defeated.

The American flag, already raised over Samaná, was hauled down. But an American "underground," established on Samaná almost half a century before, hung in there. It was not a subversive group, but a kind of "underground railroad" of U. S. black slaves and freedmen, whose descendants survive today. Though they speak an English of the Old South, some have no inkling of their roots.

The story began in 1824, a time when the whole island *(Continued on page 544)*

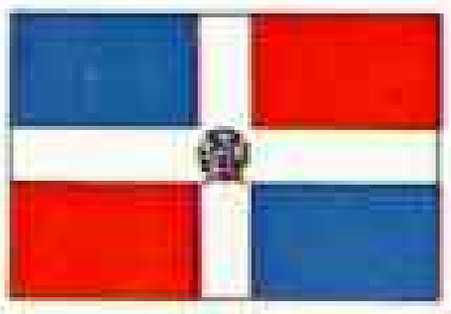
Clouds veil the beauty of the Dominican Republic's rugged heartland, where parallel mountain ranges wall lush valleys that shelter fruitful farmlands. Largely

agricultural, the Republic raises crops ranging from garlic to cacao, from tobacco to sugar—still the top money earner despite a recent sharp drop in world prices.

Warm greeting from a police official welcomes President Joaquín Balaguer (**right**) to the dedication of an irrigation canal on the Samaná Peninsula. Winning office in 1966 and twice reelected, the 70-year-old Balaguer has revitalized the nation's economy, spurred by U. S. aid. His picture on the beds of army recruits (**left**) attests his role as a father figure. A recent presidential decree bans such pictures in public buildings.

The Dominican Republic

STEPPING ONTO THE STAGE of history with Columbus's landing in 1492, the island of Hispaniola became a strategic, fought-over stepping-stone to New World riches. The Dominican Republic was ruled first by Spain, then by France, and finally by Haiti, which was ousted in 1844 after a struggle led by national hero Juan Pablo Duarte.



AREA: 18,816 square miles. **POPULATION:** 5,000,000. **LANGUAGE:** Spanish. **RELIGION:** Roman Catholic. **ECONOMY:** Sugar, coffee, ferronickel, tourism, gold, cacao, tobacco, bauxite. **MAJOR CITIES:** Santo Domingo, capital (pop. 1,000,000); Santiago (pop. 200,000). **CLIMATE:** Tropical, moderated by trade winds and altitude.

Housing for all is Balaguer's goal despite the nation's troubling 3 percent annual population growth. Chief emphasis is on condominiums for Dominicans of all income levels. Some $30,000,000 a year goes into housing for low- and middle-income families. These government-built apartments in Santo Domingo, priced for the more affluent, bring as much as $60,000.

(Continued from page 538) of Hispaniola, on which the Dominican Republic and Haiti are situated, was under Haitian dominion. The Haitian president, working with U.S. abolitionists, paid the way of escaped slaves and freedmen to settle in his island. About 6,000 came. Many died of typhus. Others, being fundamentalist Protestants, were horrified by the "immoral" ways of the Dominicans and Haitians and fled back to the United States. Those that remained mostly drifted into the Samaná Peninsula. There my wife, Hannah, and I went in search of their descendants, a few miles west of the city of Samaná, near the village of Honduras.

The King's English With a Lilt

A handsome woman with high cheekbones and burnished brown skin stood by the road. Beside her was a younger edition of herself, with two children clinging to her skirt. The older woman, I learned later, was Victoria Shepherd, and the other her daughter, Juliana.

Hannah stopped the car, and we asked the way to Honduras.

Juliana answered, "Jes ovuh yonduh."

"You speak English?" I asked, stupefied by the "yonder."

"We don't know to speak it like you all talk. You have plenty things we can't un'uhstan."

"Where did you learn it?"

"My mama kyept home in English," Victoria put in. "We speaks with our children in English."

"But *why* do you speak English?"

"I think we fum England—big island up yonduh," Victoria said.

"Do you speak Spanish too?"

"Oh, yes, massah," Victoria replied. "They put us to school in Spanish."

Victoria, we learned, had to visit the clinic at La Pascuala, so we offered a ride. As she bounced into the backseat, Juliana waved us on, "Go with the Lord."

Victoria made us a counteroffer. "If you give me a book in English, I can't read a book. But show me any hymn, and I'll take it by my head." She was, she said, in the choir of the Dominican Evangelical Church in Samaná.

Would she sing a hymn? You bet she would. With stately beat, she belted out that Olde English ballad, "When the Saints Go Marching In." Then she said, "My companion's brother fum States. He come heah and I sing 'at, he jine in, I 'stounded. How he know?"

Her voice got choky. "My companion died with the heart, three years ago. Isaiah Shepherd. I sang a hymn with tears runnin' ovuh his coffin. I like to die. We were companions 40 years; we riz up two children together, and then ahter 20 years he went to ask for me to marry. I'll meet him ovuh yonduh."

She shook off her grief and rendered "John Brown's Body"—rousingly—in Spanish. We were all so enraptured with hymns, we hadn't realized we'd driven almost to Sánchez, 15 miles west. "Lord Jesus!" Victoria cried. "This is a place I nevuh seeded. I nevuh been fum Samaná."

We turned around, found her rural clinic, and she got out, pouting that, though the treatment was free, she would have to pay two dollars for medicine. She said good-bye and thanked us for letting her sing: "When I sing, I feel joy in my soul."

And when we think of you, Señora Victoria Shepherd, we feel the same.

I dwell on Victoria not only for her American connection but also because her sweet optimism in the face of trouble is typical of Dominican countryfolk. Poverty is a fact of life over much of the Republic, though the beauty of the land softens the shock of it.

Rugged Beauty Enchanted Columbus

The Dominican Republic, as large as Vermont and New Hampshire together, is literally the high point of Caribbean scenery, with Pico Duarte soaring to 10,417 feet (map, page 542). Four massive crumpled ranges slash almost the length of the land. Between the northern three lie rich valleys with ancient black loam several feet thick in places. This land of uplifting mountains and fertile earth charmed Columbus, and here he founded cities to anchor Spain's assault on New World wealth.

Things did not go well from that point—for centuries. Columbus's first two settlements, Navidad and Isabela, failed disastrously, and he was ultimately sent home in irons. Three Hispaniola adventurers—Balboa, Cortés, and Pizarro—found riches in Panama, Mexico, and Peru respectively, precipitating an exodus from the island that became a stampede.

Hispaniola became a backwater, for three centuries a small colony squeezed by Spain. Disease, slaughter, and slavery reduced the Tainos, the gentle aborigines, from 200,000

to virtual extinction in 50 years. As the Indians vanished, the dons imported black slaves.

From 1822 to 1844 the Haitians occupied the Dominican realm. Black themselves, they emancipated the Dominican slaves, but their regime was often cruel and despotic. It has never been forgiven by Dominicans.

Juan Pablo Duarte, the "Father of the Country," drove the Haitians out and established the constitutional Dominican Republic, independent of both Spain and Haiti. A general drove *him* out and had his constitution rewritten to sanction dictatorship. It has been succeeded by 28 other constitutions—most of them administered by despots.

Much Progress, Many Problems

"The Decade of Balaguer," though in the pattern of the country's paternalistic strongman regimes, has hopeful differences. With singleness of purpose, President Balaguer, now 70 and nearing the end of his third successive term, has revved up his nation's economic growth rate to one of the highest in Latin America. Critics credit the gains to lavish U. S. aid and, until recently, high sugar prices, rather than to the president's economic expertise. In any event, Balaguer has been able to finance a massive housing program, cultural centers and dams by the dozen, and schoolhouses by the gross. The press, surprisingly, is free and critical.

But his Republic still has big troubles, not lessened by the fact that Dominicans tend to dismiss unmanageable troubles in a favorite expression, "No problem." That means, "There *is* a problem, but we don't know what to do about it—so don't worry!"

The roster of nonproblems includes: racial inequality, power and water shortages, high birthrate, malnutrition, illiteracy, unemployment. In spite of economic growth, the national per capita income is $750 (compared to $7,100 in the United States), and the entire economy is in danger of sliding down a mountain of now disastrously low-priced sugar.

Sugar is the central factor in the Dominican economy, involving 85,000 workers and producing roughly half the nation's foreign-exchange earnings. So I wanted to see the government-owned sugar mill at Haina, claimed to be the world's largest in capacity, though not in production. With Hannah at the wheel, we rolled into Haina, eight miles west of the

Flight to freedom: English-speaking Reverend William Johnson tells how his forebears left the United States and settled on the Samaná Peninsula in the 1820's. Ancestors of other Dominican blacks came as slaves direct from Africa. Black and white minorities stand at opposite ends of the social ladder, while the numerically dominant mulatto class pervades all levels of society.

Deft despite her years, Dolores Estrella cleans rice (**above**) near Sosúa, where her family raises cattle and coffee on a 150-acre farm. Most Dominican farms are of less than 12 acres and underproductive. Two-thirds of the nation's arable land awaits exploitation, mostly for lack of irrigation.

Silhouetted by a shaft of reflected sunlight, a fisherman casts into Samaná Bay (**facing page**), a bountiful area that yields mackerel, red snapper, kingfish, and shrimp. With large-scale fishing still in the future, most of the nation's 8,000-ton annual catch goes to domestic tables.

capital, turned down a narrow street—and thereby had our most forcible collision with a nonproblem.

A car ahead had drawn to the curb to let an oncoming truck pass. We pulled in behind. I noticed a building ten feet to starboard, with tall smoking stacks. After that I don't remember. But when I looked in my notebook later, this story was scrawled there:

"Here something BLOW UP! Great BOOM and WHOOSH! Great clouds white black smoke like A-bomb mushroom. Black woman babe in arms both crying. Husband in there. It is Haina power plant. Burning, Burning! Man says 'Many dead.'"

I followed developments in the newspapers. The reported casualties dropped to one dead, 16 seriously injured. Widespread blackouts continued for days. The power workers' union stated: "This demonstrates that, in the Corporacion Dominicana de Electricidad, not even a minimal program of maintenance exists." In eight years the unit that exploded had never been shut down for overhaul.

The Tyranny of Maintenance is a pervasive nonproblem, because the Dominican spirit cannot abide it. Why maintain when it is so much more romantic to build something new?

Cane Fields Not for Everybody

Since the explosion knocked out the Haina refinery that day, I never did get to see it. But later I visited Palabe, a government-owned *batey* that feeds Haina's huge cane crushers. A batey is a barrackslike community of cutters and their families fenced in by miles-thick walls of cane (pages 548-9).

Dominicans shun cane cutting, calling it "slave labor"; a man must cut three tons a day to make $4.50. Donald J. Reid Cabral, who was president from 1963 to 1965, told me that "225 percent of sugar labor is Haitian."

The Haitians don't like being called slaves, and they are not comfortable about being *black* slaves either. In Palabe, Idaria Leek, a gaunt old Haitian woman who had lived in the batey 20 years, said, "I'm black, but I'm clean. Come see my house." It was one small room—and it *was* clean, a contrast to the street outside her door with its rivulets of sewage meandering to an open drain. But something more than poverty troubled me. "Black *but* clean." A black was telling me black is not beautiful.

As obliquely, whites told me the same: "Go to Bani; the most beautiful girls—white skin, straight black hair."

"Of course, everybody wants to move *up*. A black wants his children to marry less black. Whites don't want to move down."

"But we have no racial discrimination. In the States you call a man black if he has one drop of Negro blood. Here, if he has one drop of white blood, he is white."

According to the best available figures, about 11 percent of the population is black, 16 percent white, and the rest mulatto. Whites hold most of the high professional and government jobs, and the blacks do most of the hard manual labor.

But the crisis in sugar is a threat to all, regardless of color. The price dived last winter to 7.1 cents a pound in the world market, below the Dominican cost of production. Only two years before, the price had reached 65 cents, leading to overproduction round the world, with ensuing bust.

Then the United States quota legislation expired, ending a guaranteed American market at premium prices for Dominican sugar producers. From them I did not hear, "No problem; don't worry."

Sea of sugarcane swirls around a *batey* (**left**), the barrackslike village of harvesters and their families. The Republic must admit some 12,000 Haitians annually for the harvest, largely because its own citizens consider cane cutting underpaid and demeaning. For a backbreaking day's work, this Haitian cutter (**below**) may earn $4.50.

Things are more cheerful on the coffee front. The wholesale price of the nation's second most important export crop doubled last winter, chiefly because frost killed millions of trees in Brazil.

Getting the Flavor of a Favored Bean

Dominican coffee is, to my taste, the best in the world, and I looked forward to a cup when César Estrella offered to show photographer Martin Rogers and me his parents' coffee farm. I saw much more than coffee. Gurabito de Yaroa is not even on the road maps, but if I had to choose the most typical Dominican village, Gurabito would be it.

César, a handsome man of 40, was born there. He is now general manager of the Industrial Dairy and Cattle Companies of Sosúa, an Atlantic coast town 30 miles north of his birthplace. In a small car, Martin, Hannah, and I followed César's pickup truck out of Sosúa into the Cordillera Septentrional. We would all have to transfer to the truck for the last four miles via the "access" road to the farm. César warned us that, if it rained, it would become a nonaccess road.

About a thousand feet up, we came to the turnoff at the Yaroa River, and all crowded

into César's pickup. The unbelievably rutted, boulder-strewn track jarred our bones and smashed one of Martin's cameras.

"This is the only road to take out the coffee from our district. It is the lifeline of a thousand people," César said. "We've all been hoping for years that it would be paved."

César parked the truck on "Main Street" in the cool and shady village, and we walked across the road to the Estrella farm. A small wooden farmhouse with pink walls and a tin roof. A separate cookhouse with thatched roof, and slatted sides to let the smoke out. A privy under an orange tree. Chickens, ducks, and guinea hens strident in the yard. A flock of egrets in the calabash trees above an apiary of hollowed logs.

Mama Dolores Estrella (page 546) and daughter, Rosario, were cooking in a big iron pot over the smoky wood stove, ignoring a propane gas range. Papa Angel Estrella, bald and rubicund, waved his cane in greeting from his rocker in the parlor. Mama, a white-haired mite, sparrow-quick, in her 70's, invited us to choose our lunch from the raucous fowl.

"Don't pick an egret," César warned. "No meat on them."

Restraint Needed in Two Activities

We opted for a tour of the farm and village instead of lunch. Rosario, 27, joined us, pretty and fashionable in form-fitting slacks.

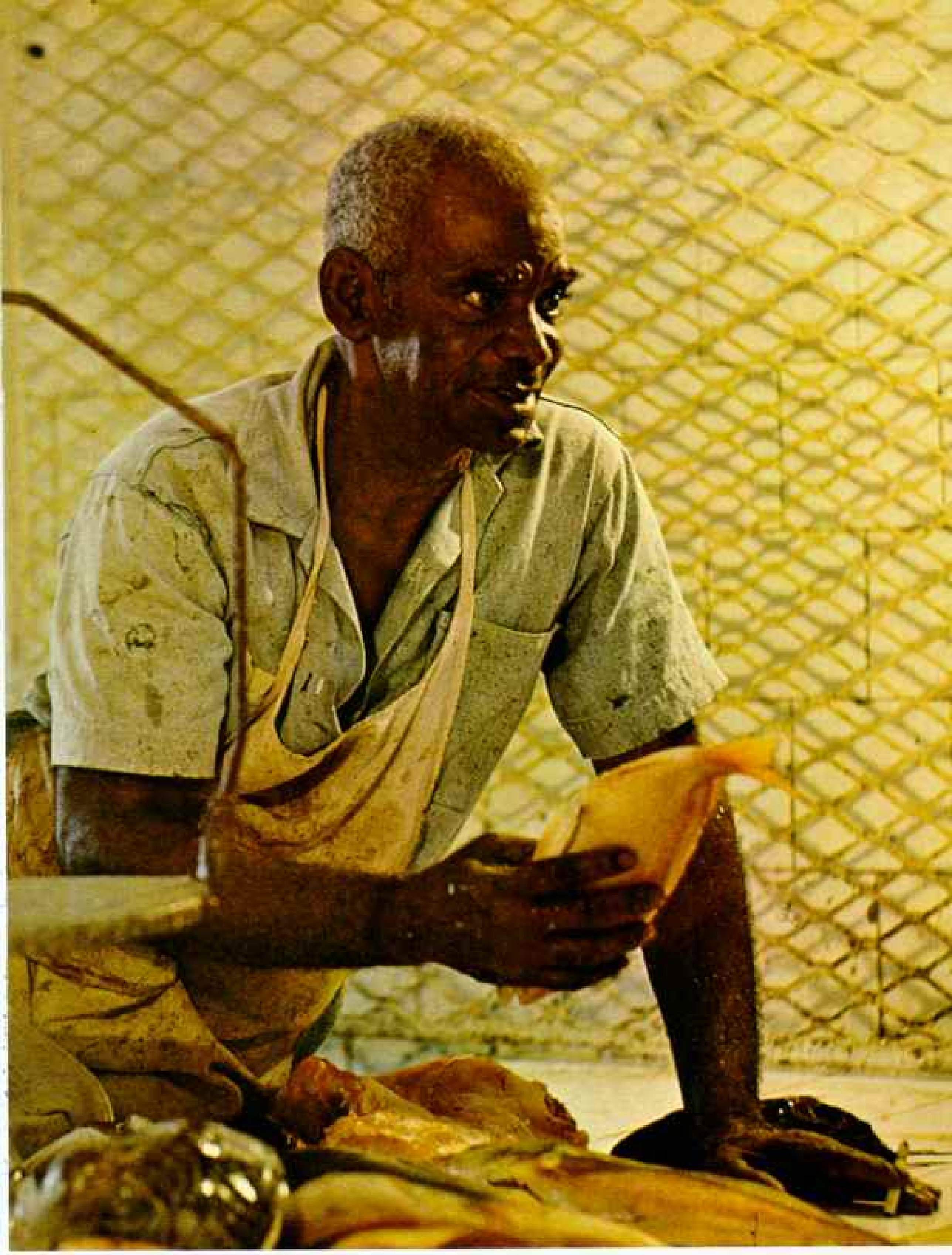
The glossy coffee trees were just up the hill, showing the red berries of ripeness, shaded by tall guama trees. "Our price is up this year to 12 dollars a box—that's about a hundred pounds," César said. "Last year a picker got one dollar a box, this year two. A family of five can pick 25 dollars a day. But many just drink, gamble, and splurge it away. New clothes till February, rags by June, and no money after that."

