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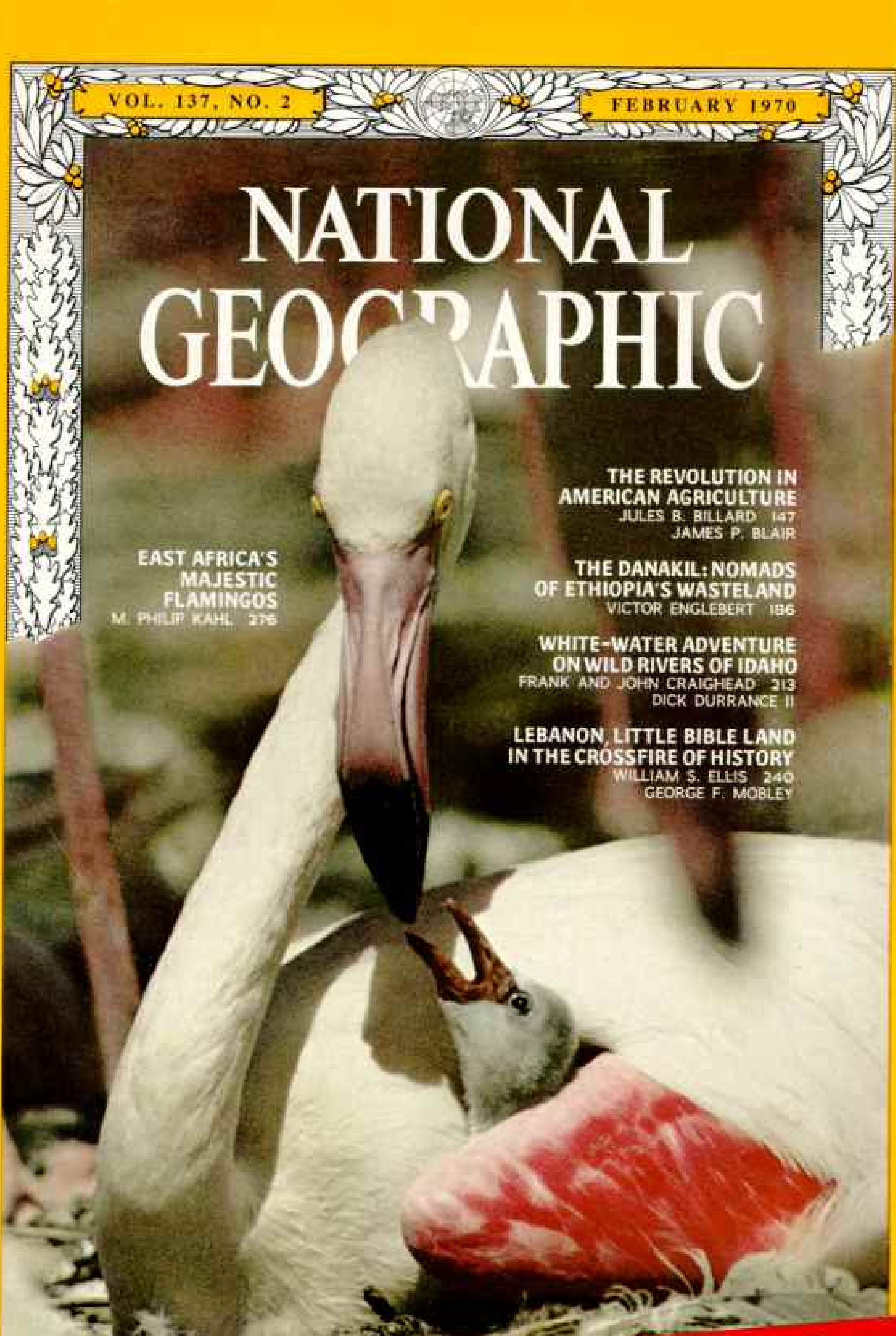
NATIONAL GEOGRAPHIC



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Anthropologist among hill tribes of Thailand

SOUND of their own songs enthralls an audience of Karens, a hill people in northwest Thailand. The recording helps piece together a picture of Karen culture for Dr. Peter Kunstadter, visiting associate professor of anthropology and preventive medicine at the University of Washington. Thailand's 150,000 Karens cling to their identity despite changing times and war nearby. Once worshipers of spirits abiding in jungle and home, many Karens are now Buddhists or Christians; once simple farmers, many are becoming educated and urbanized.

Knee-deep in rice straw (above), Dr. Kunstadter aims his lens at other Thailand friends: the neighboring Lua people. He first went among the gentle Lua in 1963, gaining a rare insight into hill-tribe life that he shared with readers of the July 1966 NATIONAL GEOGRAPHIC.

Drawing upon films, tape recordings, and his rapport with the Karens, Dr. Kunstadter prepares a detailed report on this group for a future GEOGRAPHIC. Introduce your friends to new faces around the globe by nominating them for membership on the form below.

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You won't see a rain forest in San Juan.

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You won't see a phosphorescent bay. You really have to see it at night to believe it.

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You won't see surfing on 25-foot peaks or beaches where there are more palm trees than there are people.

You won't see distilleries where they turn sugar cane into rum and welcome you with open vats, or cross the Rio Grande de Loíza on a hand-poled ferry.

You won't see a 700-year-old Indian ceremonial ground or a church that's older than St. Peter's or marine salt beds that look like glistening snow.

You'll want to bring your sunglasses.

You won't see a golf course carved from a coconut grove or take a short siesta on top of Toro Negro. Wake up and see the Atlantic to the north, the Caribbean to the south.

You won't see devout pilgrims climb a flight of

stairs on their knees to a church on a hill or smell a coffee harvest in Yauco or get to a place where English isn't spoken.

You won't try a little seafood place named Villa Cofresí in Rincón on the west shore. There won't be any tourists at the next table because it's never been mentioned before in any travel folder.

You won't see the lair that once was the home of the pirate Roberto Cofresí or the foundations of Ponce de Leon's first house or the huge hotel built on a three-hundred-foot cliff in the middle of nowhere. To get down to the beach you have to ride a tramway.

You won't see the place where the Marines landed during the Spanish-American War or the spot Christopher Columbus dropped anchor.

You won't have the fun of the dime ferry ride from behind the post office in San Juan to Cataño.

You won't see or do a lot of things you can see and do outside of San Juan.

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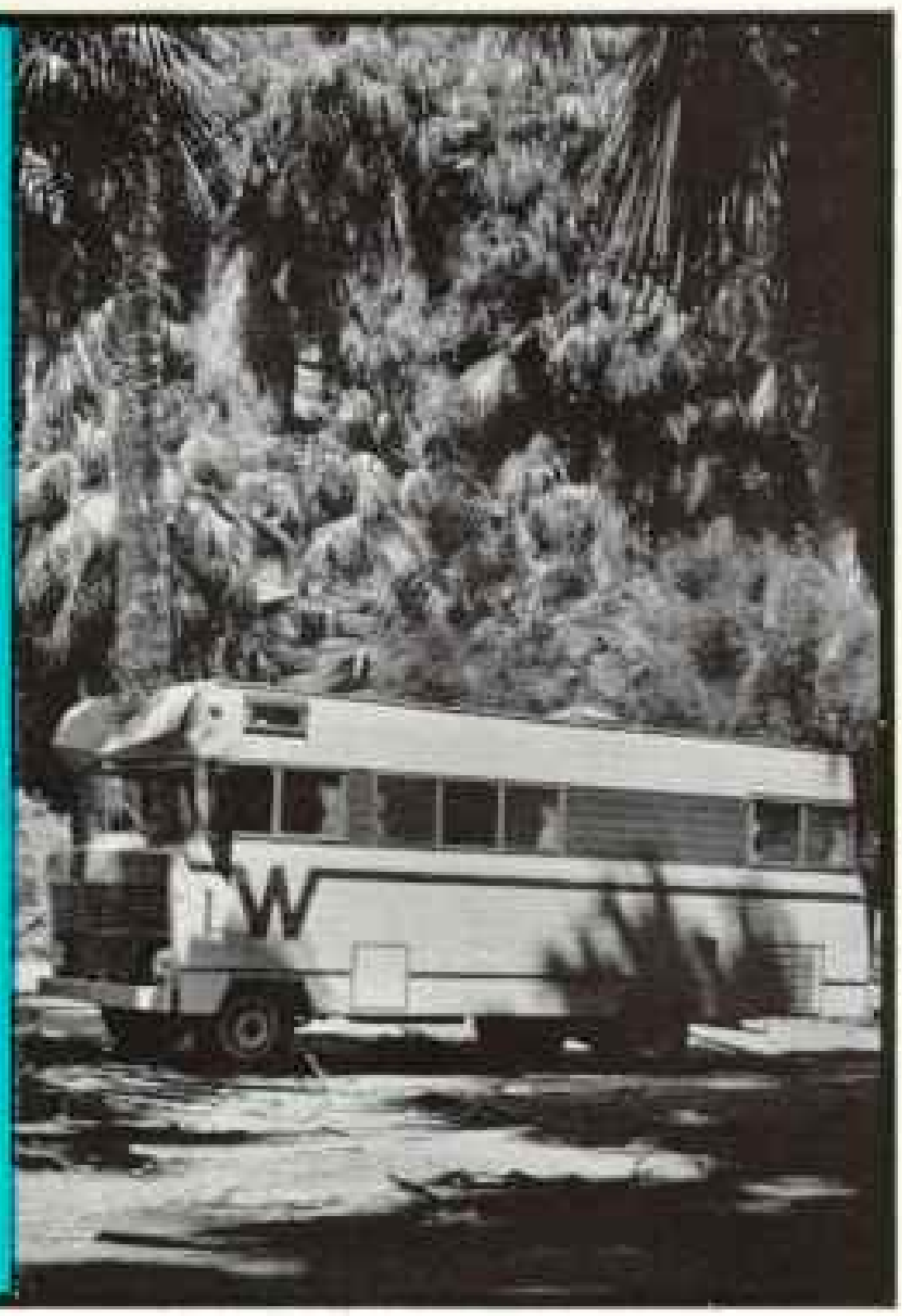