"I am a primary-school teacher here," Rosario said. "But I have also given adult courses in how to budget and in birth control. They are not much interested in either."

A picker, a handsome woman, came by, popping the berries into a woven palm-leaf shoulder bag. In reply to my rude questioning, she said she was 40 and had 11 children.

Rosario raised eyebrows. "You see," she told me, "we are too late, too late."

Behind Rosario's pessimism lay the fact that the Republic's population had tripled in



Selling the sea's bounty, a vendor offers fresh fish at Santo Domingo's Modelo Market. Although the city now boasts dozens of supermarkets, the cavernous old emporium attracts a daily parade of residents seeking local produce and tourists buying mahogany carvings and amber jewelry.

the previous 40 years to about five million.

We walked amid the village's rough amenities: a one-table pool hall, a rickety cockpit, two small general stores liberally stocked with rum, a stall from which the butcher blows his horn to signal fresh meat, a wooden church (Roman Catholic, of course, in a country 95 percent of that faith), a medical clinic hopefully built by the villagers five years ago.

"Only this year we have a permanent nurse," Rosario said. "And a doctor comes once a week. The priest comes to the church once a month—for several days."

We turned around at the edge of town, where the coffee berries were being washed in four deep concrete vats and dried on a concrete apron. Rosario led us up a slope to the three-room wooden schoolhouse.

"We have about 300 pupils in the district, and only three teachers, each with two grades," Rosario said. "The central government pays us each 90 dollars a month. After sixth grade, if the parents want more education for their children, they must send them to a city. This school is not in session now; we have a vacation of three months. It is the picking season, and the children must help make money."

Seeing the Capital City With New Eyes

After a couple of weeks in the interior, I was amazed at how dazzling Santo Domingo had become, and in such a short time. With the *bateyes* in my mind's eye for comparison, even the shantytowns along the Ozama River seemed to have spruced up. I saw the city as President Balaguer, who is spending 60 percent of the nation's development funds in the capital, must see it in *his* mind's eye.

I walked through the five-mile-long Park of the Indians, which follows a high ridge and overlooks the city. At my back, beyond artificial lakes, fountains, and gardens, the great Cordillera Central formed a thunderous backdrop. At my feet spanking new housing developments wound pastel tendrils into the mellowed fabric of the older city (page 543). In the clear light I could almost see the signs I knew were there: "Dr. Joaquín Balaguer, President of the Constitutional Government, Is Building *Multifamiliares* Here."

Santo Domingo, with a million inhabitants, is more populous than the U. S. capital, and it intends to give Washington's Mall some competition too. While I was there, President Balaguer inaugurated another unit in his Cultural Plaza, a Gallery of Modern Art. Other units: a National Theatre, National Library, a Museum of Dominican Man. The plaza is on a site once occupied by the town house of the late dictator Rafael Trujillo.

I found few reminders of the "Benefactor of the Country" (as Trujillo named himself) in the capital he renamed Ciudad Trujillo. Though some countryfolk continue to refer to him as the Chief, most sophisticated people want to forget him. His opponents calculate that, from 1930 until his assassination three decades later, he and members of his family

Sandlot with a view invites a pickup game in Puerto Plata. Baseball has no rival

appropriated half the country's resources and squirreled away several hundred million dollars in banks abroad as well.

The seaside boulevard on which Trujillo died, on May 30, 1961, is now Autopista 30 de Mayo. There, on the capital's western edge, he leaped out of his car, drawing his pistol and shouting to his ambushers, "Come on, let's fight." He lost, and his death led to five years of tension, tumult, and strife.

Trujillo's Fate Stirs Continuing Fear

Across the road from where he died of 27 bullet wounds, a monument was erected, with a plaque: "Glory to the Act of Liberation of 30 May." I found only the cracked pedestal, the inscription destroyed. Obviously Trujillo still has his admirers.

By the manner of his death, he has left the Republic a legacy of fear. Determined that there be no more assassinations or uprisings, the president and army have put the troops out where everyone can see them—and their carbines and submachine guns. A friend in the capital told me wryly, "We have 3,000 troops on the streets, to make people feel secure."

None of this makes tourists feel secure, but President Balaguer is intent on making the Republic a tourist country. Santo Domingo has several luxury hotels, good value by comparison to other Caribbean resort cities. Restaurant food in the capital is delectable, especially at the two Vesuvios (Italian), Hostal de Nicolás de Ovando (Spanish), and La Fromagerie (French). Fish and shellfish are *the* dishes, and none better than in two little open-air places far from the capital, the Oasis at Sosúa and La Roca in Barahona.

The capital (following pages) does have those sights tourists can't bear to miss: the old colonial quarter, with beautifully restored historic 16th-century structures, and the Tomb of Columbus. Dominicans are convinced that Columbus's bones rest in Santo Domingo's cathedral, though Spaniards claim they are in Seville.

The big hole in Santo Domingo's tourist array is a beach. The nearest swimming is 20 miles away at Boca Chica, a shallow bay, fringed by crowds vibrant with local color. For luxury beach life we had to move 70 miles east of the capital to Casa de Campo (pages 562-3), where Casa guests can take a half-hour yacht trip to spend the day in a bewitching cove named Bayahibe.

The Casa de Campo is one of four fashionable hotels that Gulf + Western, a conglomerate, built and operates in the Republic, while continuing its big sugar and ranching activities around La Romana. Gulf + Western is the most visible American presence, creating jobs for 15,000 Dominicans. But American mining operations are coming on strong.

Since 1975 the Rosario Dominicana company, near Cotui, has been turning out "gold bricks"—well, they're 75 percent silver—at the rate of 1,000 ounces of gold a day. "In the 16th century, the Spanish worked a gold mine

in the Dominican sports world, where fans root for U. S. as well as local teams.

The Western Hemisphere's oldest city

CAPITAL OF ADVENTURE, Santo Domingo sprawls beside the meandering Ozama River, where Columbus's brother, Bartolomé, founded the city in 1496 as seat of Spain's first New World colony. Pirates and swashbucklers coveted Santo Domingo for its gold. The English buccaneer Sir Francis Drake seized the city in 1586. His price for leaving: 25,000 gold ducats.

In the old colonial city stand scores of restored structures, including the Ozama Fortress (**above,** at lower right) and the Cathedral of Santa Maria la Menor (**left**). Here and not in Spain, say Dominicans, lie the remains of Christopher Columbus, beneath an ornate marble monument. A Santo Domingo dancer (**left, upper**) recalls the city's Spanish forebears—rootstock of the nation's influential white minority.

Dizzying growth of Santo Domingo—it has quintupled in population since 1950—reflects a massive influx of rural poor.

right here, but they walked away when their Indian slave labor died off," Henry Emdin, vice-president and general manager, told me. "We're producing about 47 million dollars of gold a year and employing 730 Dominicans."

When Rosario began, Americans owned 80 percent, the Republic 20 percent. It has been so successful the government recently decided to acquire another 26 percent—and did.

Keeping the Pay Scales in Line

A few miles from Rosario, in a huge open-pit mine, Falconbridge Dominicana produces ferronickel ingots used in making stainless steel. Owned by Canadian and American interests (and 10 percent by the Republic), the company provides jobs for more than 2,000 Dominicans. It pays blue-collar workers from $1.40 to $3.12 an hour, the latter almost as much as some cane cutters earn in a day.

Such a contrast could embarrass the government, which is the largest employer in the Republic, with 211,780 on its payroll, plus uncountable day laborers—at least a sixth of the total labor force. The government owns 34 industrial and commercial enterprises, in addition to cane fields and 12 sugar mills—all "inherited" from the Trujillo clique. If the wages paid by American companies went too high, government workers could get restless. So executives of American firms told me they prefer to provide low-profile benefits rather than raises: attractive housing, schools, medical and other social services.

Alcoa, the oldest foreign mining operation, is almost out of the Republic, close to the Haitian frontier at Cabo Rojo. The road there from the capital, after leading over burnt hills and across dry arroyos that looked like the landscape of Hell, reached a verdant coast called Paradise (Paraiso). The people were poor but, as always, cheerful. They did not envy our affluence. As Hannah drove, lurchingly, in first gear, across a series of canyons in the road, a boy on a donkey trotted past, shouting, "Get a burro!"

Arriving at Cabo Rojo, I was taken in hand by Mining Superintendent Rafael Reyes. Driving me through the red bauxite lands, he told me that Alcoa has been mining them since 1959, shipping its ore to Texas to become aluminum. Because of an oversupply of

Coveted by folk healers, who produce medicinal oil from their fat, American crocodiles face occasional poaching in the protected waters of Lake Enriquillo, saltier than the Caribbean

that metal, production has recently been cut drastically, and 70 Dominicans have lost jobs. We passed several exhausted mines, and Rafael said, a little worried, "Well, I guess we have enough left for 30 years."

That's why the current mining boom is not the answer to the Republic's long-term problems. Ore runs out.

What won't run out is the bounty of the soil and human enterprise. Santiago, more formally Santiago de los Caballeros, second largest city of the Republic with 200,000 inhabitants, is a font of these renewable assets. Situated in the Cibao, the nation's richest agricultural valley, it has crops as well as commerce on its mind.

Can-do Spirit Spurs a City

Santiago's businessmen set the tone: self-confident, aristocratic, thinking big. For me, the epitome of the Santiago spirit is Victor Espaillat M. He appeared at my door one day to show me his city. A man of about 60, with black hair, a shy smile but crackling eyes, he was dressed in slacks, a sport shirt, and a black baseball cap signifying that he was a rooter for Santiago's Aguilas Cibaeñas.

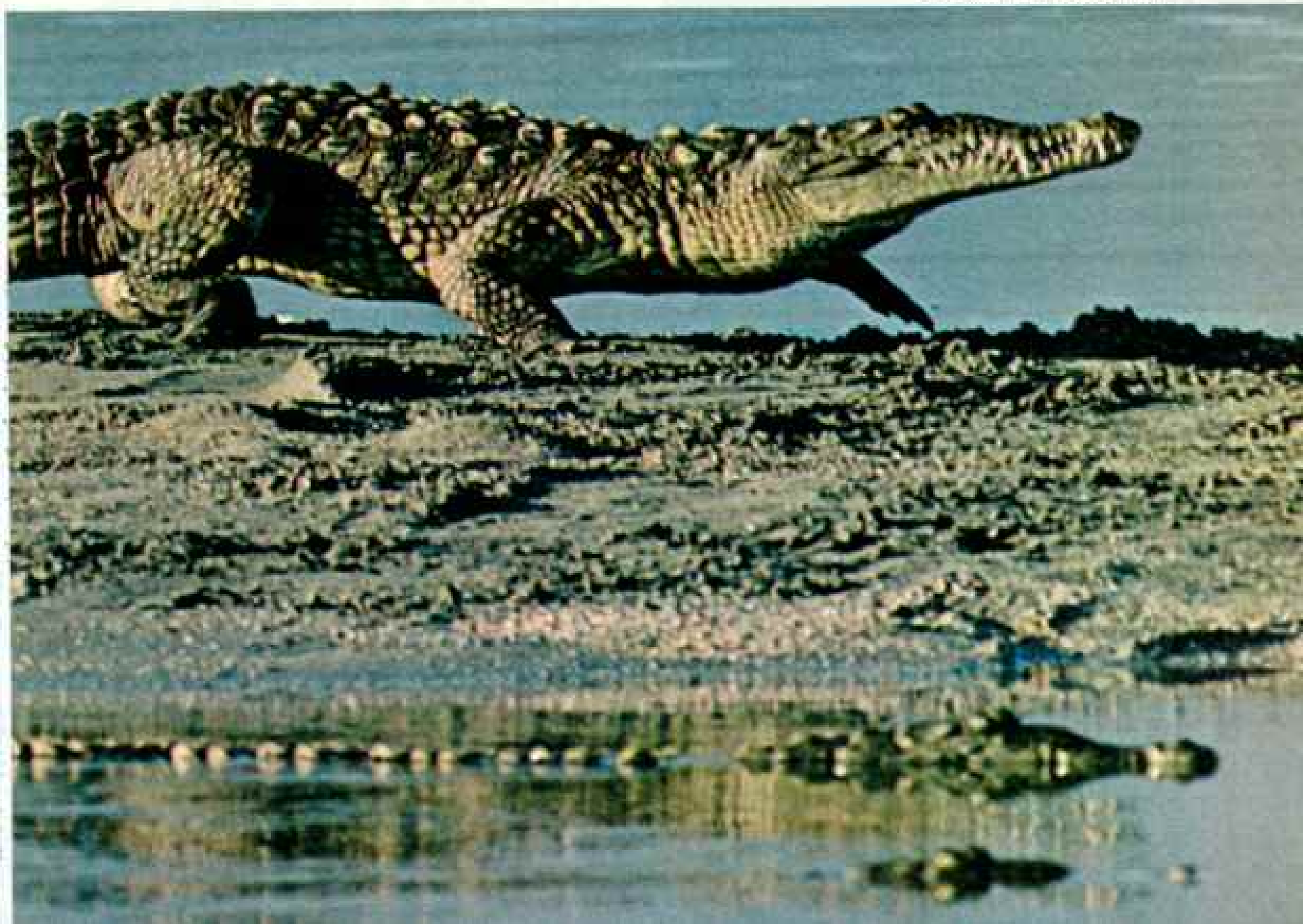
It was some time before I learned that Victor has been a friend of the president since Balaguer taught him syntax in high school. He was serving on six civic boards (no salary), with little time for his own pharmaceutical firm and candy factory. He was the first president of the Association for Development, a think tank of Santiago businessmen who conceive and execute civic projects.

Victor showed me some of their achievements: Instituto Superior de Agricultura, a prestigious agricultural school; Universidad Católica Madre y Maestra, on a beautiful rolling campus, the first Dominican university to grant degrees in mechanical, electrical, and industrial engineering.

The Santiago Industrial Free Zone is an Espaillat enthusiasm (he's president, of course). There, in the big shed of General Cigar, we watched 300 women sort Connecticut wrapper leaf by size and color. It is cheaper to ship it here, duty free, sort it at the minimum wage of 45 cents an hour, and ship it back, duty free, to the States than to pay American scale. Victor, watching the leaf sorters, exulted,

and 131 feet below sea level. The 25-mile-long landmark near Haiti shelters several hundred of the reptiles, claimed to be the largest remaining concentration of this endangered species.

CROCODYLUS ACUTUS, ABOUT 7 FEET LONG



In fast company, a young entrepreneur of Santiago delivers vegetables (**above**). The more leisurely pace of a hired carriage is the lot of another child (**facing page**). A sign on the back acknowledges the motor age with an advertisement for brake repairs.

With his nation disabled by an illiteracy rate of at least 50 percent and seriously overcrowded primary schools, President Balaguer spends millions of dollars a year for improvements in facilities and teaching quality. Yet for thousands who must go to work on the streets or in the fields, schooling will end after three or four years.

"Jobs! That is the whole idea of a free zone. And look at all those women working! Better! The money goes into the home, not rum and gambling on the way home."