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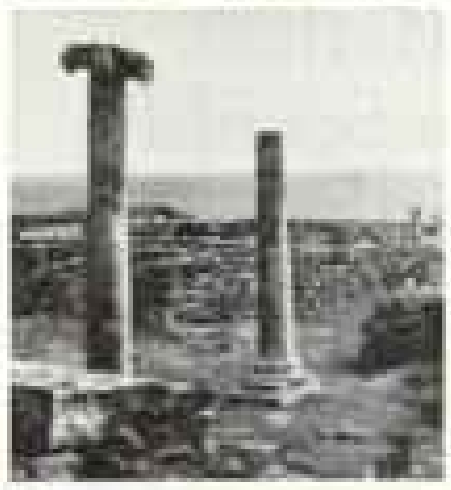

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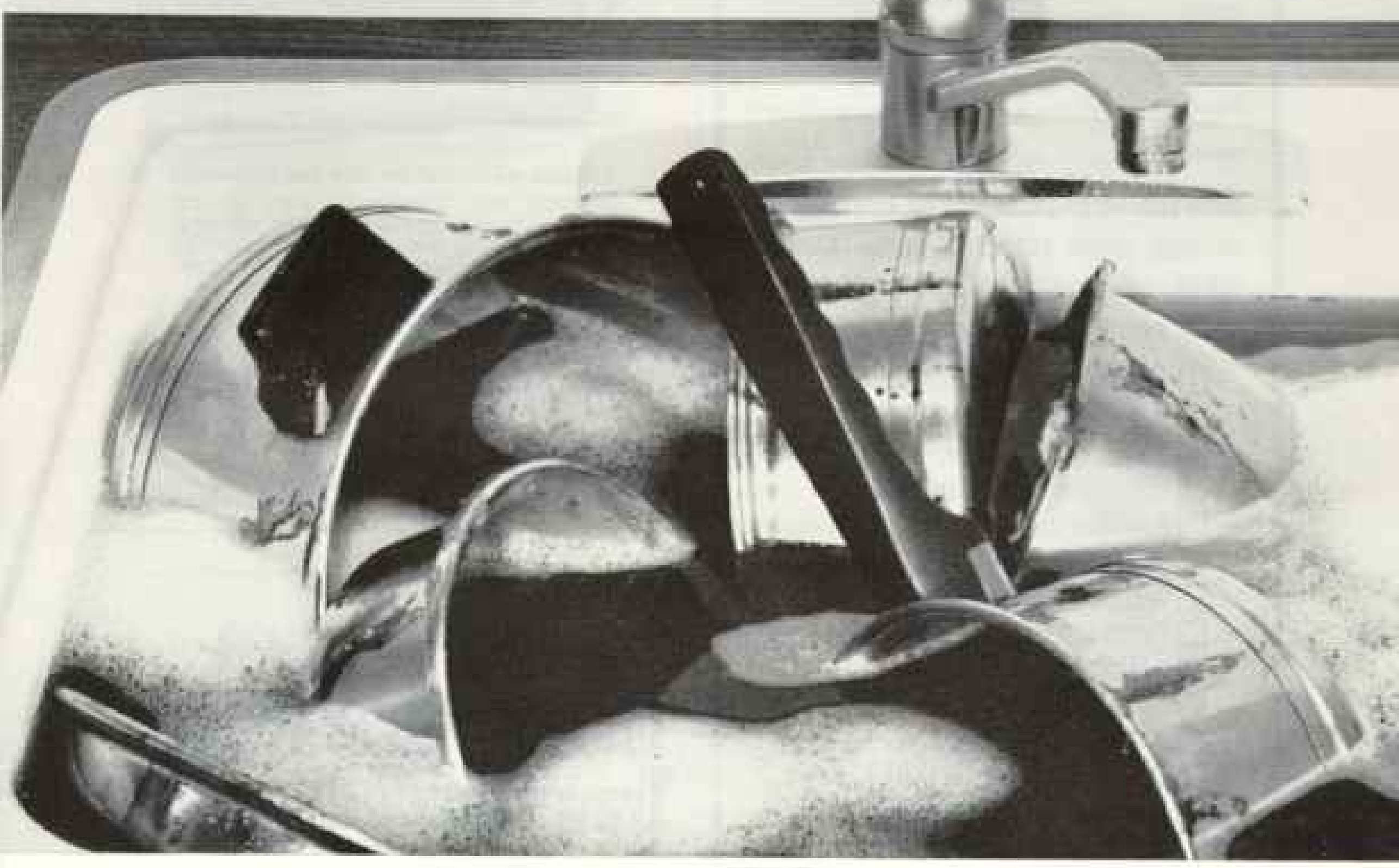

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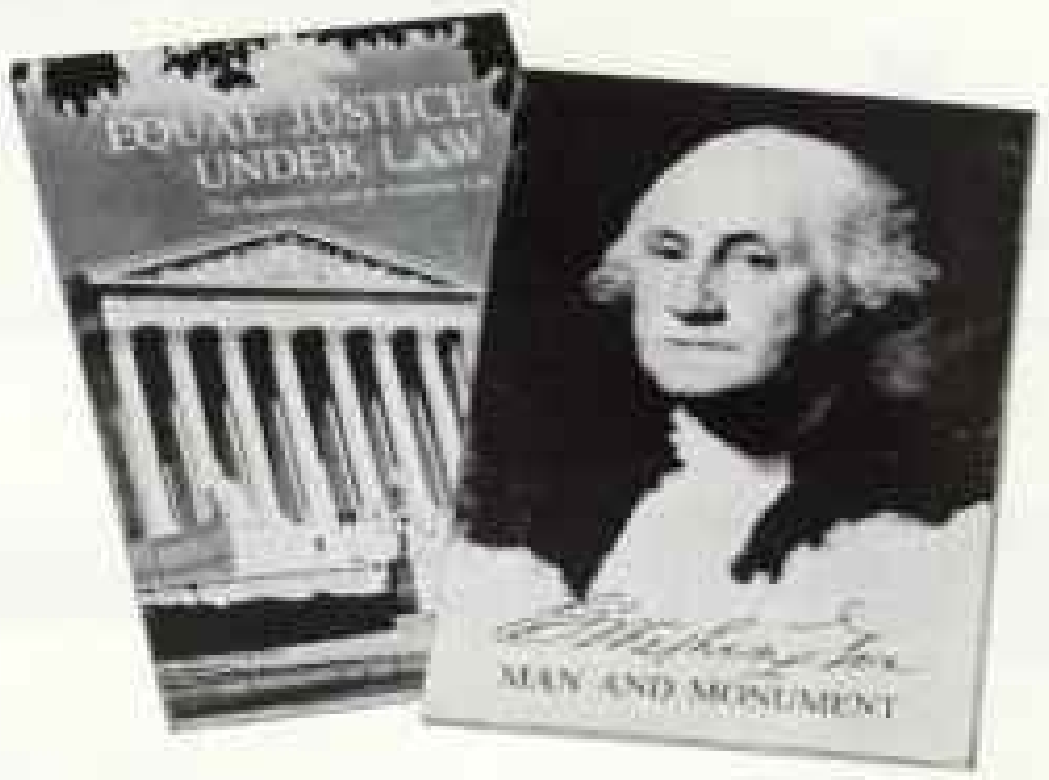

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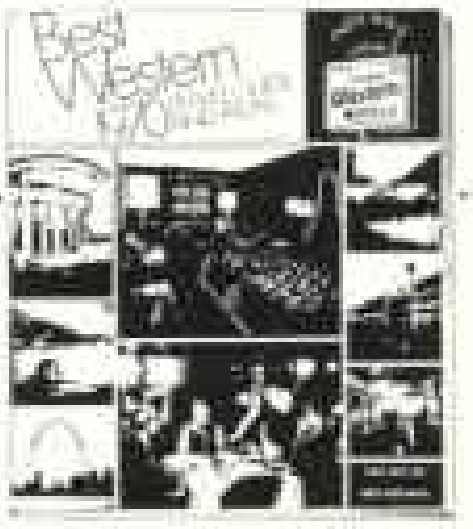

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She can see much of the world right now, because 25 countries are already linked by a satellite system operated by INTELSAT, the International Telecommunications Satellite Consortium. Still, there are parts of the globe blacked out for her.

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Sketch: astronaut on upper stage Centaur

It's another example of what technology can accomplish when it's handed a problem. At General Dynamics, we put technology to work solving problems from the bottom of the sea to outer space...and a good bit in between.

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A lot of it looks a little like a foreign country.

What a strange thing to say about one of the original thirteen colonies.

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Our beaches are a lot like the Caribbean, with the longest stretches of smooth white sand you'll ever see. (Unless you go to the Caribbean.)

Our semi-tropical islands are a lot like the South Sea Islands with their exotic flowers, tropical vegetation and wildlife. (One is a hatching ground of giant sea turtles.)

Our mountains are a lot like Scotland's, with crashing waterfalls that form two-hundred-and-fifty miles of trout streams.

And then there's Charleston. Beautiful old Charleston. It's like no city you've ever seen before with its pastel houses along cobblestone streets, and tiny gardens behind iron gates.

But it does bear the mark of the West Indies. (A bit of Jamaica here, a little Barbados there, and a lot of charm everywhere.) And it has been said of Charleston that it's the only city in America where you can eat as well as you can eat in Europe.

And when we say South Carolina is the garden spot of America, we have something to back it up. And that's three of the world's thirty-eight great gardens. Come in the spring. And see what an English garden really looks like.