Cigar makers, producing top-notch cigars like Dos Gonzalez and Ricardo Samuel, were heavily represented in the zone, because Santiago is surrounded by tobacco plantations growing a quality leaf that rivals Cuba's. Because Santiago is also headquarters for Bermudez, the largest rum company, Rafael Herrera, editor of Santo Domingo's *Listin Diario*, jokingly accuses the city of fostering "a sin economy, rum and tobacco."

Trying to Match Dams and Canals

In truth, Santiago is more interested in water than rum. Santiagueros were the driving force behind the new Tavera Dam, 15 miles south, but they feel frustrated. With irrigation an urgent necessity, Tavera is still primarily a power facility, awaiting canals. Santiagueros maintain that if the central government had let a local agency manage Tavera, there would be plenty of canals. As Santiago-born banker Jimmy Pastoriza summed it up: "We have now Tavera Dam without enough canals, and elsewhere canals without a dam."

To show what they can do on their own, Santiagueros point to their brand-new potable water supply system. They regret to see that Santo Domingo still has much undrinkable water and severe water shortages.

In Santo Domingo, Frank Piñeyro, water czar of the capital, said: "This city has grown too fast. We are trying to bring water to 200,000 rural people who have settled mainly in the eastern section in the past ten years."

Engineer Piñeyro thinks improving rural conditions will help keep them down on the farm. "We have built 300 rural water-supply systems and plan 350 more. That will serve a million countrymen."

Sewage-disposal plants are, generally, far off for country people, and Santo Domingo's raw sewage will go into the Caribbean for years to come. On the Atlantic coast, however, both Puerto Plata and Sosúa already have plants to ensure that their beaches stay lovely. The towns are the nuclei of the government's effort to turn the north coast into a luxury tourist resort. Between them President Balaguer is locating the jet strips of an


FRENE SEGURO
"FAUSTO"
TELS. 582-4139 - 583-1965

Heading down a tropic trail, cowhands round up cattle on the Peligro ranch. New breeds such as these Romana Reds are bigger and stronger than older strains, which

international airport, due to open next year.

The beach at Sosúa is my favorite in the Republic. On a great U-shaped bay, it is sheltered but spacious, and still exhilaratingly lonely; the foreign tourists are yet to arrive.

When they do, I wish them *bon appétit*, for they will find themselves in the cheese-and-salami capital of the nation. Sosúa's Industrial Dairy and Cattle Companies, which make these excellent products, were founded by Jewish refugees from Hitler.

White-haired Erich Benjamin, the companies' retired director, told me: "At our peak we had 600 people here. Now, counting our children and Dominican wives, we are down to 115. If you want to see the Jewish colony, look in the cemetery. We will all disappear in half a generation. Jewish communities cannot exist more than two generations isolated if the people around them are kind. If they are enemies, the Jewish community can last much longer."

Gingerbread Town Gets Some Icing

Sosúa's neighbor, Puerto Plata, 17 winding miles west, is getting much attention from the government: new housing, resort colonies, a seaside boulevard. It happens to be the

descend from stock introduced by Spanish colonists. Large herds raised on sugar plantations are used both to haul cane carts to mills and for beef production.

birthplace of the president's mother; also, the prettiest Dominican town I saw, with a kept-up Old Town full of gingerbread and curlicued wrought iron.

It is a good place to buy amber, the "burning stone" found in few other parts of the world. Amber *will* burn since it is organic—a fossil resin. At the Dominicanita Gift Shop, we bought pieces as big as chestnuts, complete with embedded insects (see the article on amber in the September 1977 issue), for $16 each. When I saw how amber was mined, in the mountains 20 miles south, I feared I was gouging Dominican labor. Men and boys, in constant danger of being mashed by loosened rock, chip it out of a sheer stone face with picks, shovels, hammers, and chisels.

I'm not one for courting danger, like amber miners, but I felt obliged to explore the wild west of the frontier near Haiti and the roadless tumult of the Cordillera Central, whatever the risks. Luckily President Balaguer realized he had a tenderfoot on his hands and generously lent me one of his helicopters.

Photographer Martin Rogers came along, and Lt. George Rodriguez flew us over the banana plantations behind Manzanillo Bay, then south along Haiti's border. The political

Lost balls are par for Casa de Campo's challenging golf course (**left**), where the sea and grass taller than golfers swallow hooks and slices. Sumptuous villas at the resort (**right**) beckon the rich and famous, at weekly rentals that can reach $1,735. Built by Gulf + Western Industries near its La Romana sugar mill and Peligro cattle ranch, the retreat mirrors the vital role U.S. business plays in Dominican commerce.

By courting foreign investors with tax incentives, the Republic is fast building up tourism. Only 40,000 visitors arrived in 1965, compared with more than 200,000 a decade later.

Return of a native: Dominican-born fashion designer Oscar de la Renta (**left**), now a New Yorker, retreats from pressures of his fast-paced world to the vacation house he designed and built at Casa de Campo.

A fine smoke brings a smile to a cigar worker in Santiago's Industrial Free Zone, one of three in the nation that together provide 7,000 jobs and boost export earnings. Yet even as the economy prospers, the Republic's greatest challenge lies in funneling newly gleaned benefits to its poor.

demarcation was almost palpable: on the Haitian side, denuded mountains; on the Dominican, greenery to the peaks. It is unlawful to cut timber in the Republic.

At San Juan de la Maguana, we landed on a pad behind a government warehouse. Farmers must sell their rice, beans, and corn there at controlled prices. The government fixes prices of staples, and especially of "rice and beans," a dish called the Dominican flag because it is the basic Dominican meal.

Up again and around the nearby Corral de los Indios, where the Tainos played ceremonial games. Then on toward Pico Duarte, now named in honor of the Father of the Country but earlier known as Pico Trujillo. Martin and I informed George we planned to have a picnic atop the old pico. Stony silence. When we got there, with the chopper gasping for air, like an exhausted fish atop a cataract of stone almost two miles steep, George snorted, "Picnic!" and we whispered, "Amen."

Man With a Big Dream Leads the Way

I never did get to tell the president how much I enjoyed his helicopter, but I had thanked him in advance when he made the offer in his office, early in my visit. He was sitting behind a desk that dwarfed him, as he shook my hand with a shy smile. He is only five feet two, but in spirit he must stand ten feet tall. To have come out on top in the five years of turmoil that followed Trujillo's death, he could not be a small man.

He served under Trujillo as president during the dictator's last year and for some months after his death. Mobs, political pressure, and the military drove him into exile in New York, where he remained till 1965.

While he was biding his time, Juan Bosch, a moderate leftist, won the presidency, then lost it by a military coup. A left-wing military and civilian group led a bloody rebellion to restore Bosch. The United States intervened. Balaguer returned, ran for the presidency, won, and took office in 1966. He won twice again, and his party captured almost every seat in the legislature. These victories were assisted by opposition parties that withdrew from the elections with cries of "Rigged!"

Balaguer has used his near-absolute power moderately. He is no Trujillo. He does not wish to be thought of as the successor of Trujillo but rather of the great democrat Duarte, whose portrait, I observed, stared at him as he sat at his desk.

He spoke of his concern for the people. "See

the schools, the dams." When I mentioned my trip to the blighted southwest, I thought he might cry. "All arid, all very arid," he sighed.

A lifelong bachelor, he has become, if not the Father, the Father Figure of the country. Crowds press against the gates of his residence, waiting to touch him or to ask a favor. On weekends he helicopters to remote areas to inspect pet projects and to hand out gifts to his children: chickens, baseball bats, tricycles, money.

The Dominican people seem willing to let Balaguer carry the load, to wait like children for their president to deal with their considerable problems and tell them what to do. "The hardest thing they have to learn," a friend told me, "is that they can do something for themselves."

Given time and challenge, I'm sure they will learn. But the gain may cost one cheerful trait that I personally will miss very much—the ability to turn away from the seemingly insurmountable with a shrug and a smile: "No problem! Don't worry!" □

GEOTHERMAL ENERGY

The Power of Letting Off Steam

By KENNETH F. WEAVER
ASSISTANT EDITOR

THE SMELL OF BRIMSTONE hung on the air. Steam vents hissed at me like snakes. Craters of boiling mud seethed and burped; black bubbles formed, swelled, and collapsed with rude plops.

Heat had created a scabrous landscape almost devoid of vegetation and stained with yellow streaks of sulfur and the white crusts of mineral salts. It suggested an outpost of Dante's Inferno—although it bore the more earthly name Laguna Volcano.

Only a short distance away, towering plumes of steam sent a muffled roar to my ears. These plumes marked the location of the new Cerro Prieto power plant in northern Mexico. The heat that drove the electric generators of Cerro Prieto was the same heat that had created the wasteland at my feet. It was the terrible heat from inside the earth.

The cold, hard crust of our planet gives

Plumes of hope in the search for energy, steam tapped from underground reservoirs roars through pressure-release vents at The Geysers steam field, where the Pacific Gas and Electric Company operates a generating plant. Steam-driven turbines produce enough power for a city of half a million. The California facility is the only one in the U. S. now turning earth heat into electricity.

NATIONAL GEOGRAPHIC PHOTOGRAPHER EMORY KRISTOF

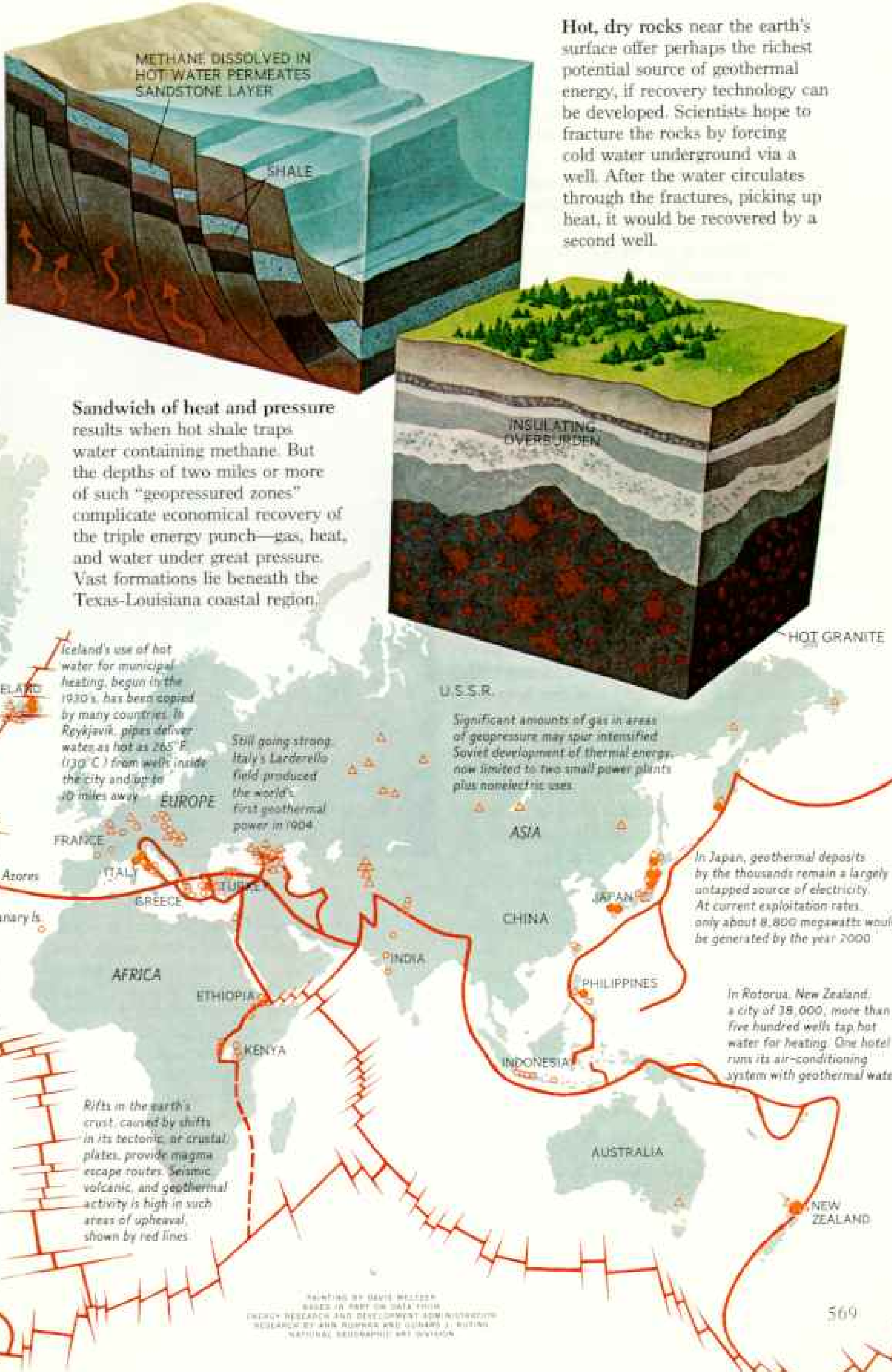
High heat flow from regions of partly melted rock in the earth's upper mantle, about 30 miles deep, warms water that seeps underground. The water then migrates back toward the surface along fractures or returns by well tapping. At the surface it vents as boiling water and steam, which can be harnessed to spin turbines.

Pockets of magma, or molten rock, transfer intense heat to surrounding rocks and water that may be trapped underground. If enough water collects in porous rock "reservoirs," it can be recovered by wells. Attempts to tap the heat of magma directly have been blocked by temperatures as high as 2200° Fahrenheit (1200° Celsius).

Tapping heat from earth's depths

FOUND throughout the world in surprising abundance, geothermal systems vary in makeup but share a common heat source—the natural radioactivity that exists in all rocks. With oil and coal rising in cost and no longer considered inexhaustible, earth's heat offers potential power that intensive development may harness.

A government survey estimates that known geothermal resources in the United States could produce 140,000 megawatts over a life expectancy of 30 years, equivalent to the output of 140 nuclear plants.



Hot, dry rocks near the earth's surface offer perhaps the richest potential source of geothermal energy, if recovery technology can be developed. Scientists hope to fracture the rocks by forcing cold water underground via a well. After the water circulates through the fractures, picking up heat, it would be recovered by a second well.

Sandwich of heat and pressure results when hot shale traps water containing methane. But the depths of two miles or more of such "geopressured zones" complicate economical recovery of the triple energy punch—gas, heat, and water under great pressure. Vast formations lie beneath the Texas-Louisiana coastal region.

Iceland's use of hot water for municipal heating, begun in the 1930's, has been copied by many countries. In Reykjavik, pipes deliver water as hot as 265° F. (130° C.) from wells inside the city and up to 30 miles away.

Still going strong, Italy's Larderello field produced the world's first geothermal power in 1904.

Significant amounts of gas in areas of geopressure may spur intensified Soviet development of thermal energy, now limited to two small power plants plus nonelectric uses.

In Japan, geothermal deposits by the thousands remain a largely untapped source of electricity. At current exploitation rates, only about 8,800 megawatts would be generated by the year 2000.

In Rotorua, New Zealand, a city of 38,000, more than five hundred wells tap hot water for heating. One hotel runs its air-conditioning system with geothermal water.

Rifts in the earth's crust, caused by shifts in its tectonic, or crustal, plates, provide magma escape routes. Seismic, volcanic, and geothermal activity is high in such areas of upheaval, shown by red lines.

PAINTING BY DAVID WILCOX
BASED IN PART ON DATA FROM
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
RESEARCH BY ANN ROONEY AND LENARD J. KUHNS
NATIONAL GEOGRAPHIC ART DIVISION

little hint of that awesome heat, chiefly the result of decay of radioactive elements. Only where the heat leaks through rifts in the crust—in the molten lava of volcanoes, the hot water of geysers and hot springs, or the steam of fumaroles—does man begin to suspect the titanic forces beneath his feet.

Yet most of earth's 260 billion cubic miles of rock are at or above the melting point—about 2200° Fahrenheit (1200° Celsius). Donald E. White of the United States Geological Survey estimates that just the top 6.2 miles (10 kilometers) of the crust hold 3×10^{26} (300 million billion billion) calories of heat.

"We would have to burn 2,000 times the world's entire supply of coal to generate that much heat," says White.

AT A TIME when fossil fuels—especially oil and gas—are becoming increasingly scarce and expensive, and when nuclear power faces an uncertain future, such a prodigious energy source cannot be ignored, even if much of it can never be used. And, indeed, geothermal ("earth heat") energy has become a warm new prospect. At present nine nations have begun tapping that resource to generate electricity. Several, such as Iceland, France, Hungary, and New Zealand, heat homes with the earth's hot water and use the heat for industrial purposes as well.

Of course, no one expects geothermal energy to solve the energy shortage; no single source can do that. Despite the magnitude of the earth's heat, capturing it on a large scale for man's use still presents a number of technological and economic problems.