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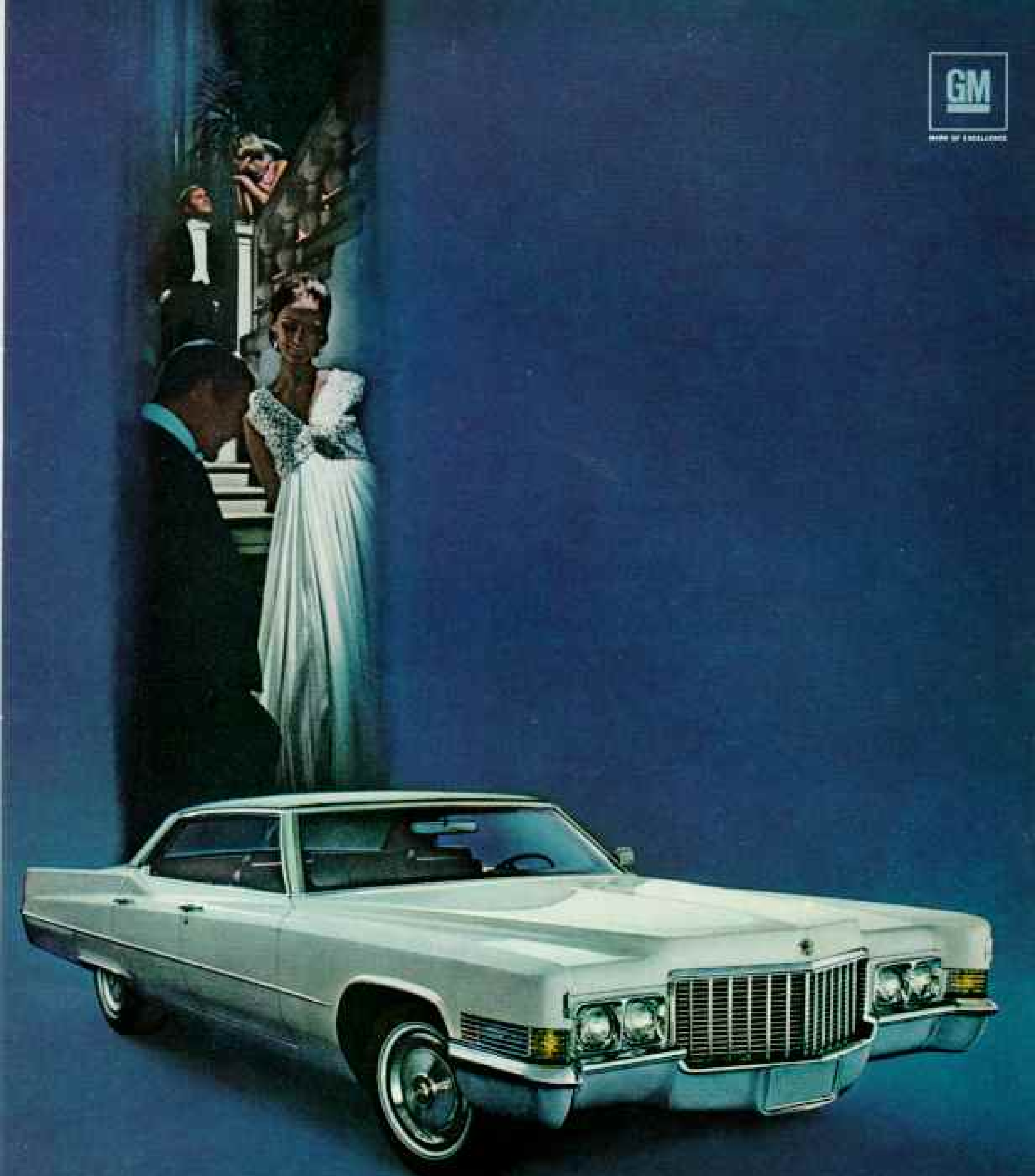

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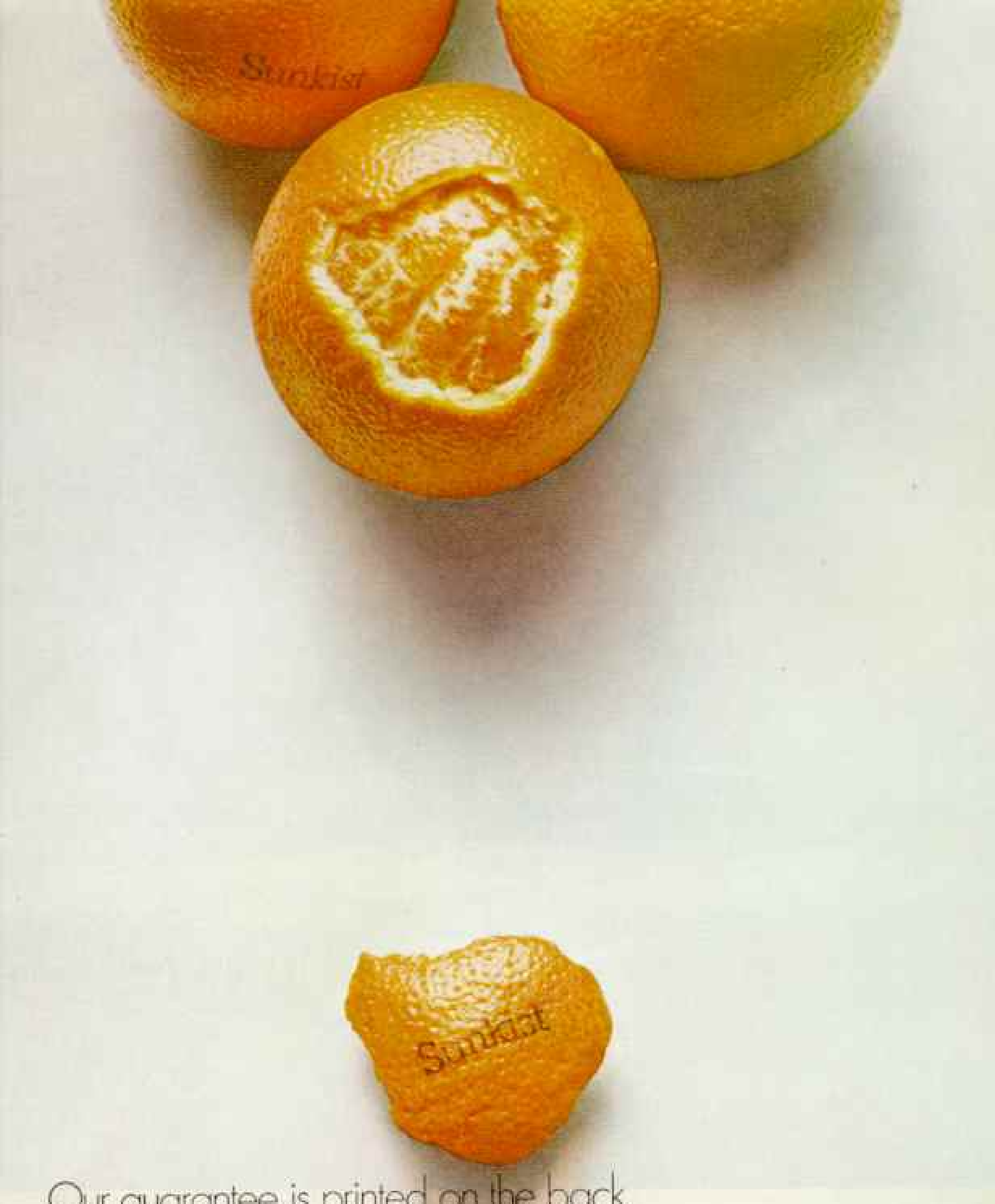

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February 1970

NATIONAL GEOGRAPHIC

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More food for our multiplying millions

THE REVOLUTION IN AMERICAN AGRICULTURE

By JULES B. BILLARD Senior Editorial Staff

Illustrations by JAMES P. BLAIR National Geographic Photographer

THE GEORGIA FARMER glanced at my city-shod feet with benevolent eyes framed by gold-rimmed spectacles. Then he handed me a pair of plastic boots—pulled from a roll that reminded me of the tear-off bags housewives use for leftovers.

"You cain't go into thet chicken house 'less'n you put these on," he drawled. "You see, you jest might not be clean."

Plastic boots, indeed! Not to preserve my polished shoes from the litter of the chicken house floor, but to protect the chickens from me! What a far cry, I thought, from the days when one of my childhood chores was scattering feed for the handful of hens Mother kept in our backyard. But that's modern agriculture for you.

Some 13,000 pullets crowded that shed I was visiting. And a sign on the door told a potent story: PPLO CLEAN BIRDS. NO TRESPASSING ALLOWED. The initials stood for pleuropneumonia-like organisms, a hazard for which the birds had been tested. It or other diseases that might be brought in on a stranger's soles could spread like wildfire. And with an expected return of only five cents a bird, my Georgia friend could ill afford to take chances. For the agricultural revolution ablaze in the United States today demands the utmost in careful management.

Bounty Flows From Fewer Farms

Secretary of Agriculture Clifford M. Hardin summarized that revolution for me. "Through the decades before the Civil War, the American farmer produced food and fiber enough to feed and clothe himself and three other persons," he said. "A century later, when we entered World War II, new machines and techniques had helped inch the figure to

The sweeping pattern of abundance

A broad flag unfurled to the horizon, wheat grows in golden stripes across Glacier County, Montana (preceding pages). Small in the vastness, two lumbering combines ply mile-long strips, harvesting grain that has already been cut and windrowed to avoid whipping winds that would thresh it on the stalk. Near a tiny pickup used for refueling the machines, a larger truck hauls away the grain. Dark strips lie fallow for spring planting in a rotation that conserves moisture and

KODACHROMES (INCLUDING PRECEDING PAGES) © N.G.S.

guards against wind erosion. Arrow-straight roads ripple the pattern in a lonely region where neighbors often live ten miles apart.

Asprawl in the shadow of the Rockies, Glacier County lies in the fertile wheat belt that extends southward to Texas and northward into Canada. Up this great corridor, traveling as the grain ripens, rumble the big custom combines, their drivers powdered with gritty dust and chaff (above). Multiplied across the land, they and their machines and the amazing results of agricultural research team up to produce a bounty unparalleled in world history.

himself and 11; today it has leaped to himself and 42. The superabundance from our fields comes from a dwindling number of farmers working fewer and fewer farms."

This incredible productivity of man and land yields bumper crops that make surpluses a problem. It sets American tables with food of a variety and quality unrivaled anywhere on earth. It has figuratively taken seasons out of the calendar. You can have strawberries in January, fresh oranges and lettuce the year round. And you can choose from a veritable cornucopia of products. Of the 6,000 to 8,000 items in the typical supermarket, 40 percent were not there a dozen years ago.

Scientists Spy on a Steer's Digestion

How has all this become possible? Simply because in a single lifetime United States agriculture has advanced more than in all the preceding millenniums of man's labor on the land. To witness this revolution firsthand, I traveled the length and breadth of the Nation.

In Maryland I saw a steer with a window in its side, through which scientists can study how different foodstuffs fare in its rumen—basic research that counts as one of the ingredients of our agricultural transformation.

In California I watched a factory-on-wheels move down celery rows—severing, trimming, washing, crating, doing the work of forty men. On such mechanization has depended part of our spectacular progress in farming.

I talked to a country banker about the credit advantage that has helped American farmers outdo their counterparts around the globe. I handled tomatoes bred for machine harvesting in one of today's amazing developments in plant genetics. I learned about heating cables buried underground to warm the soil so asparagus can grow in December—one of the changes that abundant electricity for rural America has wrought.

Research, mechanization, insect and weed control, credit, genetics, electricity, fertilizers, better communications and marketing, new food products, advances in soil and water conservation—these are major components of our farm upheaval. I explored them and marveled. And I ended my travels staggered by the idea that the revolution is just beginning.

Actually, there have been three agricultural revolutions. The first came when man began substituting animal power for human muscles. The second brought machine energy to replace animal energy and put the fruits of research into application on the farm. The third, the farmer's adoption of skilled management techniques to capitalize on today's technology, still wears swaddling clothes.

"The successful farmer today is as much a businessman as he is a tiller of the soil," Secretary of Agriculture Hardin said to me. "The sophisticated enterprise he runs calls for a wider range of managerial decisions and skills than does the average family-owned factory or business in the city."

To the farmer we nonfarming Americans owe much, the Secretary declared—more than for the food we eat and the fiber we wear and the farm products that find use in such things as paints, lubricants, and plastics.

"Because only one person in 43 is needed to produce food, others can become doctors, teachers, shoemakers, janitors—even Secretaries of Agriculture. Without agricultural advances that free people from the drudgery of limited production on the land, there would be little labor available to man the factories, stores, museums, and all the other places that make our life so rewarding."

The revolution farmers have fashioned may even be a major weapon in the battle

KODACHROMES BY JAMES P. BLAIR (ABOVE) AND JACK FIELDS © N.G.S.

against one of the gravest problems facing the world: the population explosion.

Earth's numbers now stand at 3.6 billion, and could double in 35 years. This mounting pressure against food supplies raises the specter of a famine more catastrophic than the world has ever seen. Already constant hunger or malnutrition is the lot of half the

Mass-producing the tomato

Like an open-air trolley gone astray, a 6½-ton behemoth traverses a field near Yuba City, California (left). Behind the driver, second from right, 14 women passengers busily sort tomatoes, shaded by awnings and serenaded by taped music. Their vehicle: a $23,000 harvester that picks and bins 15 tons of tomatoes an hour, once the backbreaking work of 100 migrant laborers.

The machine cuts plants underground, pulls them up with metal fingers, and gently shakes off the fruit. These tomatoes are miracles of plant genetics, bred to ripen all at once and having an easy-to-snap stem for bruiseless picking. As women cull, a conveyor feeds fruit into bins.

Like picking, planting has gone modern. Factory assembly lines slip tomato seeds into plastic tapes at precise intervals (right). Reels of tape on a planter thread down through a digging tube (above). Within a few minutes of planting, soil moisture dissolves the tape.

Pulling a six-tape rig, a lone operator can precision-plant an incredible 30 acres a day. Manufacturers foresee a day when many suburban gardeners will also seed by tapes.

TWICE ACTUAL SIZE

people on earth. In the 8.6 seconds it takes the average reader to scan this paragraph, someone somewhere dies of starvation or of disease stemming from malnutrition.

Many view darkly the race between man's fertility and that of the soil. Others see hope in the fact that the land surface of the earth receives enough energy from the sun every day to grow—theoretically at least—enough food for more than sixteen times our current numbers.

Most of the world's farmers till the soil with methods little changed in a thousand years. The spread of modern agriculture can help assure the underdeveloped two-thirds of the world the freedom from hunger it gives the economically advanced one-third. It can help us buy time against world famine while we press efforts to control the mounting population. As Dr. George W. Irving, Jr., research administrator of the U. S. Department of Agriculture, put it:

"Our agricultural revolution is setting up things so that other nations can telescope what we have done." And he pointed to Mexican wheat and Philippine rice as examples of how our revolution is spreading.

Tailor-made Grains for Hungry Lands

Mexico used to import wheat, its farmers scratching only eight or ten bushels an acre out of their fields. Then a program supported by the Rockefeller Foundation crossed Mexican wheats with a dwarf Japanese strain. Slowly at first, then burgeoning, use of resulting varieties spread. In little more than a decade Mexico became a wheat exporter; farmers could brag of yields of more than forty bushels an acre.

Mexican wheat, crossed in Pakistan with native strains adapted to local soil and climate, has revolutionized grain production in that part of Asia.*

Ford Foundation and Rockefeller funds have made possible an equally dramatic advance with rice in the Far East. At a research center in the Philippines, scientists bred a strain they named IR-8. It boosts harvests three- or fourfold and can yield a crop in two-thirds the normal growing time.†

Mexican wheat and IR-8 rice and their descendants aren't the only genetic developments with startling impact. In my travels I heard talk of tailoring cotton plants to grow fewer leaves so shade-loving boll weevils would be discouraged. And I saw how scientists and engineers revitalized California farming and saved a canning industry by creating a tomato plus a machine to harvest it.

White-haired, genial Professor Coby Lorenzen, of the department of agricultural engineering at the University of California's Davis campus, sketched the background for me.

"In farming, as in industry, laborsaving devices make jobs easier and cut costs," he said. "It didn't take too much foresight to realize that the stoop work of tomato-picking would one day be a prime target. My colleague G. C. Hanna—he's a plant breeder—first sparked my interest in the problem.

"We knew we couldn't develop a machine to handle the

*See "Pakistan: Problems of a Two-part Land," by Bern Keating, NATIONAL GEOGRAPHIC, January 1967.

†This project was described by Robert de Roos in "The Philippines, Freedom's Pacific Frontier," GEOGRAPHIC, September 1966, and by Peter T. White in "The Mekong, River of Terror and Hope," December 1968.

Research, yeast of the revolution

As an apple nests on an electronic vibrator, a recorder rolls out a message that tomorrow's shoppers will welcome. Registering the passage of sound waves through the fruit, the instrument tells whether the Red Delicious is too green, too ripe, or a juicy just right. When perfected for use by packers, the device could do away with the doubting squeezes that shoppers bestow on fruit.

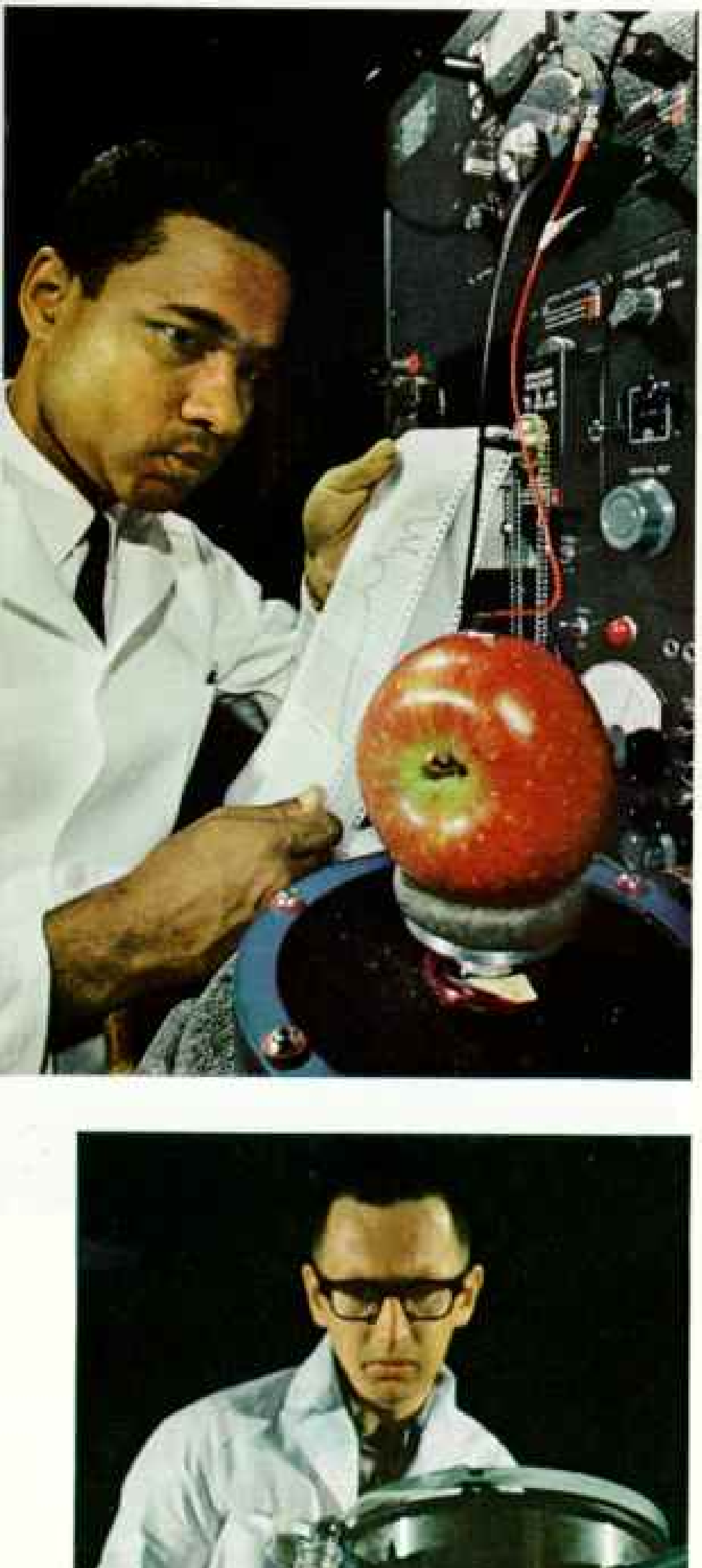
Here an agricultural engineer seeks to improve the vibrator at the U. S. Department of Agriculture's research center in Beltsville, Maryland.