But a few years from now we may well be scrambling for every kilowatt of power we can get. Geothermal energy may then be more available and very welcome. Already it provides more electricity than the world extracts from the sun's heat or from wind power—two other promising sources.*

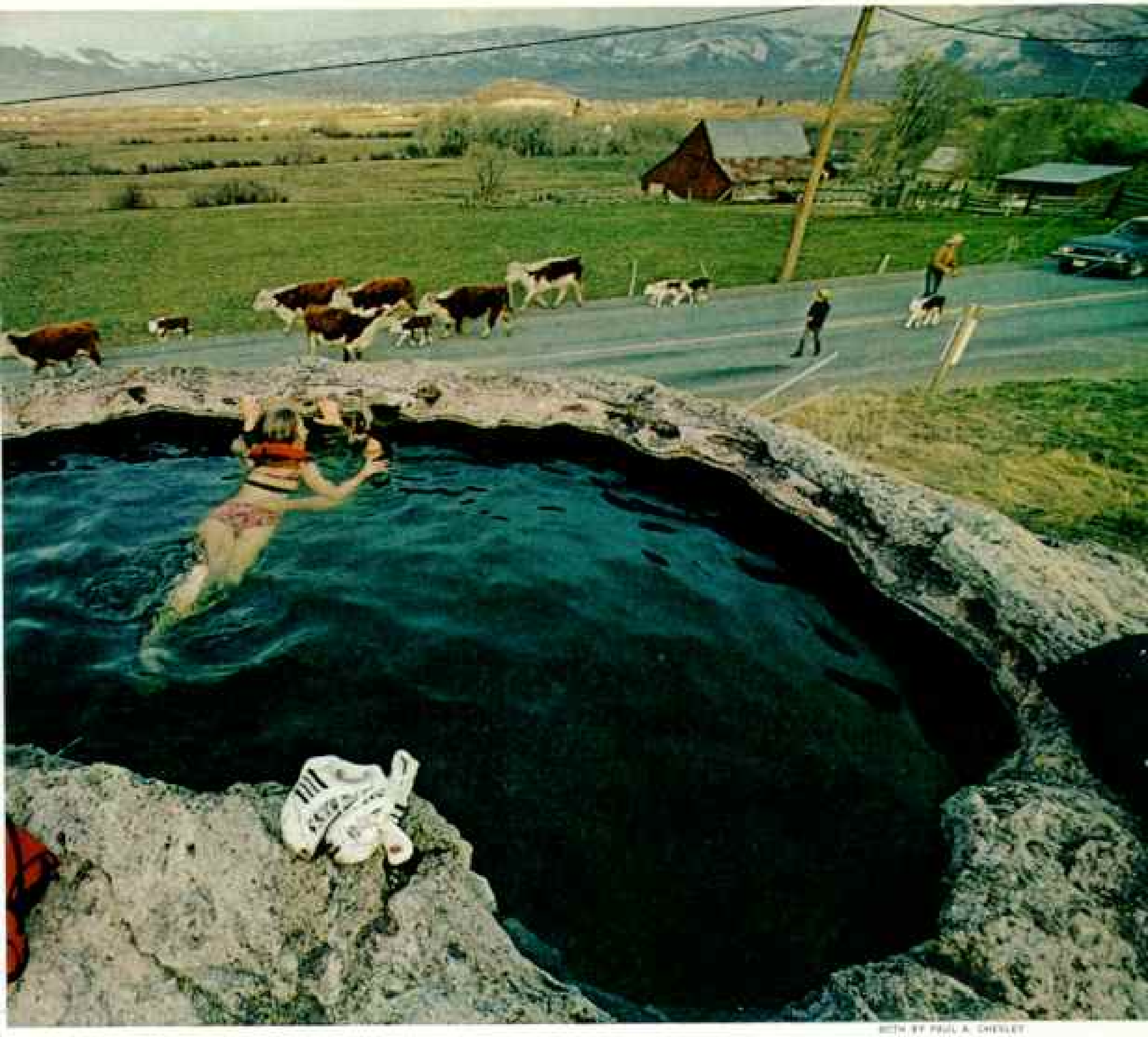
The Federal Government's Energy Research and Development Administration (ERDA)† thinks geothermal energy is so important that the agency has included 101 million dollars in its fiscal 1978 budget to

*See "Solar Energy, the Ultimate Powerhouse," by John L. Wilhelm, NATIONAL GEOGRAPHIC, March 1976, and "Can We Harness the Wind?" by Roger Hamilton, in the December 1975 issue.

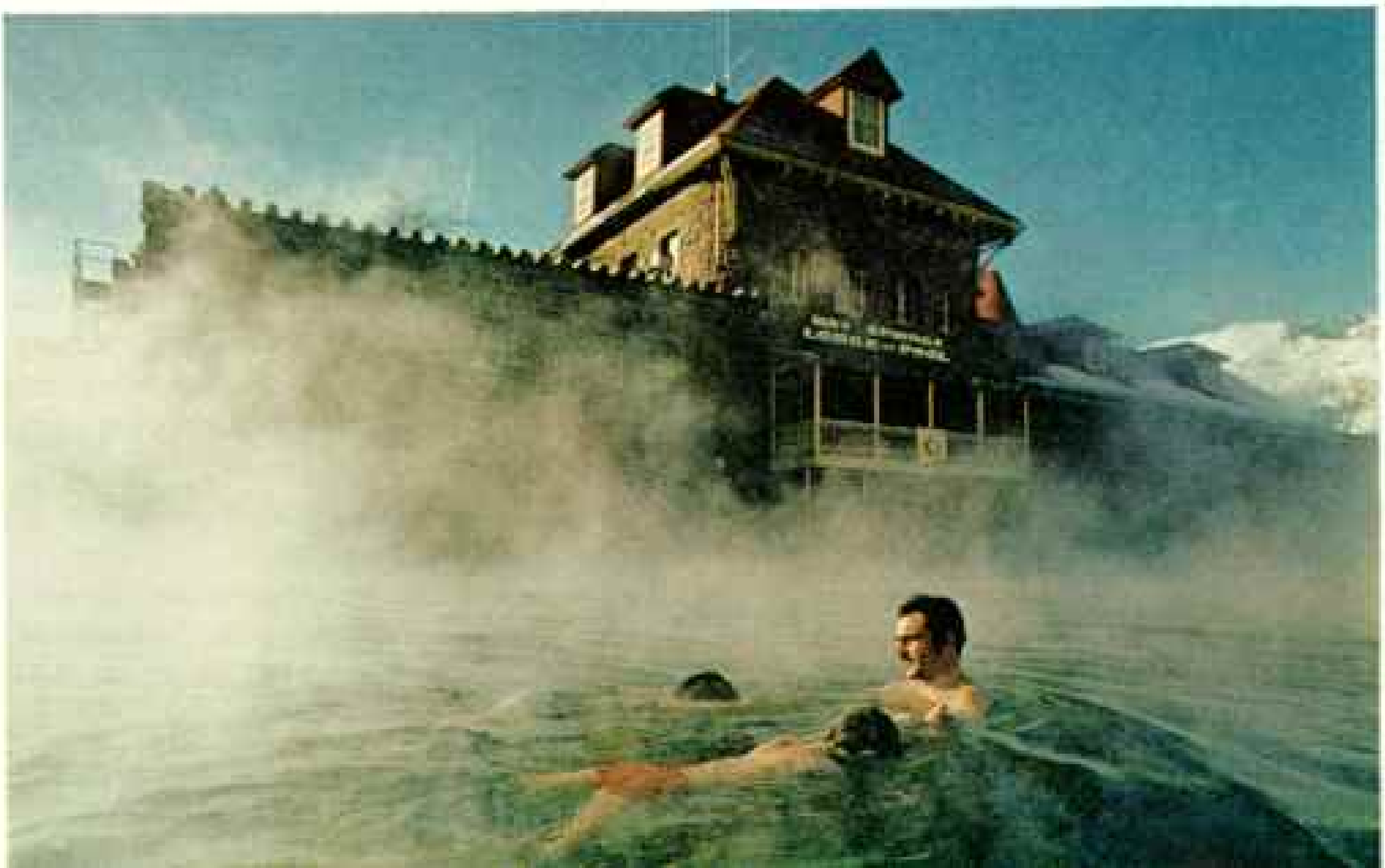
†By the time you read this article, ERDA may have become part of the new Department of Energy.

"It's like a warm bath—you tend to stay in too long and risk having a heat stroke," one diver warned after exploring a thermal spring (**above**) in Utah's Wasatch Range. Dissolved minerals deposited this "hot pot's" volcanolike cone. Temperatures in the region's pools, some 100 feet deep, range from 86°F to an uncomfortable 113°F. Subsurface waters under pressure may exceed 500°F (260°C).

Mineral-rich water throughout the world, such as that piped into Colorado's Glenwood Springs pool (**right**), has been considered healthful since Roman times.



BOTH BY PAUL A. CHEVALIER



encourage development. That's 84 percent more than in fiscal 1977.

And industry is more than mildly interested. In January 1974 the Bureau of Land Management opened up large areas of public lands in the West for geothermal exploration. The demand for leases recalled the frenzy of the Oklahoma land rush. In the first month, nearly 2,500 applications were filed for leases covering 5,280,000 acres in 11 states. Both wildcatters and giant oil companies are beginning to drill on these lands, looking not for oil or gas but for heat.

L. LOUIS MAZZATENTA, NATIONAL GEOGRAPHIC STAFF

Hole-in-the-ground oven will cook pork, kale, and cabbage in three hours for these Azoreans on São Miguel. Metal containers in the bags keep out sulfur—an unpleasant by-product of some geothermal systems.

How much contribution can geothermal energy make? Estimates of its potential in the United States vary widely. Some enthusiasts have suggested that the Southwest could in time get all its energy from geothermal. Some very conservative observers doubt that geothermal could ever provide more than one percent of U. S. power needs.

The truth probably lies between these extremes. A 1975 study by the U. S. Geological Survey foresees 12,000 megawatts (12,000,000 kilowatts) of electricity from hydrothermal reserves, lasting for at least 30 years, at present prices and with current technology. (A thousand megawatts is about the energy needed for a city of a million persons.)

The USGS further estimates that perhaps 12 times this much hot-water energy remains to be discovered in the United States, or awaits higher prices or improved technology before it will be economical to develop.

BY FAR THE SIMPLEST, cheapest, and best form of geothermal energy comes from the ground in the form of dry steam. It can be used directly to drive turbine generators with a minimum of problems.

Unfortunately, dry steam occurs in only a few places. As Morton Smith of the Los Alamos Scientific Laboratory puts it, "Dry steam is a geological freak." But this highly desirable freak is found in Japan and Italy, and in the United States at The Geysers, in California's Sonoma County about 90 miles north of San Francisco.

I found The Geysers after following the tortuous windings of an old stagecoach road deep into the Mayacmas Mountains. Miles of pipelines streaking along the sides of Big Sulphur Canyon, vapor billowing from rows of generating-plant cooling towers, and roaring jets of steam from vent valves gave the valley an awesome appearance (pages 566-7).

The Geysers must have been a frightening place to William Bell Elliott when he discovered its fumaroles in 1847 while hunting a grizzly bear. The explorer-surveyor was overwhelmed by the sight of steam pouring from fissures along the steep canyon.

"I thought I had come upon the gates of hell itself," he told friends.

Today at The Geysers, the Pacific Gas and Electric Company, drawing on a hundred wells operated by Union Oil, produces 500

megawatts of electricity, about half of San Francisco's needs. More wells and new generator units should increase output to about 900 megawatts by mid-1979.

By the 1990's PG and E hopes to develop The Geysers to a level of 2,000 megawatts—almost the capacity of two Hoover Dams or two large fossil-fuel or nuclear power plants.

THE EARTH is stingy with its natural steam. Aside from The Geysers, dry steam has been found in the United States only in Yellowstone National Park, where law forbids development.

But earth's heat is much more readily available in the form of very hot water under pressure. All along the world's earthquake and volcano belts, pockets of magma, or molten rock, have worked their way close to the surface. Water filtering into permeable rock layers above these pockets is heated—often far above the normal boiling point.

Sometimes the superheated water forces its way out as hot springs or geysers. More often, trapped by an impermeable cap rock above it, the water becomes a subterranean caldron under extremely high pressure, waiting to be tapped by wells (diagrams, pages 568-9).

Mexico's Cerro Prieto, not far south of the border city of Mexicali, is a prime example of tapping such a reservoir. As the 570°F water rises to the wellhead, the pressure drops and the water flashes, or boils. About 20 percent turns to steam, which is separated out and piped to the generator turbines. The remaining hot water roars through discharge pipes into large ponds, but it could be used for industrial or household purposes.

Just to the north of Cerro Prieto, in the Imperial Valley of California, I found intensive interest in geothermal water. Signs at the airport predict that this rich agricultural region might become the nation's teakettle as well as its salad bowl.

Oddly enough, were it not for the higher country around it, the Imperial Valley would be an inland sea and therefore worthless for either agriculture or geothermal energy. A flagpole in Calipatria, which advertises itself as the lowest city in the Western Hemisphere, raises its tip 184 feet, to the level the sea would reach if it could get into the valley.

And, strangely, this extremely flat valley, resting upon vast reservoirs of subterranean waters, would be desert were it not for irrigation water brought in from the Colorado River. "Rain for rent" reads the sign of one firm that provides sprinkler systems.

Amid the interminable checkerboard fields of lettuce, cantaloupes, and cotton, the endless rows of baled alfalfa, and the occasional palm trees, evidences of a fledgling geothermal industry are becoming steadily more apparent. At places like Heber and Brawley, Niland and East Mesa, drilling rigs grind day and night searching for hot water. Dozens of completed wells tell of successful searches.

EMORY KRISTOF

Not bad for winter in Iceland! Hothouse tomatoes and other vegetables thrive year round in Reykjavik, where geothermal water has heated homes and buildings for some forty years.


噴気熱

And at Niland, near the Salton Sea, a test facility takes boiling brine from the earth and simulates the conditions of a power plant. This facility, a venture of ERDA and San Diego Gas & Electric in cooperation with the Magma Power Company, tests materials, methods of handling hot brine, and techniques for extracting heat.

I USE THE WORD "BRINE" advisedly, for geothermal waters are sometimes highly saline. Hot water under pressure can dissolve and carry astonishing amounts of salts and minerals from the rocks.

In most places, to be sure, the concentration of such materials is quite low—even much less than seawater's 3.5 percent. But in the Imperial Valley, which holds some of the nation's most important high-temperature geothermal resources, salinity can run high. At Niland it reaches the incredible level of 20 to 30 percent dissolved solids. Such concentrated brine creates major problems. It can be violently corrosive and erosive, swiftly eating away turbine blades and nozzles. Even worse, the minerals precipitate rapidly as temperature and pressure are reduced. I have seen pipes choked by an inch-thick layer of hard rusty scale that deposited in only a few hundred hours of operation.

"The total energy in the Niland area is about equal to the recoverable energy in Alaska's North Slope," an ERDA official, Eric H. Willis, once told me. "But how do you stop it from having arteriosclerosis?"

Until recently these problems seemed likely to block geothermal development in parts of the valley. But new developments alter the prospects.

At the Niland test facility, a four-stage heat exchanger offers one solution. When heat is drawn from the hot brine in several stages

PAUL A. SIDLEY (LEFT) AND NATIONAL GEOGRAPHIC PHOTOGRAPHER GEORGE F. MOBLEY

Land of rising steam, Japan first used geothermal heat for generating electricity at Beppu in 1924. Today the city also taps its extensive fields for heating (**above**), for health spas, and even for restaurant cooking (**left**). Elsewhere in Japan many towns that operate profitable spas oppose geothermal-power development, fearing loss of their springs. Japan also harnesses natural heat for a variety of industrial and agricultural uses, ranging from sulfur-extraction plants to eel and alligator farms.

instead of all at once, and when the pressure is lowered gradually, scaling is sharply cut.

At ERDA's Lawrence Livermore Laboratory near San Francisco, engineers have developed a new process known as "total flow," which uses a well's entire output, liquid and vapor, to drive specially designed turbines. As part of this work, they believe they have solved the scaling problem by treating the brine with hydrochloric acid.

"Under the worst conditions we add only about 200 parts per million to the brine," Roy Austin told me. "This will probably cost less than two-tenths of a cent a kilowatt-hour. And we get absolutely no scaling in the nozzles. They come out so clean we can still see the machine marks. We have also tested materials that appear promisingly resistant under these conditions."

SO FAR THE IMPERIAL VALLEY seems to offer the nation's richest prospects for geothermal hot-water development. Pilot power plants are already on engineers' drawing boards. By the 1980's the industry expects that Imperial Valley electricity will be flowing into the grid, just as it already does at The Geysers.

But the Imperial Valley holds only a few of the 106 geothermal systems in the Western States that have been identified by the Geological Survey as KGRA's (Known Geothermal Resource Areas). Thirty-seven of these yield water at temperatures above 300°F—hot enough for electric-power generation.