Bare hands fleece a sheep painlessly in an experiment at Beltsville. Researchers give the sheep an anti-tumor drug which sometimes causes the hair of human cancer patients to fall out temporarily. The technique would call for care on a farmer's part to harvest his wool before it dropped off in the field.

Frothy alfalfa juice bubbles in a freeze-drier at the Deere & Company Technical Center in Moline, Illinois (lower left). The center seeks a low-cost way to extract alfalfa's abundant protein for human consumption.

Far-spreading roots of a soybean plant are laid bare at the National Tillage Machinery Laboratory (lower right) in Auburn, Alabama; a squirt bottle cleans matted rootlets. Determining soil conditions that bring optimum growth helps agronomists design better plows.

In the unending struggle to keep research a long jump ahead of food and fiber needs, state and federal governments invested almost $500,000,000 last year, while private industry surpassed that amount.



Spinning a morning mist, a helicopter sprays an orange grove for rust mite near Waverly, Florida. Nozzles on the boom eject diluted chlorobenzilate, a pesticide of little danger to man or animals. Wash of the blades drives it down on the fruit.

To lessen the hazard of more toxic insecticides, farm scientists experiment with airborne atomizers that spray ultrasmall droplets of undiluted chemicals, reducing the quantity needed.

conventional tomato plants; we'd have to develop a plant to fit a machine. Ideally it would be a vine on which all the tomatoes would ripen at the same time, because, for efficiency, the machine should harvest plant and all on a 'once-through' operation.

"The tomatoes should stay ripe on the vine longer," Professor Lorenzen said. "That would give more leeway at picking time. Skins and interiors should be a bit sturdier to withstand machine handling, and there were other requirements."

The two men began their work in 1949. Mr. Hanna bred plant after plant. Professor Lorenzen tried dozens of machine designs. Finally, in 1960, a suitable tomato and an experimental machine were ready. J. Bernell Harlan, who with a partner farms 1,500 acres near UC's Davis campus, tested both.

"Lots of things went wrong," Mr. Harlan recalled. "Tomatoes got crushed. Too much dirt came up with the vines. Breakdowns were frequent. But we could see possibilities."

And just in time. Congress ordered an end to the bracero program which permitted migrant labor from Mexico to enter the U. S. This had been the major source of field hands.

Said Mr. Harlan: "Many tomato growers figured they'd have to give up farming. Canners made plans to move to Mexico. But by 1965, when the bracero ban went into effect, most of the bugs had been worked out of the harvesting machine, and we had learned what cultivation practices the new tomato plant required. The way this saved the tomato business in California reminds me of those cavalry rescues in Wild West movies."

Machines Multiply Farmers' Output

Today 90 percent of the state's tomato crop is picked mechanically (pages 152-3). Indeed, mechanization is one of the key inputs of America's agricultural revolution. The average farmer has more horsepower working for him than does the average factory employee. It helps him produce with each hour's labor seven times as much as he did 50 years ago.

"Machines do replace labor," G. E. Vandenberg told me when we discussed farm mechanization in his office at the USDA's Agricultural Research Center in Beltsville, Maryland.* "However, it is the scarcity of labor that really spurs adoption of machines. For example, tractors didn't get into widespread use until the U. S. Army took horses and mules off the farms to meet the needs of World War I. The corn picker and the hay baler had been around before World War II, but they weren't widely used until farm youths went off to fight and farmers had to have machines to get the work done."

Then he described an incredible parade of

*See "Beltsville Brings Science to the Farm," by Samuel W. Matthews, NATIONAL GEOGRAPHIC, August 1953.

machines at work today on U. S. farms: Acre-eaters that in an hour can plow a hundred times as much land as a farmer with a string of oxen. Self-propelled combines that permit a man to ride in an air-conditioned cab to harvest a crop of corn that used to take a crew of 80 hands. Monster road-building machinery to level terraces or shape rice fields. Helicopters to spray cucumber fields. In all, such a host of devices that today U. S. farmers are investing eight times as much capital as they did thirty years ago.

I got other insights into mechanization when I talked to a peach grower in Georgia and a wheat harvester in South Dakota.

"We used to thin peaches by hand at a cost of as much as a dollar a tree," William J. Wilson said as he drove me around his orchards at Fort Valley, Georgia, county seat of appropriately named Peach County. "Now a mechanical shaker does the job at a labor expense of only a few cents. The machine cost $10,000, but I saved almost enough in labor the first year to pay for it."

A thousand miles away, on the rolling prairies of South Dakota, I rode the platform of a wheat combine with wiry, 74-year-old J. D. Davis. Dust sifted through my clothes and turned my underwear gray. Grit from the chaff reddened my eyes. Its constant rubbing had given the ironwork of the cutter bar a mirror polish.

"I've been doing this for 39 years," the World War I ex-Marine told me over the combine's clanking. "The first machines I owned were like toys compared to this thing. Then, 20 acres was a good day's work; today one combine can cut more than 100."

Behind us five more combines in echelon chewed a widening swath through the golden grain. Davis is a custom combiner, working on contract for wheat growers (pages 148-51).

"I started with one combine. Now I have six. Growers keep increasing their acreage, and so I have to expand."

This trend to bigness and specialization finds no sharper examples than in the Nation's poultry industry. I dug out part of the story in the red-clay hills of Georgia, and part from southern California's citrus-dotted slopes.

"Twenty years ago broilers sold for 65 cents a pound, and fried chicken was a treat for Sunday dinner," Ralph D. Mobley said in a soft Georgia accent. "Most farms had a little flock that helped provide the farmwife with butter-and-egg money. Now chicken is cheaper than hamburger, and coops on the average farm are empty because the farmwife can buy dressed birds in the supermarket for less than it would cost her to raise them herself. The reason? Research and greater efficiency in the broiler business."

Tenth of a Cent Spells Profit or Loss

Mr. Mobley has watched those changes come tumbling. He is director of broiler and hatchery operations for the Cotton Producers Association, a cooperative based in Atlanta, Georgia. It is a major producer of broilers in the state which leads all the rest of the U. S. in this field.

"It used to take 14 weeks of growing time, plus 4½ pounds of feed for each pound of weight gained, to raise a chick to broiler size," Mr. Mobley said. "Nowadays the average is 8 weeks and 2 pounds. Part of the improvement comes from genetic development of a breastier, meatier, tastier bird. Part comes from better feeding—scientists know more about chicken nutrition than they do about that of humans."

And he showed me a page-long list of the ingredients in a broiler formula, everything from alfalfa meal to xanthophyll—a plant compound used to give chicken skin a pleasing yellow tinge. Computers, he explained, figure the items on a cost-per-nutritional-element basis. They help decide whether to substitute, say, fish meal from Peru if the price of domestic meat and bone scrap goes up a mere dollar a ton. Such factors can be of vital importance, since a tenth of a cent per pound in the market price of broilers can mean the difference between profit and loss.

"The producer also has to pay attention to little things like how full the automatic feed troughs are kept," added Dr. Donald H. Sherwood, chief scientist at the cooperative's research farm in Talmo, Georgia. "The birds may scatter

From field to freezer—fast!

Dislodged by a workman's rake (right), peas fresh from the field slide down sloping wagon sides onto a conveyor belt at Seabrook Farms in New Jersey. Flowing into a processing plant, the green flood will swirl through cleanings and cullings to emerge in only 20 minutes, quick-frozen for the table at the moment of prime ripeness.

From a hailstorm of frozen peas, an inspector scoops a sample to scrutinize for color and maturity (below).

Vegetables and fruits, unlike meats, posed a problem to early processors by deteriorating even when frozen. In the 1920's came the discovery that a brief

dunking in hot water inactivates quality-damaging enzymes that defy subzero temperatures. Faithfully preserving the food's flavor, appearance, and nutriments, quick-freezing wrought one of the early innovations of the agricultural revolution.

Like rubies spilled from a black silk bag, fields of the lush Imperial Valley flow from the dark Salton Sea; infrared film turns healthy vegetation red in this photograph taken 150 miles above California, Arizona, and Mexico by the astronauts of Apollo 9. Irrigation waters from the Colorado River, far right, run along the dark lines of the All American Canal to convert the desert into a greenhouse of vegetables, cotton, sugar beets, alfalfa, and other crops. To carry away salts borne in by the river

waters. California farmers bury miles of drain tiles. In Mexico, where growers are less able to afford tiling, the salinity withers crops. The result appears here with grim clarity as California's lushness ends on a line that sharply marks the international border.

and waste a third of the feed if troughs are full, compared with only 1 percent if they are one-third full. And with a flock of 10,000 birds, that could mean a saving of nearly a third of a ton of feed a day."

Automated feeders, waterers, ventilators, and other labor savers make it possible for one man to take care of 100,000 broilers at a time, Dr. Sherwood added. The average producer handles about 20,000. Altogether in a year farmers in the United States raise more than two and a half billion birds—a dozen for every man, woman, and child in our population.

The competitive pressure for efficiency has led to specialization among poultrymen—one growing broilers, another raising chicks to egg-laying age, another keeping breeding flocks, a fourth producing eggs. My grizzled friend of the plastic boots put it succinctly, "It's gettin' so there's too much to keep track of in one part of this business, 'thout tryin' to know 'em all."

River of Eggs for Los Angeles

I saw this specialization dramatized in Julius Goldman's Egg City, 50 miles northwest of Los Angeles. One of the world's largest egg producers, it has two million hens.

Julius Goldman got into the egg business in 1951. An immigrant from Germany, he invested in 5,000 chickens to have something to do while he polished his English enough to pursue his regular profession, metallurgy.

"In those days a farmer might make only a dollar or so a year per bird," Mr. Goldman said. "Now he's lucky to make half that. To gain efficiency, we had to expand."

With Ben Shames, Egg City's Executive Vice President, as my guide, I saw what that expansion has required: A mill to produce the 250 tons of feed a day needed for the craws of Egg City's layers. Two wells to supply a daily demand for 100,000 gallons of water. A packing plant that cleans, inspects, and packages a million eggs a day. Block-long buildings, each housing 90,000 White Leghorns, cooped five birds to a 16-by-18-inch cage, and with row after row of cages suspended three feet above the floor (pages 172-3).

Wire-mesh bottoms of the cages slant, so eggs when laid roll out to a collection rack at the front. Fascinated, I watched employees push carts down the aisles between rows, shoving them ahead with their chests and loading the eggs onto plastic trays with both hands. And I followed a little battery-powered

truck as it moved along, pumping feed from a hopper into troughs before the cages. A dial indicated amounts delivered.

Mr. Shames explained: "We keep track of the feed eaten and the eggs collected in two rows of cages among the 110 rows in each building. When production drops to the uneconomic point, all 90,000 birds are sold to processors for potpies or chicken soup. It doesn't pay to keep track of every row in the house, let alone individual hens; with two million birds on hand, you have to rely on statistical sampling."

Droppings Pose a Problem

Just then a little tractor came by, equipped with an arm that plowed through the droppings on the floor beneath the cages.

"We used to spend thousands of dollars on insecticides to keep down flies," Mr. Shames said. "Now blades on the arm windrow the droppings, speeding drying and thus curtailing fly-breeding. At the same time the material is moved in stages toward the center aisle, where the tractor picks it up. We've just about solved the fly problem, but not what to do with the collected manure. And we have 120 *tons* a day to contend with."

This was a facet of farming I hadn't imagined. I got a more jolting awakening when I roamed the feed lots of the Blair Cattle Company in Blair, Nebraska.

"One cow produces as much waste as 16 humans," Harry J. Webb, the company's president, said matter-of-factly. "With 20,000 animals in our pens, we have a problem equal to a city of 320,000 people. But we kept that in mind when we bought this place."

Details of how this energetic cattleman and his associates put together their feed lot epitomize the keen management involved in successful farming today.

"The company started in 1965," Webb told me. "We began with feasibility studies, using computers, to pinpoint an ideal location in relation to sources of feed and cattle. It also had to be central to slaughterhouses, on a major highway, and near a railroad. The land had to be hilly, so quick runoff would leave dry footing for the cattle after rains. The slopes should have a south exposure, so the winter sun would work for us, and we wanted a prevailing breeze for coolness in the summer. Lastly, there had to be pastureland where manure could be spread, and a place to build a drainage pond which would keep runoff from polluting nearby streams.

Farmer-executive

Airplane and office are as familiar as the field to this modern American farmer of Marysville, California. Gesturing behind his long desk (below), burly Earl Blaser maps a harvesting campaign with his son and son-in-law. Working as many as 75 hands and $250,000 worth of equipment, they farm 2,500 acres planted in tomatoes, cucumbers, rice, and fruit. Diversifying like other businessmen, they also operate a farm-equipment agency and a duck-hunting club.

Piloting his own plane, Blaser inspects crops —and prospects for more acreage (right).

"Dad kept his farm records in a cigar box," chuckles Blaser, who today employs a full-time accountant. For decisions on planting and efficiency, he consults a computer, nowadays the progressive farmer's almanac.

"When this 320-acre place twenty miles from Omaha measured up, we bought."

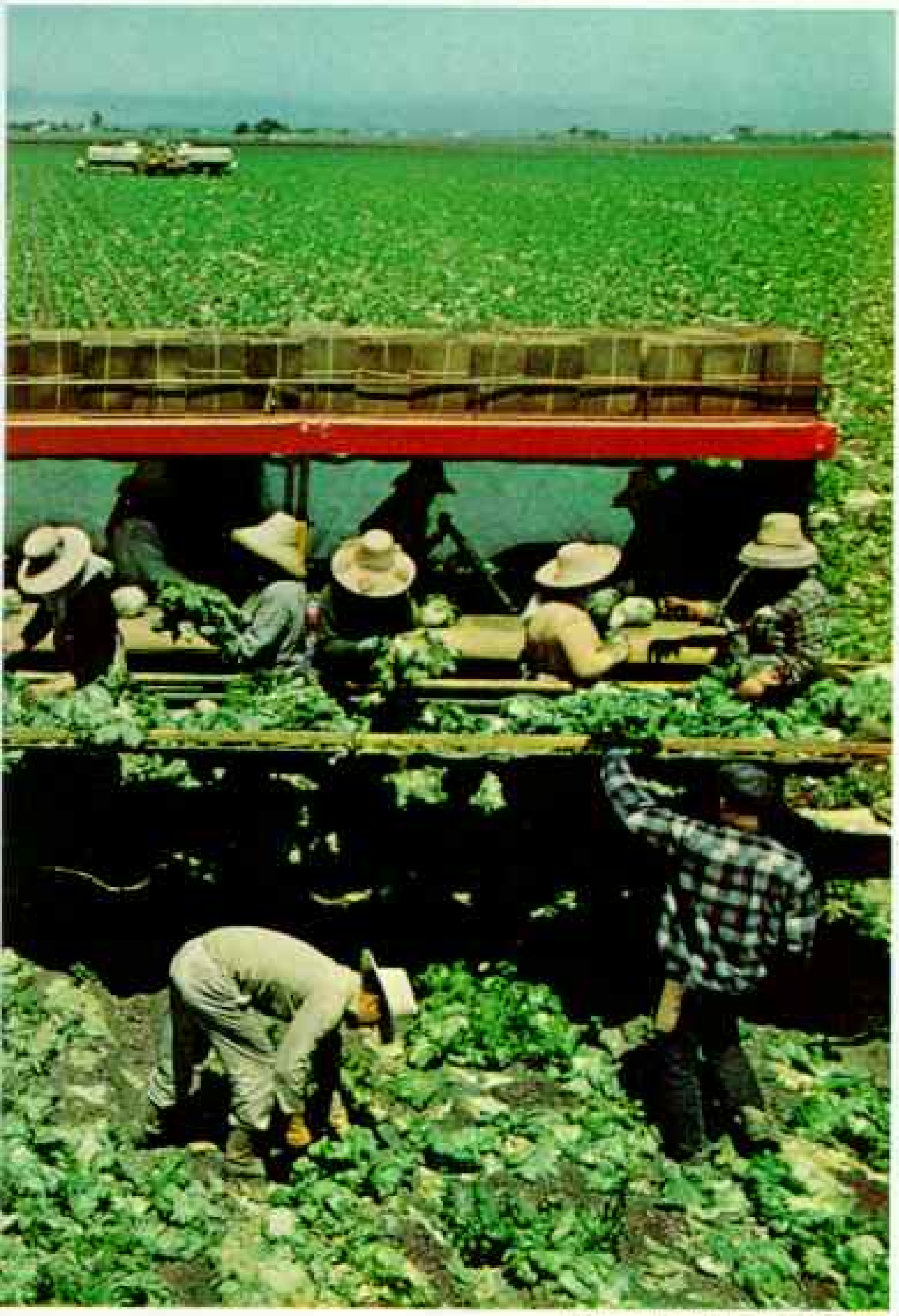
Now four miles of feed bunkers and concrete roadways to service them lace the one-time grain farm. A quarter-million-dollar feed mill rolls corn into tasty flakes and mixes a molasses-flavored ration that puts 2.7 pounds of weight on a steer every day. Calves bought for fattening grow to slaughter size in as few as five months; in the 1930's cattlemen figured on two and a half years.

Another revolutionary development in cattle raising unfolded for me when I traveled the hills of west Texas and the flatlands of the lower Rio Grande Valley.

"Used to be you couldn't afford to have calves born between early spring and late fall," a rancher told me. "Chances were that three out of four would die from screwworms getting in unhealed navels. Now that the screwworm eradication program is working, you can drop calves year round."

The screwworm, I learned, is the larva of a fly that lays its eggs in open wounds of animals. Hatched maggots eat the living flesh; a severe infestation can kill a full-grown steer in ten days. The insect's eradication is one of the brilliant achievements of our agricultural revolution.

"The female screwworm fly mates only once in her life span of three to four weeks," explained Dr. S. C. Gartman, director of the USDA's Screwworm Eradication Program facility at Mission, Texas.



Factory in the field

Its crew a precision team, a lettuce packer trundles along endless rows in California's Salinas Valley. Developed by Bud Antle, Inc., a mammoth growing and shipping firm, the machine packages the lettuce for market in a "once-through" operation that typifies the efficiency of today's large-scale truck farms.

As the machine crawls at 1½ miles an hour, men follow on foot cutting ripe heads. Women riding the harvester lop off outer leaves and wrap each head in transparent plastic. A heated "shrink tunnel" tightens the wrapper. Men at center pack 200 cartons an hour and leave them for trucks that will rush them for shipment to food stores across the Nation and in Europe.

After the harvester finishes the field, it will fold its outspread "wings" and propel itself at 45 miles an hour down California's freeways to reach the next crop.

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

"Back in the 1930's, an entomologist studying the fly's life cycle suggested that if the female could be mated with a sterile male, all her eggs would be infertile. No progeny would result. Continuous release of an oversupply of sterile flies would progressively increase the odds against a fertile mating. In time, eradication would result."

Naked in a Fly Factory

Not until 1951, Dr. Gartman added, was a way—irradiation—found to sterilize the males. Tried in a test program on the island of Curaçao in 1954, the technique wiped out the pest in four months. A bigger-scale operation rid Florida of screwworm flies in less than two years. The plant at Mission, dedicated in 1962, currently produces as many as 200,000,000 sterile flies a week for release in a wide strip along the U. S.-Mexican border.