For example, near Los Alamos, New Mexico, the Union Oil Company has brought in a number of productive wells inside the Valles Caldera, an enormous volcanic basin some 13 miles across. Union is now negotiating with potential purchasers of the steam.

Around Roosevelt Hot Springs in southwestern Utah, five major companies and several smaller ones are probing a very important new reservoir. On the slopes above an ancient lake bed, amid sagebrush, yellow-flowered rabbit bush, and juniper, drill rigs are sprouting and geologists are measuring heat flow and electrical properties to find likely spots for wells.

At places on this Utah site, one does not have to go far below the surface to find evidence of heat. On one claim I found a prospector's trench scooped into the bank of a wash. Idly curious, I stooped over to scratch at the bottom of the trench. I had flicked away no more than half an inch of soil when I jerked my hand back. I had burned my fingers as surely as if they had touched a hot kettle.

Temperatures of the water from some of the Utah wells exceed 500°F (260°C). But geothermal water in many other places is nowhere near as hot—not even up to the 300°F regarded as minimum for efficient production of electricity. Can these cooler waters be used?

I FOUND abundant answers in Iceland, whose volcanic hills and rifts lie directly on the Mid-Atlantic Ridge (map, pages 568-9). There, where upwelling magma is steadily forcing apart the crustal plates, the inner fires of earth are always close at hand.*

When the Vikings first approached Iceland, they saw geothermal steam rising from the area now occupied by Reykjavik. They thought it was smoke; hence the name Reykjavik (Smoking Bay).

As recently as three decades ago, Reykjavik was indeed smoky. Early photographs show it as a filthy, black-stained town shrouded by smoke from coal fires.

Then geothermal energy came to the rescue. Today virtually all the buildings in the Reykjavik area are heated by geothermal water. Some 115,000 persons enjoy one of the cleanest cities in the world.

Simple sheds covering the wellheads, a few low storage tanks, and raised concrete conduits carrying the major pipelines are the only outward evidence of this splendid heating system. The cost? The average householder pays from 130 to 160 dollars a year for heating and hot water—on an island that touches the Arctic Circle!

With two scientists from Iceland's National Energy Authority—Dr. Stefán Arnórsson, a geochemist, and Dr. Kristján Saemundsson, a geologist—I visited other communities in Iceland whose very existence depends on geothermal springs and wells.

Our road traversed a huge lava flow and we passed between volcanic hills that had pushed up under the ice sheet some 20,000 years ago. We saw fumaroles steaming in the snow and little Icelandic ponies standing with their tails to the wind.

*See "This Changing Earth," by Samuel W. Matthews, NATIONAL GEOGRAPHIC, January 1973.

Dropping below an escarpment, we came into the valley town of Hveragerdi (Garden of Hot Springs). A thousand souls have settled here since the first house was built in 1928. As in most geothermal towns, escaping steam is ever present. At the center of town, a violently boiling hot spring and an abandoned borehole that erupts at intervals are fenced off for safety.

Large greenhouse complexes make efficient use of Hveragerdi's geothermal water. I visited one owned by Ingimar Sigurdsson. Outside, the sharp winds of February had slashed through my coat; inside, I found springlike temperatures.

The gardener picked a rosebud from one of 50,000 plants. "I'll have blooms," he said, "from now till mid-December."

The borehole for the greenhouse goes down only 2,000 feet, he told us. Water and steam come up without aid of pumps or electricity. The rejected water goes into the river after heating a swimming pool.

DR. ARNÓRSSON told me that Iceland is turning its natural heat more and more to purposes other than space heating. One farmer we visited, for example, uses hot water to heat air to dry his hay.

In the northern part of the island, an industrial plant takes diatomaceous material from a lake bed, dries it with geothermal steam, and produces diatomite for use in filters, insulation, and other industrial purposes.

In addition, Iceland is beginning to develop hot water for electric power. Since much of the water is below 300°F (150°C), and thus will not produce efficient amounts of steam, the Icelanders have considered using the vapor-turbine cycle technique: The water would heat low-boiling-point liquids such as Freon and isobutane, and the resulting vapor would drive the turbine generators.

This technique is being used successfully on the Soviet peninsula of Kamchatka in the northwest Pacific Ocean to supply power to the Paratunka State Farms.

Geothermal heating in the United States goes back even further than in Iceland. Some 350 households in Klamath Falls, Oregon, have long had individual hot-water wells. In Boise, Idaho, homes along Warm Springs Avenue have drawn hot water from a central well for nearly a century. And today, in Boise, the Idaho state government is considering the investment of more than three million dollars to bring geothermal hot water to heat the state university, the capitol, and a number of other state buildings.

TWO ESPECIALLY RICH SOURCES of geothermal energy glimmer in the future, if they can be developed economically.

One, known as "geopressured zones," involves large hot-water reservoirs in the Texas-Louisiana area, both onshore and off. These hot waters, at depths of two to three miles, are trapped below thick sedimentary deposits under abnormally high pressures.

Drilling in such areas is difficult and costly. But dissolved in the waters are vast amounts of methane—the chief ingredient of the natural gas we sought so avidly during the deep freeze of last winter. It is estimated that the potential of the geopressured resource is as much as 115,000 megawatts for 30 years, with the methane of equal value for power. (Total U. S. power capacity last year was about 550,000 megawatts.)

As prices for other forms of energy rise, it may become economically profitable to extract geopressured water and gas.

The other far-out possibility is called "hot dry rock." It refers to many regions of heated rock near the surface that lack reservoirs of water to carry away the heat. Such deposits, much more common than the hot-water reservoirs already being exploited, are found even in the eastern U. S.

Scientists at the Los Alamos Scientific Laboratory in New Mexico believe that this heat can be tapped with water from the surface. Their technique is to force cold water down a well to cause the heated rocks to fracture, circulate the water through the network of fractures, then bring it back to the surface through a second well.

To test this idea, the Los Alamos scientists have been making test drills on the Jemez Plateau near the Valles Caldera. Two holes 250 feet apart, reaching depths of approximately 10,000 feet, have been successfully connected. Fracturing experiments to increase the hot-rock area exposed to the water flow seem promising.

Like all other energy sources, geothermal offers both advantages and disadvantages. On the plus side, it is relatively clean, there is

no fuel to buy, and the reserves (of hot water, if not of steam) are thought to be long lasting.

On the negative side, critics note that the best geothermal deposits seem to be localized in the West. However, recent discoveries point to rich potential in the eastern United States as well.

Further, the capital investment for developing geothermal energy is high, and, under present taxes and regulations, prospecting is somewhat limited. The Federal Government is meeting this problem in part by providing for government-guaranteed loans and tax credits.

Then there is the problem of subsidence. If large amounts of water are drawn out of the earth, will the earth sink in that area? The answers are uncertain, and some geothermal plants avoid the problem by injecting the water into wells after extracting its heat.

Finally, there is the problem of pollution. The odor of rotten eggs hangs over some geothermal sites because of hydrogen sulfide gas. More serious is the presence of poisonous

Wildcatter's dream: Steam from Chile's El Tatio field (**left**) eventually may produce electricity and two valuable by-products: the metal lithium, used in nuclear reactors and metallurgy, and water that can be desalinated.

GEORGE F. MOBLEY (LEFT); LAWRENCE LIVERMORE LABORATORY (BELOW); AND UNITED NATIONS CENTRE FOR NATURAL RESOURCES, ENERGY, AND TRANSPORT

Energy treasure map, an enhanced infrared image (**above**) helped U. N. experts assess the geothermal potential of Ethiopia's Great Rift Valley. Hottest areas within the 2.3-mile-wide ring are orange, coolest are blue.

Briny flow from a geothermal well quickly clogs a 9/10-inch pipe (**right**); scientists at Lawrence Livermore Laboratory in California fight it by adding hydrochloric acid. Such techniques may open new areas to development, including parts of California's Imperial Valley.

arsenic and boron in geothermal waters. But this problem is usually avoided if waste waters are re-injected into wells.

All things considered, then, mining the earth for heat may offer a highly desirable substitute for gas and oil in the not too distant future.

WHEN EXPERTS TALK about enormous amounts of energy, they often use the term "quads." One quad is a quadrillion (10^{15}) British thermal units, or BTU's. The United States last year used on the order of 74 quads of energy.

I asked Dr. Robert C. Seamans, Jr., then head of ERDA, how he evaluated the contribution of geothermal energy in quads.

"By the year 2000," he said, "geothermal energy might well amount to as much as four quads, and by 2020 as much as fourteen quads. That may not sound like much, but if you think of it in terms of oil, every two quads a year represents a million barrels a day."

And that's not peanuts! □

See America's history unfold right before your eyes...

. . . in Jamestown and Colonial Williamsburg . . . on the battlefields of the Revolution and the Civil War . . . in graceful mansions of the Old South . . . along wagon trails worn by westbound pioneers . . . in the President's box at Ford's Theatre . . . at such legendary places as the graveyard at Sleepy Hollow in the Hudson Valley and the O.K. Corral in Tombstone, Arizona . . .

These and hundreds of such historic sites have been preserved or reconstructed to allow you to see our yesterdays today.

And this brand-new holiday-of-a-book from National Geographic will be your guide!

Seven Colorful Sections!

- Footholds in a New World
- The Colonial Frontier
- In Pursuit of Liberty
- Americans Spread Out
- Hallowed Ground
- Taming the West
- Mechanizing a Nation

SPECIAL LIMITED-TIME PRICE*

Only $11.95

*After Dec. 31, 1977, price will be $12.95

Twenty-one Picture Stories!

When we gave National Geographic photographers and writers the assignments to cover such colorful places as restored Williamsburg, Virginia, and Old Salem, North Carolina, we knew they would come up with exciting picture stories!

Now *Visiting Our Past* presents twenty-one of these entertaining photo-tours to guide you through America's historylands.

Jamestown • Plymouth • New England Puritans • Williamsburg • Tidewater Plantations • The Colonial Southland • Boston to Bunker Hill • The World of George Washington • Wealth From the Sea • Santa Fe to San Francisco • Sumter to Appomattox • Travels With Lincoln • Gold Fever • The Cow Town • and seven others!

400 pages
Hardbound
8½″ x 10¾″
Bonus travel guide booklet included!

DETACH HERE

Take advantage of this limited-time offer now!

Yes, please send me a first-edition copy of *Visiting Our Past*—along with the bonus *Supplemental Guide to Selected Sites*. During this special, limited-time offer bill me just $11.95* plus postage and handling, at time of shipment. If not satisfied, I may return this book without payment.
**After December 31, 1977, the price will be $12.95.*

00003

NAME (please print; do not use mailing label)

ADDRESS

CITY, STATE, ZIP 1961

California and Maryland residents please add applicable sales or use tax.

Complete order form; remove flap from magazine; then fold on line, staple or tape, affix stamp, and mail.

Please place stamp here

National Geographic Society
Post Office Box 1640
Washington, D. C. 20013

Pack your suitcase, or settle back into your armchair...

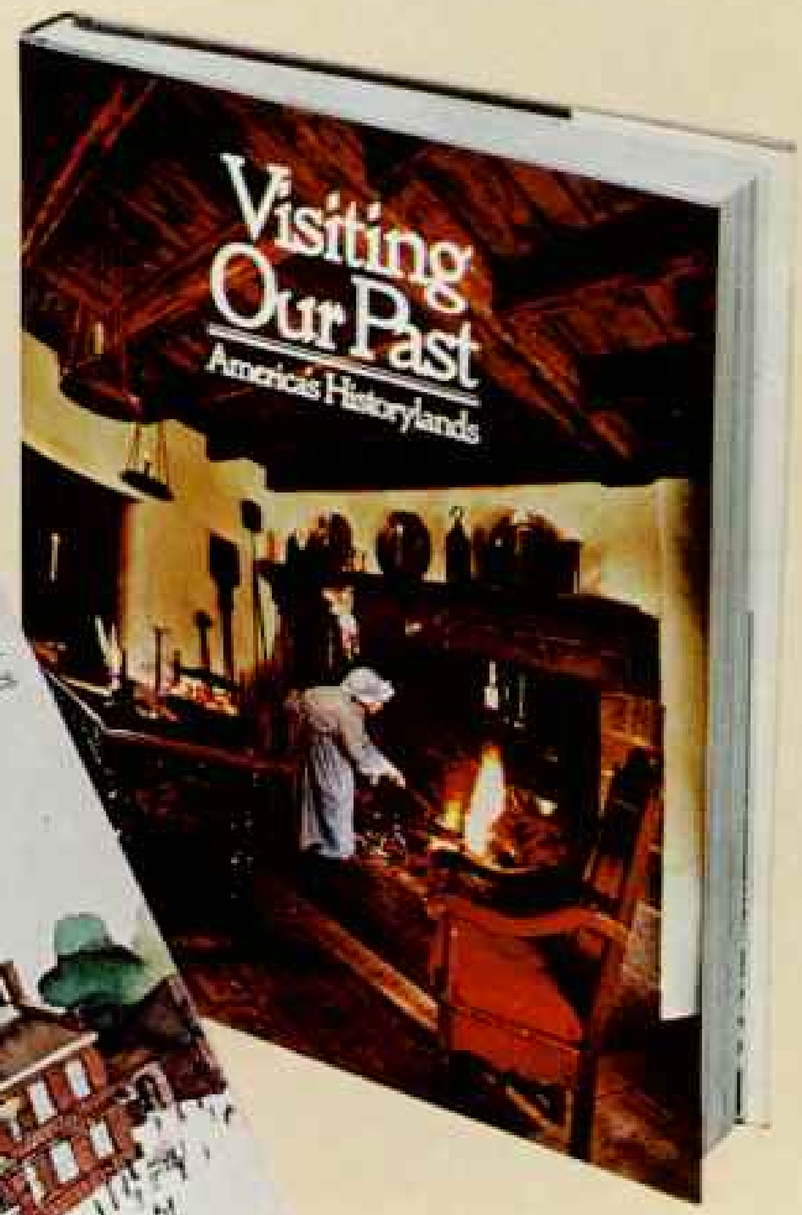
Either way, this new book from National Geographic is going to guide you to America's living history!

The legendary Plymouth Rock; the Virginia plantations of Washington and Lee; the John Alden House in Duxbury, Massachusetts; the Shaker village at Pleasant Hill, Kentucky; Sutter's Mill in California; a bullet-scarred mission called the Alamo . . .

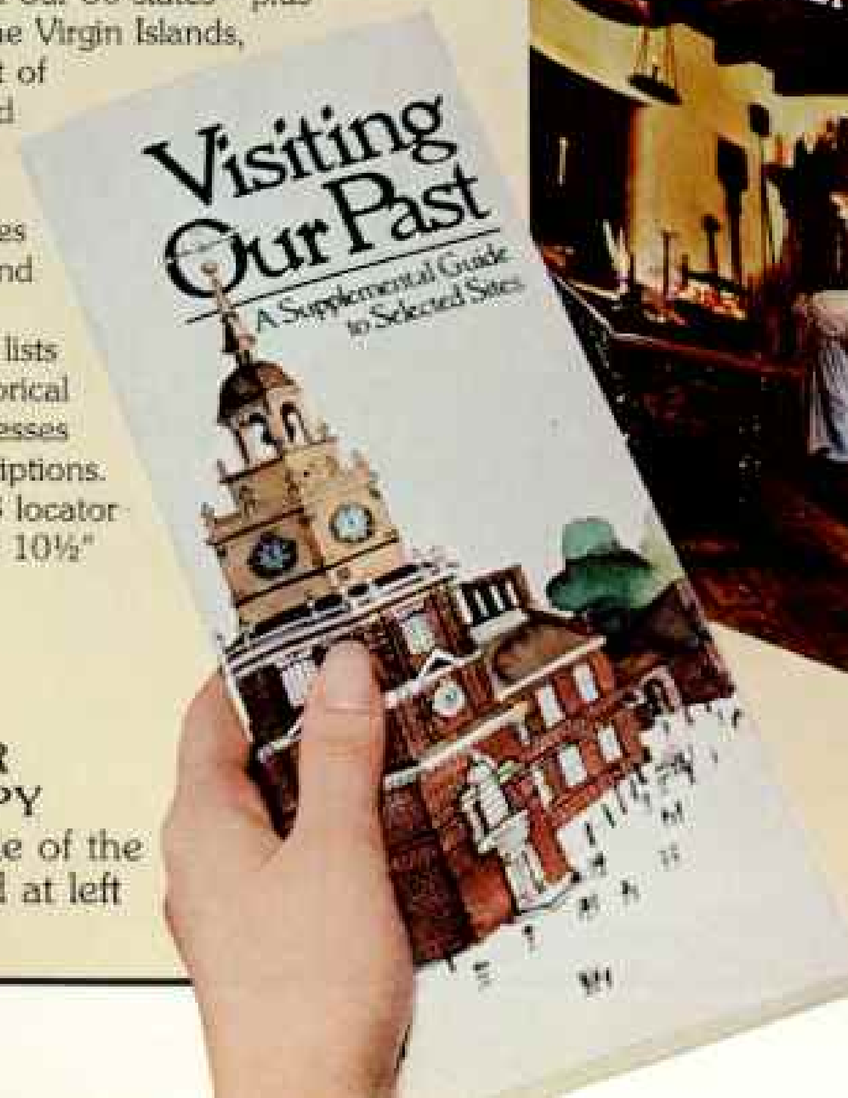
. . . just a few of the fascinating places you'll visit in the pages of National Geographic's new book, *Visiting Our Past: America's Historylands.*

And you'll enjoy pageants and reenactments . . . monuments and shrines—hundreds of exciting people, places, and things that bring the sweeping story of America's past to life!

Introduction by Daniel J. Boorstin—historian and Librarian of Congress.
Seven Colorful Sections—each introduced with an informative article by an expert historian.
Twenty-one Illustrated Chapters—colorful photographs of places you can visit, with information about each.
Five Illustrated Maps—pinpoint preserved homes and churches that you can see or tour.
Detailed Index.
Special Portfolio, "Freedom's Capital"—shrines and monuments in Washington, D. C.
400 Pages • 413 Full-color Illustrations • Large 8½" x 10¾" format.



Plus, a bonus booklet! *A Supplemental Guide to Selected Sites.* Open this pocket-size guide to any of our 50 states—plus Puerto Rico, the Virgin Islands, and the District of Columbia—and at a glance you'll discover additional places you can visit and explore. This handy booklet lists some 400 historical sites with addresses and brief descriptions. 64 pages • 53 locator maps • 4¼" x 10½"



TO ORDER YOUR COPY
use the inside of the flap attached at left

NATIONAL GEOGRAPHIC SOCIETY

WASHINGTON, D. C.

Organized "for the increase and diffusion of geographic knowledge"

GILBERT HOVEY GROSVENOR
Editor, 1899-1954; President, 1920-1954
Chairman of the Board, 1954-1966

THE NATIONAL GEOGRAPHIC SOCIETY is chartered in Washington, D.C., in accordance with the laws of the United States, as a nonprofit scientific and educational organization for increasing and diffusing geographic knowledge and promoting research and exploration. Since 1890 the Society has supported 1,442 explorations and research projects, adding immeasurably to man's knowledge of earth, sea, and sky. It diffuses this knowledge through its monthly journal, NATIONAL GEOGRAPHIC; supplement maps distributed to members; its books, globes, atlases, filmstrips, and educational films; *National Geographic WORLD*, a magazine for children age 8 and older; information services to press, radio, and television; technical reports; exhibits from around the world in Explorers Hall; and a nationwide series of programs on television.

Articles and photographs of travel, natural history, and expeditions to far places are desired. For material used, generous remuneration is made.

NATIONAL GEOGRAPHIC MAGAZINE

POSTMASTER: Send change of address form 3579 to National Geographic, 17th and M Sts. N.W., Washington, D. C. 20036.

To become less dependent on foreign oil, we need more than American oil. We need American energy.

In the last few years, America's dependence on oil from other countries has increased to more than 40 per cent, and is still growing.

One way to reduce that dependence is to conserve energy—to use it more wisely and efficiently.

And while companies such as Conoco continue to search for more domestic petroleum, it's imperative that we also develop other kinds of energy.

For example, there's enough coal and uranium in the U.S. to meet our energy needs until solar power and other fuels of the future can begin to play a significant role.

We think it's a good thing that Conoco has the skilled people and the financial strength to go beyond petroleum—into coal, uranium and newer forms of energy.

That's the best way to reduce our dependence on foreign oil.

conoco

Doing more with energy.

To learn more about what we're doing with energy, write Dept. D, Continental Oil Company, Stamford, Conn. 06904.

For more than 75 years,
the name Cadillac has stood for excellence.
Calling something "the Cadillac of its field"
is one of the finest compliments you can pay a product.
Through the years . . . in each generation . . . there
has been a Cadillac right for its day.
And now there is a new breed
of Cadillac . . . superbly luxurious, yet
engineered for the changing
world of today. Announcing . . .

Cadillac 1978

Behind the great name...

...a great car.

A car of classic elegance—with all the comfort, all the luxury, all the quality you expect of Cadillac. And yet, the 1978 Fleetwood Brougham (pictured), Coupe deVille and Sedan deVille are beautifully agile. Responsive. Lively. Maneuverable.

It's luxury all the way—but luxury you can feel good about. Because Cadillac 1978 is engineered for the changing world of today—while preserving traditional Cadillac legroom and headroom.

The luxury leaders have arrived. See them. Drive them. And for another kind of luxury, there's Seville by Cadillac. And the 1978 Eldorado with front-wheel drive and a flair all its own.

At your Cadillac dealer now.

Cadillac 1978

THIS BE ROY MOORE (ABOVE) AND DAGMAR I. WERNER

Is this another species doomed to disappear?

POISED ON A LAVA BED, a Galapagos land iguana can serve as a table for a tick-eating finch—or as a meal for cats and dogs gone wild. A century ago the giant, cactus-eating lizards swarmed across much of the Galapagos Islands' harsh terrain. Today they survive only as isolated populations—victims of rapacious introduced life.

Assisted by a National Geographic Society grant, German-born zoologist Dr. Dagmar I. Werner has accepted the challenge of studying the life habits of these endangered reptiles. Camping for weeks at a time on the wild, uninhabited island of Fernandina, Dr. Werner now carries her study to the rim of a still-fuming volcano. Contribute to the success of such timely research. Nominate a friend for membership today.

NATIONAL GEOGRAPHIC SOCIETY MEMBERSHIP

$8.50 CALENDAR YEAR 1978 MEMBERSHIP DUES INCLUDE SUBSCRIPTION TO THE NATIONAL GEOGRAPHIC

ANNUAL DUES in the United States and throughout the world are $8.50 U. S. funds or equivalent. To compensate for additional postage and handling for mailing magazine outside the U.S.A. and its outlying areas, please remit: for Canada, $11.00 Canadian or $10.45 U. S.; for the British Isles, Australia, and New Zealand, $12.80; for all other countries, $12.35 by U. S. bank draft or international money order. Eighty percent of dues is designated for magazine subscription. Annual membership starts with the January issue.

EIGHTEEN-MONTH MEMBERSHIP. Applicants who prefer delivery of their NATIONAL GEOGRAPHIC to start with the July 1977 instead of the January 1978 issue may upon request become members and receive the magazine for 18 months from July 1, 1977, through December 1978. Upon expiration, such memberships will be renewable annually on a calendar-year basis. For 18-month membership check here: ☐ and remit: for U. S. and its outlying areas, $12.75 U. S. funds or equivalent; for Canada, $16.53 Canadian or $15.70 U. S.; for the British Isles, Australia, and New Zealand, $19.20; for all other countries, $18.55 by U. S. bank draft or international money order.

LIFE MEMBERSHIP is available to persons 10 years of age or older. The fee for U. S. (including its outlying areas) is $200 U. S. funds or equivalent; for Canada, $210 Canadian funds ($200 U. S. acceptable); for all other countries, $250 by U. S. bank draft or international money order.

Mail to: The Secretary
National Geographic Society
Post Office Box 2895
Washington, D. C. 20013

CHECK ONE

I WISH TO JOIN the NATIONAL GEOGRAPHIC SOCIETY and enclose my dues $_____ ☐

(FILL IN NAME AT LEFT.)

(GIFT MEMBERSHIP) I nominate and enclose $_____ for dues of the person named at left. ☐

Send gift card signed: _____

I NOMINATE for Society membership the person named at left. (Use separate sheet for additional nominations.) ☐

NEW MEMBER _____
PRINT NAME OF AN INDIVIDUAL ONLY (MR., MRS., MISS, MS.)

STREET

CITY, STATE, ZIP CODE

MY NAME _____
PLEASE PRINT (MR., MRS., MISS, MS.)

STREET

CITY, STATE, ZIP CODE

21977

Why do so many women worry about vitamins when they're pregnant, and stop when they're not?

If you've ever been pregnant, or plan to have a baby someday, you should know how important good nutrition is to health.

Pregnant women have substantially lower vitamin levels than their fetuses. This is because the growing, unborn child gets its nourishment directly from its mother's blood. So, while the fetus is getting the lion's share of vitamins, its mother is coming up short.

Before and after birth: nutrition counts.

One third of all pregnant women also have a folic acid vitamin deficiency, a condition that could lead to certain forms of anemia.

There is also evidence that poor nutrition in a pregnant woman can affect the transfer of nutrients to the fetus.

Because of the importance of vitamins during pregnancy, the Food & Nutrition Board of the National Academy of Sciences recommends a vitamin intake increase of 25 to 50%.

Even after birth, vitamins are important. Nursing mothers who are not receiving adequate nutrition suffer a reduction in milk. On the other hand, an increase in the mother's vitamin intake rapidly raises the level of vitamins in her milk.

Vitamins are essential to everyone's life and health.

It's very possible to come up short on vitamins over a period of time with gradual depletion of body stores. Then, once levels are significantly depleted, noticeable symptoms can result. You can lose your appetite and then body weight. Often increased irritableness, sleeplessness or constant drowsiness occur. Lowering of vitamin levels over extended periods can change your body's chemistry and, in turn, result in abnormal metabolism.

You don't have to be pregnant to need extra vitamins.

If you take birth control pills you could need extra folic acid, B_1, B_2, B_{12} and up to ten times the normal amount of vitamin B_6.

This has been confirmed in several studies. However, your own physician should be consulted.

Men as well as women may need extra vitamins.

If you drink, smoke, diet or happen to be sick, you may be robbing your body of vitamins.

There are a variety of ways to make sure you get enough vitamins. First, eat a balanced diet and look at the nutritional labels of the foods you buy. Today, many foods are vitamin enriched or fortified.

To be sure, you can take vitamin supplements daily. There are a number of different formulations including multiple vitamins and B complex with C, as well as supplements of individual vitamins.

Vitamin Information Service, Hoffmann-La Roche Inc., Nutley, New Jersey 07110.

ROCHE

Your health is our concern.

Rowan and Martin explain how the GE Weathertron® Heat Pump can cut your bill for ordinary electric heat 30-60%.*

1. **Dan:** The General Electric Weathertron heats your home in the winter, cools it in the summer.
Dick: Like a furnace and an air conditioner in one.

2. **Dan:** Even on cold days, there's heat in the outside air. The Weathertron extracts this heat and pumps it into the house.
Very often, that's all it takes to heat a house.
Dick: And no gas or oil shortage to worry about.

3. **Dan:** Then in the summer, it works in reverse—it's an air conditioner—pumps heat from inside the house to the outside.
Dick: Keeps you comfortable all year round.

4. **Dan:** *Saves you 30-60% on your heating bill—compared to ordinary electric heating, depending on where you live.
Dick: Makes perfect sense to me.

For more information, write to General Electric, Appliance Park, Bldg. 4, Room 206A, Louisville, Ky. 40225.

GENERAL ELECTRIC

THE WORLD'S GREAT ART FROM THE WORLD'S GREAT MUSEUMS

in 24 karat gold on sterling silver

An extraordinary collection of one hundred beautifully sculptured art medals portraying the greatest masterpieces from the world's most famous museums.

Subscription deadline: October 31, 1977

The Louvre in Paris. *The Hermitage* in Leningrad. *The Rijksmuseum* in Amsterdam. *The Prado* in Madrid. *The Uffizi* in Florence. *The Royal Museum* in Brussels. *The National Gallery* in London. *The Egyptian Museum* in Cairo. *The Acropolis Museum* in Athens. *The Metropolitan* in New York . . .

These are the greatest museums in all the world. Each one the home of priceless art treasures that are acclaimed and admired as the finest masterpieces ever created—the crowning achievements of man's artistic genius.

And now, the greatest works of art from the world's great museums will be captured for all time in a unique and enduring form. One hundred works of power and perfection—masterpieces of every kind, from every era and every part of the world—captured forever in a magnificent new collection of finely sculptured art medals.

MICHELANGELO: THE PIETA · St. Peter's/The Vatican

Masterpieces—selected by a distinguished panel

The works of art to be portrayed in this collection have been selected by an independent international panel of eminent scholars and art historians. And their choices are the result of careful and totally objective consideration—one hundred of the most significant and stirring works of art ever created. Timeless masterpieces of every kind, from every major period in the glorious history of art—*the very best* that the great museums have to offer . . .

Rembrandt's haunting *Self-Portrait in Old Age*, from London's National Gallery. Van Gogh's beautiful and serene still life, *Irises*, from The Metropolitan Museum of Art. The exotic *Flying Horse of Kansu*, sculptured over two thousand years ago and now displayed in Peking's Imperial Palace; Michelangelo's *Pietà*, from the Vatican collection. The divine *Venus de Milo* from The Louvre. Dürer's powerful woodcut *The Four Horsemen of the Apocalypse*, from the British Museum. And masterpieces by Leonardo da Vinci, Titian, Goya, Vermeer, Botticelli, Rubens, Raphael, Velazquez, Renoir, Rodin—the supreme masters of every age.

In all, 100 immortal works of beauty and power. Works that have profoundly shaped the history of art and inspired millions of people throughout the world. And *each* will be beautifully and sensitively interpreted in the medium of fine medallic art.

Exquisite art medals of precious gold and silver

These exquisite art medals will be meticulously crafted by the master sculptors and engravers of The Franklin Mint—renowned throughout the world for the beauty and fidelity of their medallic art. Thus, each of these medals will capture the very *essence* of the work portrayed.

Those who act promptly have the opportunity to acquire this beautiful Mint Edition in 24 karat gold electroplate on sterling silver. Furthermore, subscribers will be able to acquire this collection at the convenient and systematic rate of one medal per month. And the original issue price of $29.50 for each precious gold on sterling silver medal will be *guaranteed* for every medal in the series.

To possess these fine art medals is to own a collection of great meaning and lasting beauty. A treasury of fine art in precious metal, drawn from the fabulous art treasures of the world's most famous museums.

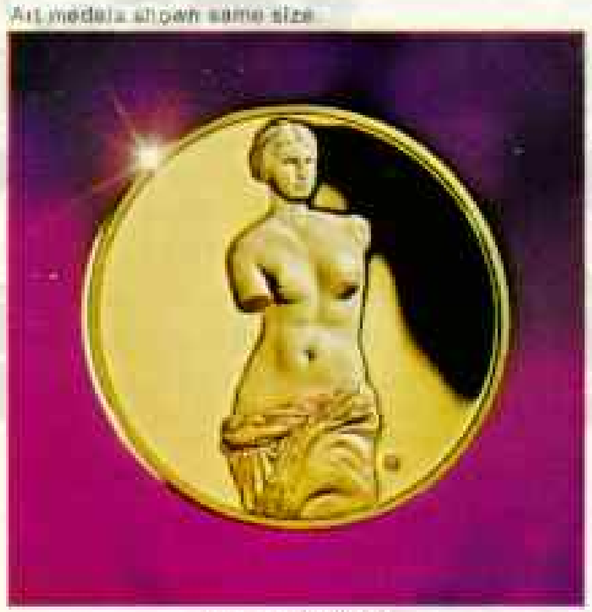
Such a collection will be a never-ending source of inspiration and cultural enrichment for the collector and his family. For as you study these magnificent medals, you and your loved ones will gain an ever deeper appreciation of the greatest artistic geniuses who ever lived—and their immortal masterpieces.

Subscription deadline: October 31, 1977

This exceptionally desirable Mint Edition of *The World's Great Art from the World's Great Museums* is being made available for a very limited time. To be accepted, the coupon below must be mailed no later than October 31, 1977. Please note, however, that no subscriber may acquire more than one set in this strictly limited Mint Edition.

It is not necessary to send any payment at this time. Each of the medals will be billed to you, individually, prior to its shipment. But please be sure to mail your coupon by October 31st.

Art medals shown same size



VENUS DE MILO
The Louvre, Paris

SELF-PORTRAIT IN OLD AGE / Rembrandt
The National Gallery, London

MAY 3, 1808 / Goya
The Prado, Madrid

Give a college freshman our keys to success.

If you think you can't measure success in terms of typewriters, pay attention.

Over three quarters of the families making at least $20,000 a year own a typewriter.

And for the last twenty years the electric portable they've consistently bought more than any other is Smith-Corona.*

Why?

Well it could be because no other portable typewriter has our patented Cartridge Ribbon System which allows you to change ribbons and correct mistakes in seconds.

There are a lot of portables on the market but only a Smith-Corona is a Smith-Corona.

So be careful.

It may be *summa cum laude* tomorrow, but it should be *caveat emptor* today.