I toured the facility with USDA entomologist Bill Sudlow. Its operations—and security precautions against escape of fertile flies—astounded me. You strip off street clothes in a locker room, then walk stark naked through a double-doored corridor designed to trap errant flies. In an equipment room you don a hospital-white uniform. Three successive fly-trap corridors next have to be passed before you enter the fly-rearing room.

When you leave the factory, you reverse your route, pausing for a shower that washes away any pinpoint-size egg or half-inch larva you might have picked up. Even the notebook

Making hay the acheless way: A bale sails 15 feet high into a wagon at Columbus, Wisconsin. Hydraulic catapult on the baler flings the 60-pounder, saving human backs from one of farming's most onerous chores.

Row-side service: As his wife delivers the lunch pail, Norman Barker empties corn from his combine on the family farm near Le Mars, Iowa. Fertilizing heavily, Mr. Barker raises enough corn on 140 acres to fatten more than 700 hogs and 100 head of cattle. Electrically heated pens permit the hogs to farrow even in winter, when he can tend them free of field work.

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


JOHN DEERE
24T

I carried had to go through a decontaminating "hot room."

I watched tiny larvae grow in racks of trays, eating in waves through a slurry of food made mostly from packing-house waste —"20 tons of ground pork lungs every day," Bill said. Reaching full size in 80 hours, they crawl over the edges of the trays and drop into troughs for mixing with sawdust, in which they transform into hard-shelled pupae.

Five days and 16 hours after pupation, sex cells begin maturing. Precisely then the pupae are exposed to sterilizing rays from radioactive cobalt. I marveled at the mass production of 200,000,000 living things a week with the precision you'd expect in a factory turning out nuts and bolts. And I was impressed by the implications outlined by Dr. E. F. Knipling, now director of the USDA's Entomology Research Division and the scientist who conceived the sterile male idea.

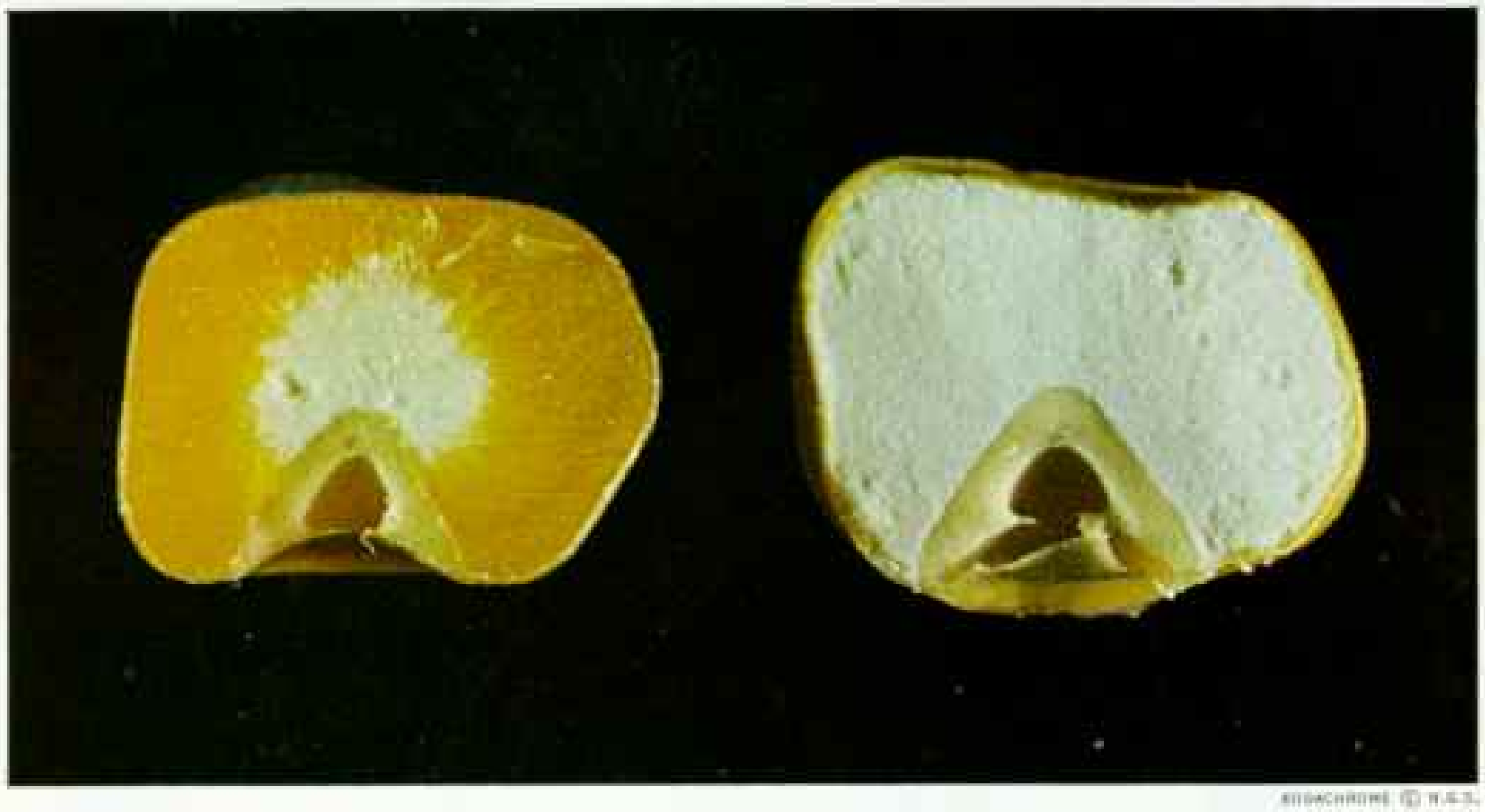
"Insects can't develop immunity to sterilization as they can to chemicals," he said. "There's no harm to beneficial insects, as may be the case with spraying—or residue to affect crops or wildlife. And we are now adapting the techniques to other insect pests."

Science also is learning how to turn other of the insect's own secrets into weapons. Among recent accomplishments in this field:

• Isolation of a hormone that, in a dose of only a billionth of a gram, keeps the young of certain insect pests from developing beyond the juvenile stage.

• Discovery that a hibernation-like stage known as the diapause may be affected by light, perhaps making it possible to trick insects into emerging in killing weather by means of light flashed over a field.

• Synthesis of sex attractants to lure insects to baited traps, where they can be destroyed or chemically sterilized. One substance, similar to that produced by female pink bollworm moths, is so powerful that a single pound would provide enough to bait 100,000 traps.



BIOMEDIA © N.G.S.

Bland coloring belies a nutritional wallop possessed by a new protein-rich corn strain, shown in cross section beside a yellow kernel of common corn. A team of scientists at Indiana's Purdue University bred the new variety by adding a protein-building gene, opaque-2, to common corn. Although still experimental, the new cereal stirs worldwide excitement: If geneticists can breed grains to rival meats in protein quality, mankind will win a major victory in the war against malnutrition.

Researchers seek ways, too, of pitting natural enemies against plant and insect pests that plague the farmer. Wasps that lay eggs in alfalfa weevils have been released in twenty states. Leaf-eating caterpillars and seed-eating fly grubs shape a double-barreled attack against a weed poisonous to cattle on Western ranges. Bacteria fatal to corn borers are being packaged in capsules whose coatings

dissolve at different rates—like timed-release medicines people take—to prolong the bacteria's effectiveness.

But the war against farm pests is a monumental struggle, Dr. Knipling cautioned. "Experts estimate that 75,000,000 acres of crops each year are lost to insects, weeds, and plant diseases. Biological control using natural enemies has built-in limitations—the parasites cannot eliminate all hosts without also destroying themselves."

Science Lessens Chemical Hazards

New pesticides and safer ways of using them pop from the laboratories. Systemic insecticides, for example, that plants absorb through leaves or roots for built-in protection, or ultralow-volume spraying of undiluted chemicals, which does more with less material (pages 156-7). Teamed with biological controls, such developments may ease problems posed by DDT and other poisons.

Last November the U.S. Department of Health, Education, and Welfare announced the Government's intention to curtail all except "essential" uses of DDT. The move spotlighted national concern over possible risks from pesticide residues in foods and the spread of chemicals in the environment through runoff from fields.

I discussed the subject of farm chemicals and their dissemination with Dr. Irving of the Agricultural Research Service.

"It is in the public interest to minimize contamination of our surroundings," he said. "But the farmer is not the big offender. Much of the problem is associated with industrialization and urbanization."

More phosphorus, with its oxygen-robbing effects on lakes and streams, comes from detergents and other city wastes than from farm soil, where the chemical is relatively immobile. And no cost-conscious farmer loses fertilizer to runoff by putting more nitrogen on his fields than he gets back in crop yields.

We talked, too, about agricultural research and its promise for the future. "Today's advances are based on yesterday's research," Dr. Irving said. "Right now more scientists are working on investigations related to agriculture than ever before. And this progressive accumulation of knowledge can only accelerate the farm revolution."

In laboratories of the U.S. agricultural research system—which reaches into every state—I learned about a changed emphasis in scientific aims. Said one scientist, "What's important now—and farther reaching—is not how to grow corn, but how corn grows."

I found scientists feeding plants radioactive fertilizer to analyze their growth; using chemicals to try to turn wheat straw, soybean hulls, and other waste products into nutritious animal feed; dosing sheep with a drug that enables the wool to be pulled off by hand, eliminating shearing (page 155).

I saw sorghum being popped, like popcorn, as an experimental cattle feed in a specially developed machine; wool being chemically treated so scales on the fibers won't tangle after a wetting—eliminating the cause of fabric shrinkage; wheat being processed into a quick-cooking nutritious form that can be substituted for rice (following page), or be used to make meatless dishes tasting like chicken, beef, or ham.