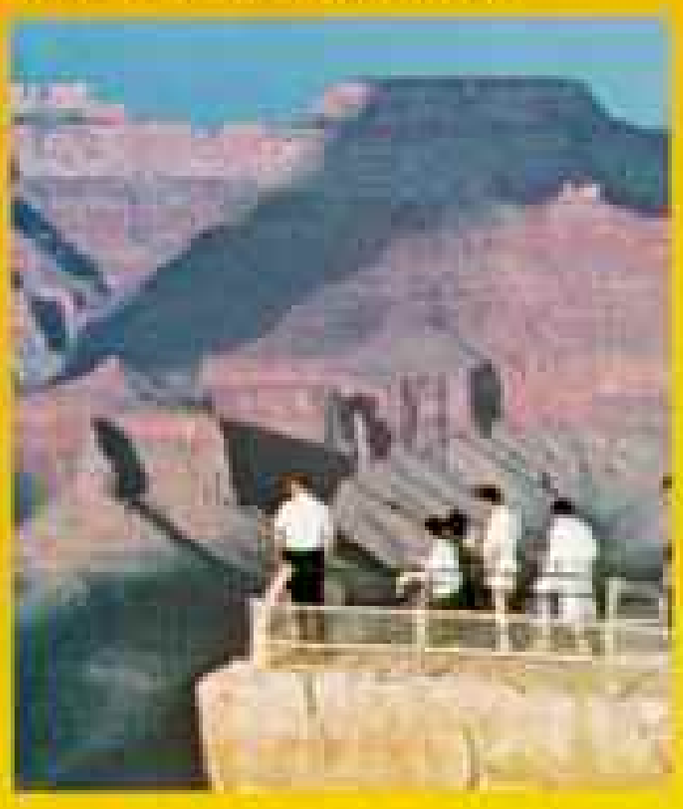
Smith-Corona's patented snap-in cartridge

SCM SMITH-CORONA
SCM CORPORATION

Arizona

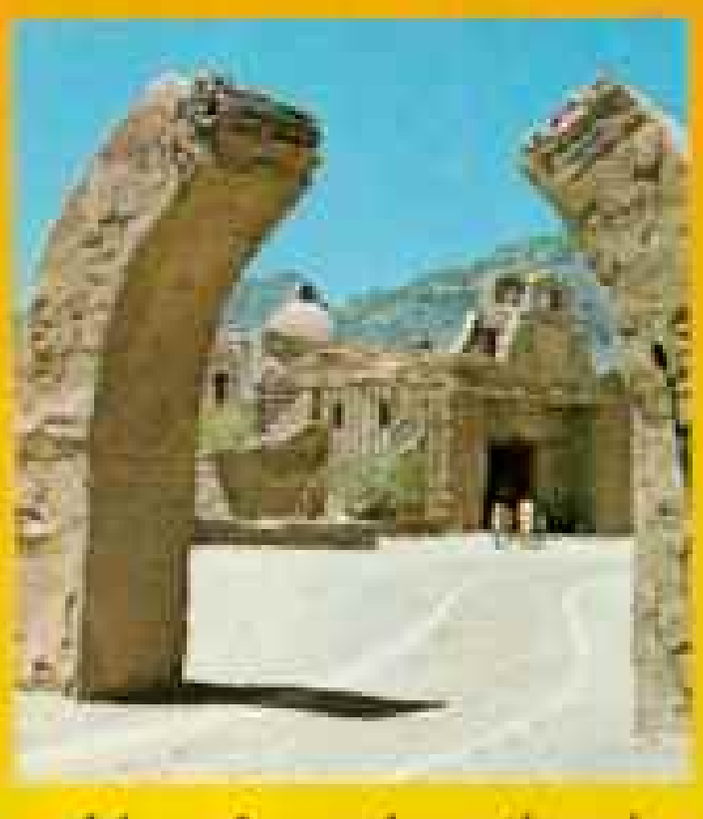
Within a few hours of where you are right now is one of the most extraordinary vacation places in the world.

A place with more sunshine than just about anywhere. (Over 310 sunny days a year. With an average maximum temperature of 77 degrees.)

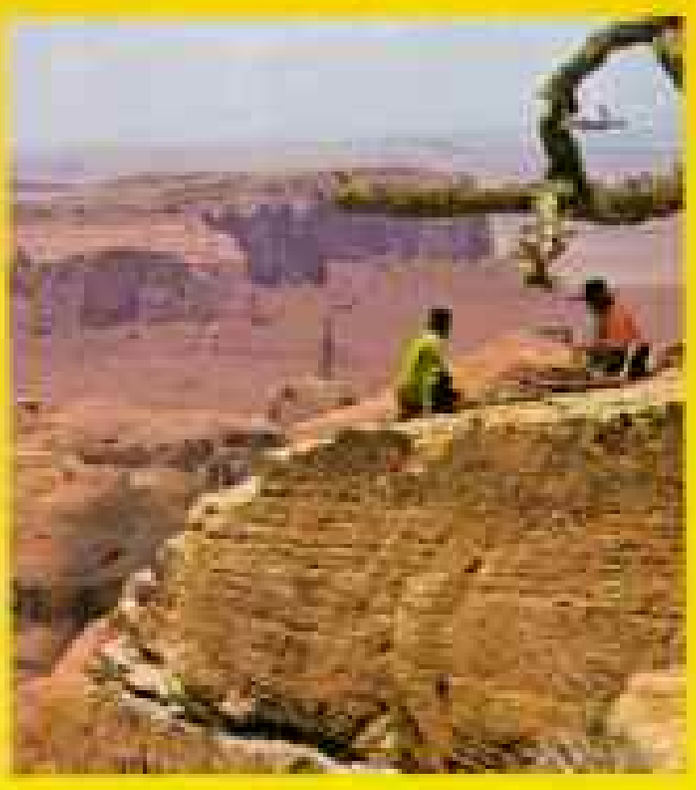


A place with more than 100 golf courses, from sea level to 8,000 feet. Tennis ranches that rank among the best in the world. Camping and spectacular trails to ride and hike. Trout streams to fish. Mountain slopes to ski. Indian villages to explore. Quiet lakes to sail.

There's rodeo. Races. Championship football. NBA basketball. Major league baseball in spring training.



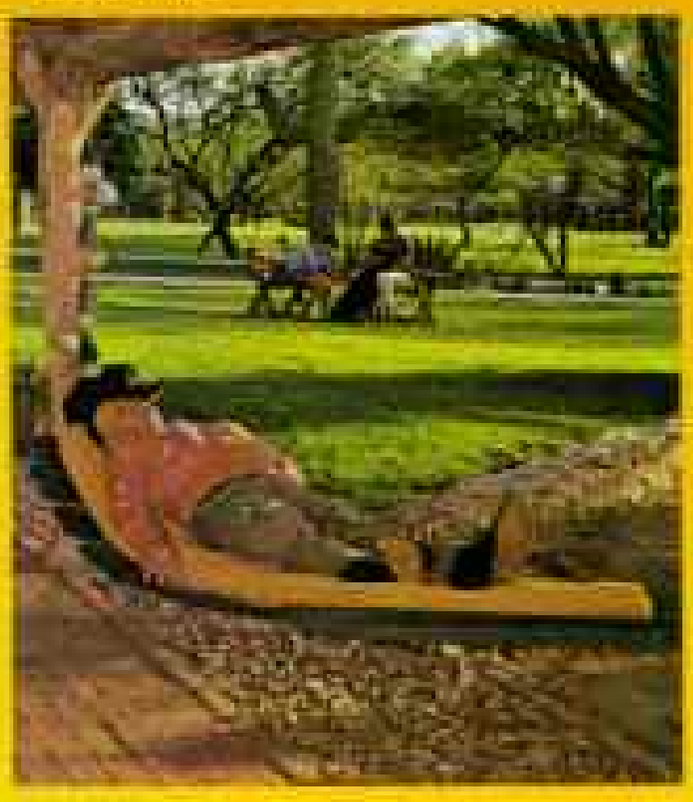
It's a place where there's so much to see, all so close by.



You can breakfast in a cactus forest in the morning and have cocktails in a ski lodge that same afternoon.

Ghost towns. Movie sets. Desert wildlife museums. Historic missions. Indian ruins. Art colonies. A world of things you can see. All in the same day.

It's also a place where you can have a terrific time doing nothing at all. Pull on a bathing suit and relax with us under the warm, dry Arizona sun. Get a tan; take a swim; or just catch a nap by the pool. Come and relax. Leave your watch at home.



Come, enjoy Amazing Arizona with us.

For more information, send us a postcard: Arizona Office of Tourism, 1700 West Washington, Dept. 130, Phoenix, AZ 85007.

Thomas Edison, reminiscing in 1928, at age 81, is portrayed by actor Pat Hingle in a unique series of television commercials. One is reprinted here. You can see many of the others on upcoming GE television specials.

If you asked Edison about his greatest invention, we don't think he'd say it was the light bulb.

We think he'd say something like this:
"Some people have called the light bulb my greatest invention. I'd have to disagree.

It wasn't the light bulb. Or the phonograph. Or the motion picture. I think my greatest invention was the commercial research lab. A place where I could develop all kinds of inventions.

I built the very first commercial research lab in the country in Menlo Park, New Jersey, in 1876.

You could say that was the start of the General Electric Company. But, of course, I didn't know it at the time.

At Menlo Park, we had as many as 44 different inventions under way at the same time. Sometimes you couldn't hear yourself think. Of course, in my case it didn't matter. I've been deaf since I was twelve.

It was my goal to turn out a minor invention every ten days and a big thing every six months or so.

Two of my big things were the light bulb and the power plant.

They had to be developed at the same time. Because I had no hope of selling the light bulb if there was no electricity. And I had no hope of selling electricity unless there was a light bulb.

The company I set up to sell the light bulb was called the Edison Electric Light Company. Later, it became the General Electric Company.

How did I get in the whole inventing business anyway?

Quite frankly, I saw it as a way to make some money. When I was a newsboy, I had a chance to learn that money can be made out of a little careful thought. And, being poor, I already knew that money was a valuable thing.

Boys who don't know that are under a disadvantage greater than deafness."

The research tradition Thomas Edison started continues today at the General Electric Research and Development Center in Schenectady, N.Y. Over the years, this General Electric laboratory has pioneered many developments such as the x-ray, industrial plastics, radio, television, the jet engine, Man-Made™ diamonds.

Progress for People.

GENERAL ELECTRIC

A good breakfast doesn't have to be high in cholesterol.

The proof is in the Special K Breakfast.*
A one-ounce serving of Special K with ½ cup of skim milk gives you 10 grams of protein** to start off your morning. Yet a serving of Special K with skim milk is low in cholesterol. Make a bowl of Special K a part of a complete breakfast. And get a good breakfast without a lot of cholesterol.

*The Special K Breakfast
4 oz. orange juice or tomato juice
1⅛ cups (1 oz.) Kellogg's® Special K® high-protein cereal
1 teaspoon sugar
4 oz. skim milk
One cup black coffee or tea

** 6 grams from a one-ounce serving of Special K; 4 grams from ½ cup skim milk.

Kellogg's®
SPECIAL K

"Railroads belong to Grandfather's Day."

The rails. Outdated? Or an efficient necessity? You can argue both sides.

Wheel-on-rail technology goes back 150 years and more. In some areas track equipment and terminals show their years. Though certain lines are well run, profitable, average return is low. Several roads are in marginal condition. It could cost $7 billion to modernize our entire network. Some say it isn't worth it.

But railroads provide a fuel efficiency important to an energy short world. Trucks are more mobile but rails move near 2,000 tons of freight per train load. High speed roadbeds can handle speeds to 80 mph. In ton mile terms, rails carry almost 40% of all intercity freight. 60% of our grain. More than 70% of our new cars, coal, lumber and household appliances. Other modes would be hard pressed to carry the load should rails come to a halt.

What to do? First recognize the importance of all transportation modes. Then support programs designed to relax some old notions about how they must do business; programs that will help maintain profitability. It may require changes by labor and management.

But profitability is the key to an efficient, self-sufficient system. And changes in regulations, services, taxing and financing are needed to let that happen.

We care because Caterpillar products construct, maintain or operate transportation systems of all kinds — and we're one of the country's leading shippers.

"Trains are an efficient transportation mode."

There are no simple solutions. Only intelligent choices.

CATERPILLAR

Caterpillar, Cat and the "CAT" are Trademarks of Caterpillar Tractor Co.

Energy for a st

Burning high sulfur coal cleanly: it's a hot subject at Exxon.

The fiery column next to Exxon research engineer Rene Bertrand holds the kind of coal that could add pollution to the air we breathe. But the coal here is being burned in a new, cleaner way called "fluidized bed combustion." In this process, crushed coal is burned in a bed of limestone granules while a stream of air is injected into the mixture. The air causes the powdered solids to behave like fluids so they can be moved through the process. Most of the sulfur gases that are released as the coal is burned react with the limestone and do not escape into the atmosphere. Later the sulfur can be recovered for use as a chemical raw material.

Exxon's research affiliate built and is operating a pilot plant for the U.S. Government to demonstrate the fluidized bed combustion process. Exxon is one of several firms involved in a national program aimed at developing this cleaner way to burn high sulfur coal.

We expect the process will someday help electric utilities and industrial firms make greater use of America's huge reserves of high sulfur coal.

Exxon pioneered the development of fluidized bed technology for refining gasoline and other fuels. Applying it in this new way to help satisfy our nation's energy needs is a good example of how experience in one form of energy can pay off in another.

rong America

Pour it on.

With style.

Business is good. You've got the momentum going. Now's the time to pull out all the stops. Few business investments let you pour it on with as much style as the hard-charging Beechcraft Duke.

Move out on your own schedules. Nose out competition by getting where you need to be when the time is right. A company Beechcraft is today's answer to the curtailed schedules and rising costs of public transportation.

Did you know that there are more than 12,000 airports accessible only by private and business aircraft?

These are potential business destinations you may not be able to reach today except by time-wasting surface transportation.

The Beechcraft Duke takes you to these destinations in pressurized, air-conditioned comfort at speeds up to 286 mph.

It seats six people in a superbly furnished cabin that can be custom-styled to reflect your personal good taste.

The Beechcraft Duke is a sophisticated but uncomplicated airplane. It's so easy to fly that over 70% are owner-flown by business and professional men.

If pouring it on is your style, make your move now to get the information you need to give the Beechcraft Duke a realistic evaluation.

The case contains facts on airplane ownership and operation, product information, and a corporation Capital Recovery Guide (discover your low net capital cost of owning a Beechcraft).

Write on your company letterhead: Beech Aircraft Corp., Dept. A, Wichita, Ks. 67201. Please mention if you're a pilot.

Or call collect. Ask for Art Cross. (316) 681-7080.

Get the Beechcraft case for business flying. Free.

Member of General Aviation Manufacturers Association

Learn to fly and you could win a $50,000 airplane.

Get all the details now about the General Aviation Manufacturers Association TAKEOFF Sweepstakes. Call **800-447-4700,** toll free. (In Illinois, call 800-322-4400) and ask for BEECH TAKEOFF information.

A simple truth about color TV:
You don't have to settle for a color picture that won't stay right. Zenith's Color Sentry controls and corrects your color picture. Thirty times a second. Think of it as a TV control room in your set. To give you that great Zenith picture—automatically.

ZENITH

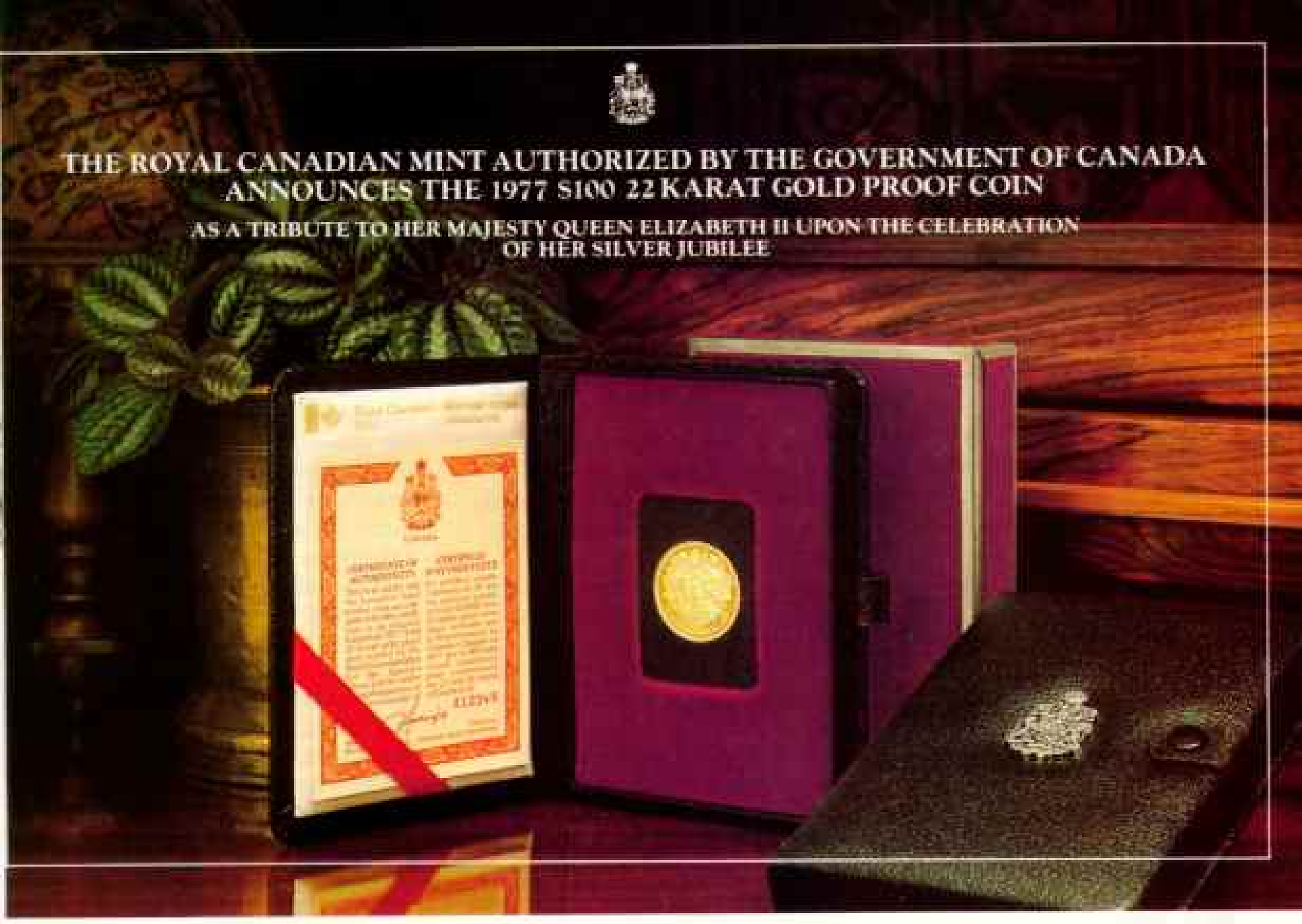
COLOR SENTRY

The quality goes in before the name goes on.®

Color Sentry available in 13" through 25" (diagonal) screen sizes.
Shown: The Reynolds, SJ2543E, with Oak veneers on top and ends; front and base of simulated wood. Simulated TV picture.

THE ROYAL CANADIAN MINT AUTHORIZED BY THE GOVERNMENT OF CANADA ANNOUNCES THE 1977 $100 22 KARAT GOLD PROOF COIN

AS A TRIBUTE TO HER MAJESTY QUEEN ELIZABETH II UPON THE CELEBRATION OF HER SILVER JUBILEE



This year Canada celebrates for the first time in her history the Silver Jubilee of a Sovereign Queen—Her Majesty Queen Elizabeth II. To commemorate this rare and important event, the Government of Canada by Proclamation authorized the Royal Canadian Mint to strike, as legal tender:

The 1977 Canadian $100 22 Karat Gold Proof Coin

The design, as submitted by Raymond Lee of Toronto, Ontario, symbolizes Canada with outstanding success.

The obverse bears Sir Arnold Machin's effigy of the Queen; the reverse depicts the floral emblems of Canada's ten Provinces and two Territories. The coin has a diameter of 27 mm and weighs 16.965 grams of which 15.551 grams (½ Troy oz.) are fine gold. This precious metal legal tender coin contains 91.66% fine gold (22k) and 8.34% fine silver.

Canada has issued only six gold coins of varied denominations in her history; many have appreciated greatly in value. This 1977 $100 gold proof coin is only the second $100 gold coin to be issued by Canada.

Luxurious moroccan leather case

Your $100 22k gold proof coin comes to you in an attractive black moroccan leather case, bearing the Coat of Arms of Canada and lined inside with red Dior velvet. The case fits into a decorative book-like "sleeve" for elegant exhibition in your home. It is accompanied by a Certificate of Authenticity signed by the Master of the Royal Canadian Mint certifying that your coin is legal tender and redeemable for its full $100 face value in Canada.

Obverse — Reverse

Royal Canadian Mint / Monnaie royale canadienne

RETURN TO:
Royal Canadian Mint
P.O. Box 457, Station "A", Ottawa, Ontario, Canada K1N 8V8

Please send me _____ $100 22k Gold Proof Coin(s)
Qty.

at $140 (Can.) each . . . . . $_____

*Canadian residents add Prov. Sales Tax where applicable . . . . . $_____

Total . . . . . $_____

*Prov. Tax not applic. in P.E.I., Quebec, Alberta, N.W.T., Yukon.

Sales Tax Exempt. No. _____

Orders accepted on a first-come, first-serve basis, to a maximum mintage of 300,000. Please allow 6 weeks delivery. **Orders must be postmarked no later than 31st December 1977.**

METHOD OF PAYMENT (check only one)

☐ Enclosed is my cheque/money order made payable to: The Royal Canadian Mint **OR**

Please charge my Credit Card, as indicated:

☐ Master Charge ☐ Chargex/Visa ☐ American Express

Credit Card Number |_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|

Expiry date |_|_|_|_|

Signature _____
(Application must be signed to be accepted)

Name _____

Address _____

City _____

Province/State _____ Postal code/Zip code _____

NV-01

Photograph of Queen Elizabeth II: C.O.I., London

From lizard skins and human bones man creates music

Small arched harps like the one below are heard throughout central Africa. One tribesman may build its soundbox from a dried gourd or a turtle shell. Another will carve it, as this one was, from a block of silver cottonwood, covered with the skin of a male monitor lizard. The five strings are ordinary wire for stringing beads, picked up at a trading post.

In Burma, 4,500 miles away, a similar hand-held harp, the melodious *saung-gauk*, is a little larger but vastly more elegant: its strings are of silk.

The "strings" of Madagascar's zitherlike *valiha* are actually long slivers of wood, partly lifted from a length of bamboo but kept tightly fastened at either end.

Most wind instruments are simpler to make. In Chicago, a boy blows across the top of an empty bottle. In Missouri, he cuts a willow whistle. On the island of Tonga, a section of bamboo becomes a *fangufangu*, or nose flute. Its plaintive notes breathe music into the morning air.

In the Himalayas, a horn made of the thigh bone of a long-departed monk calls Tibetans to prayer.

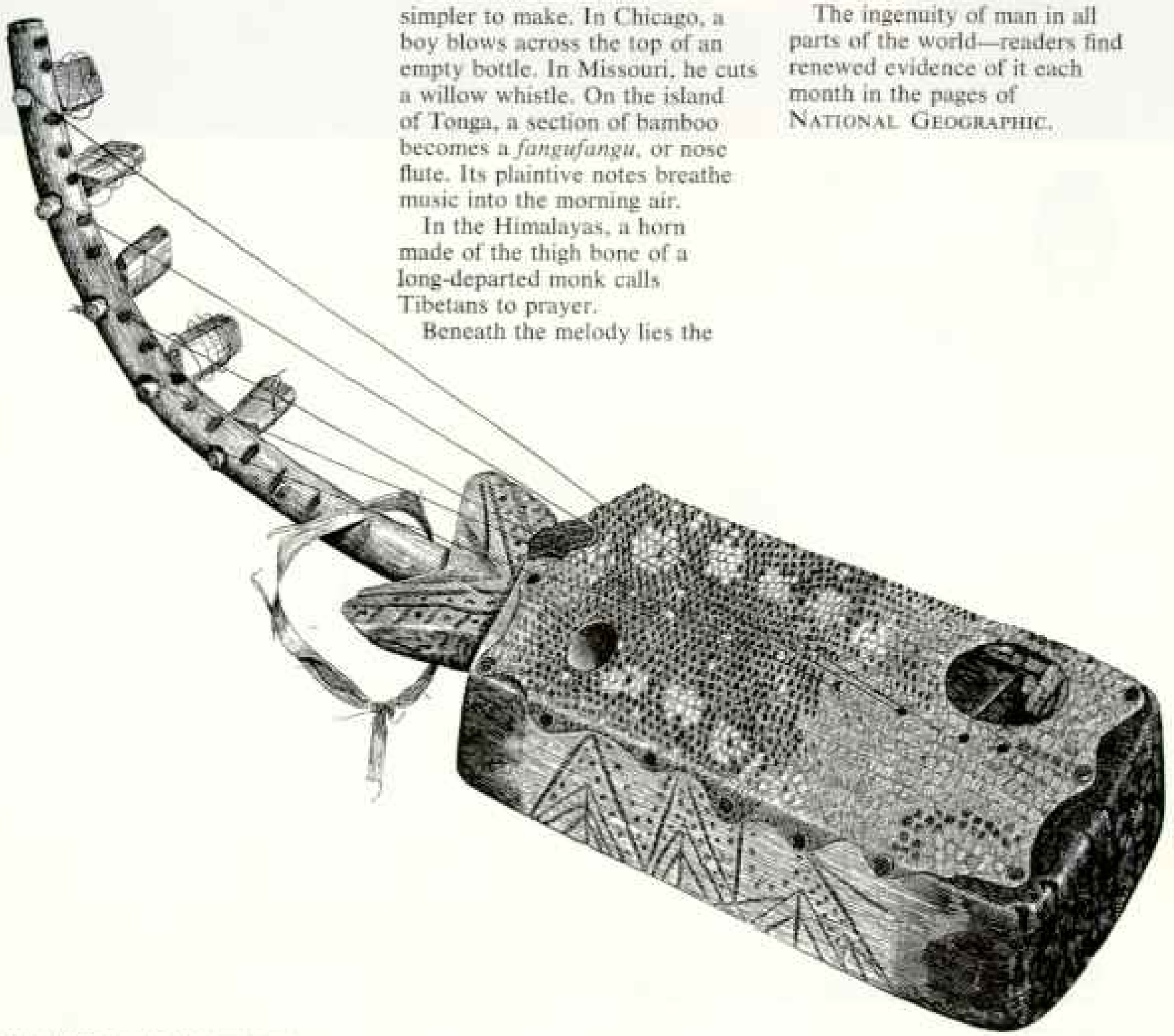
Beneath the melody lies the beat, and primitive drums everywhere express it with intensity.

Nigeria's "talking drum," the *iyalu dundun*, a large, double-ended instrument, is squeezed in the middle to tighten the skins on either end. A powerful Yoruba drummer can thus change pitch as much as an octave.

In Trinidad the top of an oil drum, tuned by heating and hammering, produces the now-familiar calypso rhythms of the steel drum. A drum only in appearance, it functions more as a one-piece xylophone laid out in a circle.

From conch shells and kerosene cans, from taut strings and hollowed sticks and skins stretched tight, from seed pods and silver bells and pipes of clay, man, it seems, will always find a way to create music.

The ingenuity of man in all parts of the world—readers find renewed evidence of it each month in the pages of NATIONAL GEOGRAPHIC.



AFRICAN ARCHED HARP, ABOUT HALF-SIZE

Sculpture & Jewelry Replicas from Authentic Museum Treasures

Our sumptuous full-color catalog spans 5000 years of art with something for every taste at surprisingly modest cost. Choose from hundreds of hand-crafted authorized reproductions of art from the world's great museums. Send $1 to:

Museum Collections

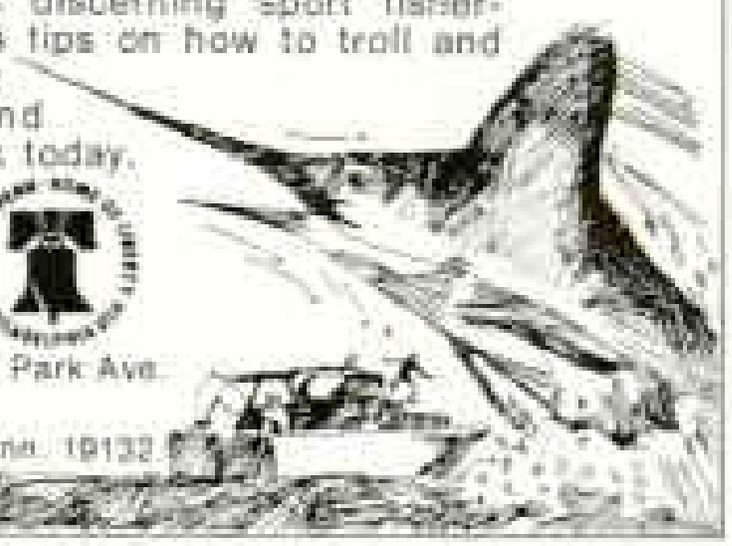
Dept. NG, 140 Greenwich Ave.
Greenwich, Conn. 06830

New! **PENN CATALOG**

New 32 Page Color Catalog is here. Illustrates Penn's Complete line of fresh and salt water reels for America's discerning sport fishermen. Includes tips on how to troll and cast. Yours for **only 50¢**. Send coin or check today.

PENN REELS

3028 W. Hunting Park Ave.
Dept. NG-10
Philadelphia, Penn. 19132



GEOTHERMAL ENERGY

"The GEYSER"

Geothermal Energy Newsletter

Brings you the facts about this cost-saving, non-depleting, worldwide energy resource.

3 Sample Issues — $5.
Yearly Subscription — $10.

Send your cheque or M.O. for samples or subscription to: The GEYSER
Postal Office Box 1256 • Santa Monica, California 90406

ANNOUNCING A NEW GENERATION OF SLIDE PROJECTORS. AND A FREE OFFER TO SEE HOW GOOD THEY ARE FOR YOURSELF.

Bright. Sharp. Clear. That's how our new Slide Cube™ System II Projectors will show your slides. Even if you already own a projector, we want you to see for yourself. That's why we'll send you a free space-saving Slide Cube Cartridge, information on the system, and a special money-saving offer. Just load the cartridge with your own slides and visit your Bell & Howell dealer for a demonstration. Can you think of a better way to see how revolutionary our new projectors really are?

BHMC

Send me one free Bell & Howell Slide Cube™ Cartridge. I'll load it with my slides and visit my Bell & Howell dealer for a demonstration.

Name_____

Address_____

City_____ State_____ Zip Code_____

Mail this coupon (or a postcard) to:
Bell & Howell/Mamiya Company
Dept. 8878, 7100 McCormick Road, Chicago, IL 60645
Offer expires 12/31/77 and is not available outside the U.S. Dept. NG-189

THE NEW BELL & HOWELL SLIDE CUBE SYSTEM II

PPG believes windows should become working parts of your home's energy system.

Whether your home is in the south or the north, PPG has an energy-saving environmental glass for your windows and sliding glass doors.

Where the climate is blistering, you can save air conditioning costs by as much as 20 percent by letting your home wear windows and patio doors made of Solarcool® Bronze reflective glass instead of clear glass.

Newest in the PPG line, Solarcool cuts way down on ultraviolet light, too, which is a major cause of fading. Its beautiful mirrored face provides comparative privacy, and by reducing glare makes it a lot nicer to look out on a summer's day.

Up north, PPG Twindow® insulating glass uses two sealed panes to bring breathtaking winter scenes indoors while you breathe in comfort. Since it reduces heat loss through the glass more than 40 percent, it obviously saves energy. It cuts messy condensation. And if you want to save even more, add storm windows for triple glazing.

Let PPG glass become part of your energy-saving system. Write for a free copy of our Solarcool idea book: "Best Glass Under the Sun." PPG Industries, Inc., Dept. N-410, One Gateway Center, Pittsburgh, Pa. 15222.

PPG: a Concern for the Future

PPG INDUSTRIES

Invest in the sun. Start collecting today.

Solar energy is here, today. With it comes a shining answer to soaring fuel costs: the Grumman Sunstream™ Solar Domestic Water Heating System.

Sunstream won't eliminate all your energy costs. But it could save up to 50% of your domestic water heating costs.

Savings are considerable, because the hot water an average family of four uses for showers, bathing, washing clothes and dishes adds up to more than 27,000 gallons each year.

Using the sun's free energy, the Sunstream system preheats the water entering your existing electric, oil or gas water heater or the domestic water heating coil in your boiler. Energy costs are low (and because the solar heated water requires less conventional energy to raise it to the desired temperature.

The Sunstream system gives you an investment that may add immediately to the value of your house. It's also an investment that pays you increasing dividends, as all other energy costs continue to rise.

So, get your sun working hard for you. Capture its free energy with the Grumman Sunstream Solar Domestic Water Heating System, now in use in homes across the country. Suggested retail prices start at $995, plus transportation, local taxes, and dealer installation.

For more information on how you can get solar energy to pay dividends today, write Dept. 320, Grumman Sunstream, 4175 Veterans Memorial Hwy., Ronkonkoma, NY 11779.

GRUMMAN *Sunstream*™

The reliable source

A product of Grumman Energy Systems - a division of Grumman Corporation