And I visited industrial plants and university campuses where brilliant minds are at work on other intriguing projects, such as farming the vast reaches of the sea, making protein from bacteria that live on the waxes in petroleum, and producing food for man or his animals from algae, newsprint, and even animal wastes.

City Boys Now Become Farm Experts

At one campus, the University of California at Davis, I was jolted by an unexpected fact. Even though the number of farmers in the United States is shrinking, enrollment in agricultural colleges grows.

"Job opportunities for graduates keep expanding," Dr. James H. Meyer, chancellor of the Davis campus, explained. "Many today are in agri-business—industries such as machinery or chemicals with farms as a market. Others are in rural sociology or environmental toxicology or one of the other fields that colleges have had to add to their curriculums to keep pace with the agricultural revolution.

"Once, only farm youths went to agricultural college. Today, four out of five of our students come from urban areas. We've even had to put in a course to teach city boys and girls such things as how to drive a tractor and what a milking machine looks like."

I had read statistics revealing that a third of the Nation's three million farms produce a gross income of less than $2,500 a year. At the same time, to own a farm requires an

Wheat for rice-eating peoples: Peeled by lye, wheat gleams near-white beside untreated grain, left. Giving chewy, high-protein wheat the color and "mouth feel" of tender rice, the process makes it palatable to Asians unaccustomed to it. Scientists call the product WURLD wheat for its place of origin: Western Utilization Research Laboratory in Albany, California.

Walls of wheat rise from the Kansas plains at Hutchinson. Half-mile-long Far-Mar-Co elevator, rear, holds 18 million bushels. Each summer the elevators fill with wheat, then empty again as they feed the Nation's flour mills.

investment ranging from $20,000 for a small North Carolina tobacco farm to $100,000 or more for a well-equipped place in the Corn Belt and as much as $1,000,000 for one in California's productive San Joaquin Valley.

I had been told of some of the perils farmers face. "One year the crop was so bad I got only three peaches on my trees, and the birds and the ants beat me to those," my Georgia friend Bill Wilson had said.

"Just One Big Poker Game"

Why, then, would anyone want to farm? I got the answer from chats and chance remarks all across this productive land.

Ned Tyson, who raises corn and cattle on his Nebraska bottomland, phrased it one way. "Some days you lose, and some days you make it. Farming is just one big poker game, and I guess farmers are all gamblers."

Dairy farmer Fred W. Marshall of Munnsville, New York, put it another way. "Sure I have to get up at 5 a.m. and keep on the go for 12 hours. But there's constantly something different to do—fixing fences, cutting brush, milking, planting, studying computer records, making business decisions, and so on. That's a lot better than tightening the same nut on the same part on an assembly line all day long."

Perhaps, though, the shrewdest summation of why farming attracts was expressed by a veteran farm publication editor in Washington, D. C. "Getting up to go to work in the fields is different from going to an office," he

Egg City, California

With a cart as his basket, a workman gathers part of the million eggs produced each day at an egg factory near Los Angeles. Egg City shelters two million Leghorns that gobble 250 tons of feed a day. When the 90,000 birds in a house slump below a computer-calculated output, all are consigned to chicken soup or potpies to make way for lustier layers.

Bright lights (below) underneath a conveyor reveal defects in shell, yolk, or white.

said. "Nobody makes you do it but yourself. And if you want to knock off at 2 p.m. to go fishing, and come back after supper to finish the plowing, nobody says you can't."

The number of farms with annual gross incomes of $10,000 or less is dwindling. Hard-pressed farmers sell out or lease to a neighbor who wants to expand. Older people retire. Death creates an estate, and the heirs decide the home place is too small to work profitably, so it goes on the block. Paper after paper that I picked up in farm states reiterated the story in poignant want ads: "Leaving farm. Dairy herd to be sold at auction." "Due to health, am moving to town. Machinery for sale." "Farm and equipment offered at sacrifice prices."

On the other hand, farms grossing more than $10,000 a year expand in number, with those in the more-than-$40,000 category increasing rapidly. The family farm figures largest in this growth. It accounts for 95 percent of all farms and 64 percent of total marketings. Corporate behemoths play no greater role today than 20 years ago; the specter of their progressively gobbling up all the farmland and in the end holding consumers at their mercy seems farfetched.

Leonard Warner of the American Farm Bureau Federation told me about limitations to the growth of corporate farms.

"The big corporation has to pay its farm managers and labor before it can count its

EXTACHROME (OPPOSITE) AND KODACHROME (INCLUDING FOLLOWING PAGES) © N.G.S.

profit. But the individual owner pays himself with the difference between the farm's income and expenses; instead of hiring labor, he takes the hours of sweat out of his own hide. And as long as we consumers reward him with enough to provide the standard of living he aspires to, he'll hold his own against the big corporations."

Is She or Isn't She a Farmwife?

That standard of living has changed greatly. Once it was fairly easy to tell a farmwife because of her ill-moded attire and drudgery-hardened hands. Today she's as likely to be mini-skirted as her city sister, and as likely to own a dishwasher or self-cleaning oven or color television set. And her husband, who drives a tractor with automatic transmission and uses power tools to eliminate back-straining labor, is as likely to have gone to college as his town cousin.

Out where the Bearpaw Mountains rise against Montana's skies, and where wheatlands and cattle ranges stretch for empty miles, I discovered how profoundly life has changed for the farmer.

"Electricity has played a tremendous role," ebullient cigar-smoking Harold C. Ebaugh said. As manager of the Hill County Electric Cooperative, he bought its first pole in 1946 and shepherded its growth into a 2,990-mile network of power lines supplying ranches and farms around Havre, the county seat.

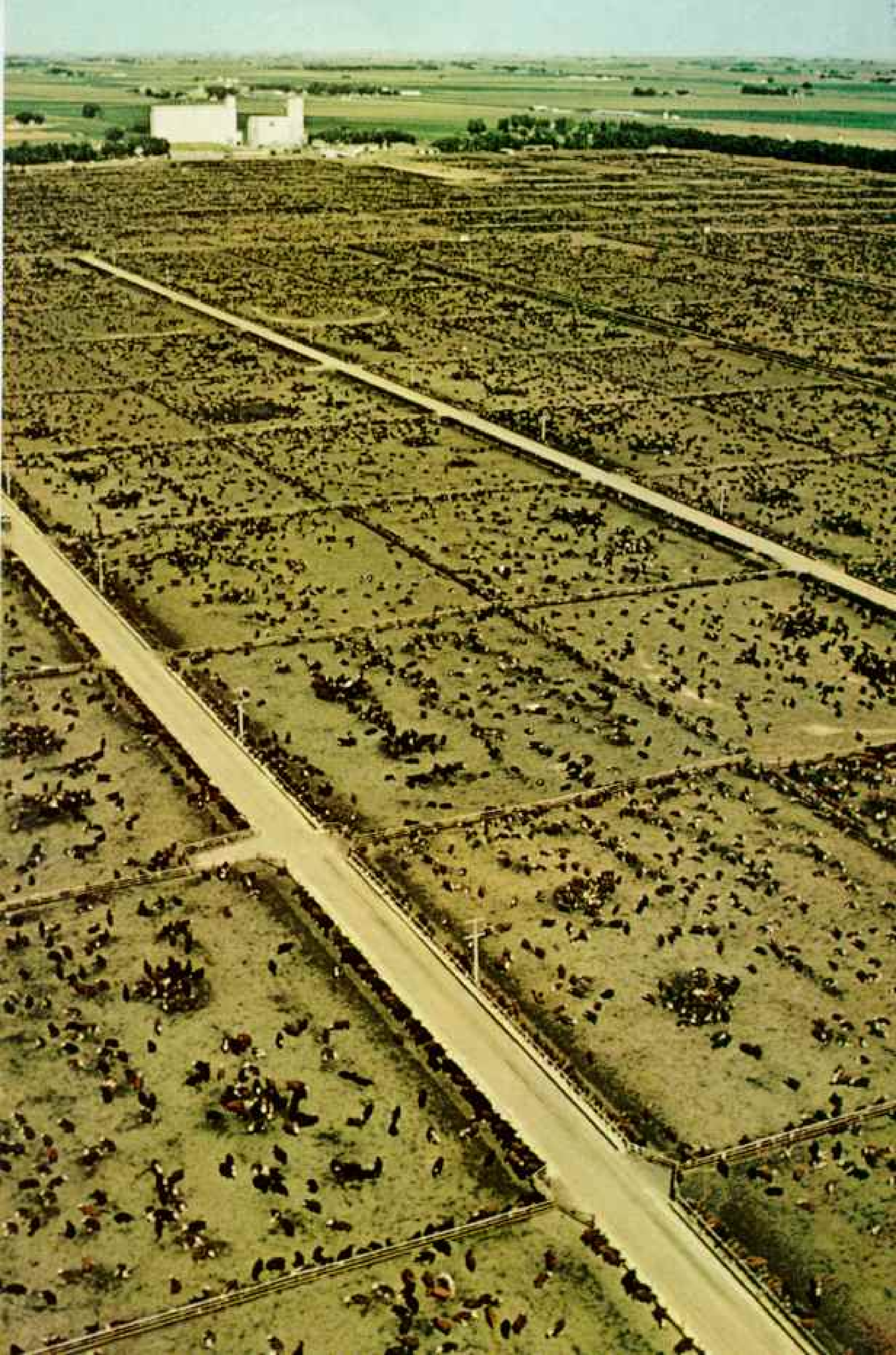
"Before we started, only a few farms had wind chargers or gasoline-driven generators, and they were adequate for no more than a few lamp bulbs and maybe a small water pump. Today our typical customer uses half again as much electricity as the city dweller. At least 35 different electric appliances and a hundred other machines with electric motors are being used on U. S. farms these days."

Electricity offers surprising niceties—having radiant heat in the concrete floors of pigpens, for example. I learned about this when I visited the 440-acre corn-and-hog farm of Norman Barker in the rolling prairie country of northwestern Iowa.

"Makes possible farrowing in the wintertime," he explained. "With insulated buildings, electric heat, and thermostatically

Beefburg, Colorado ▶

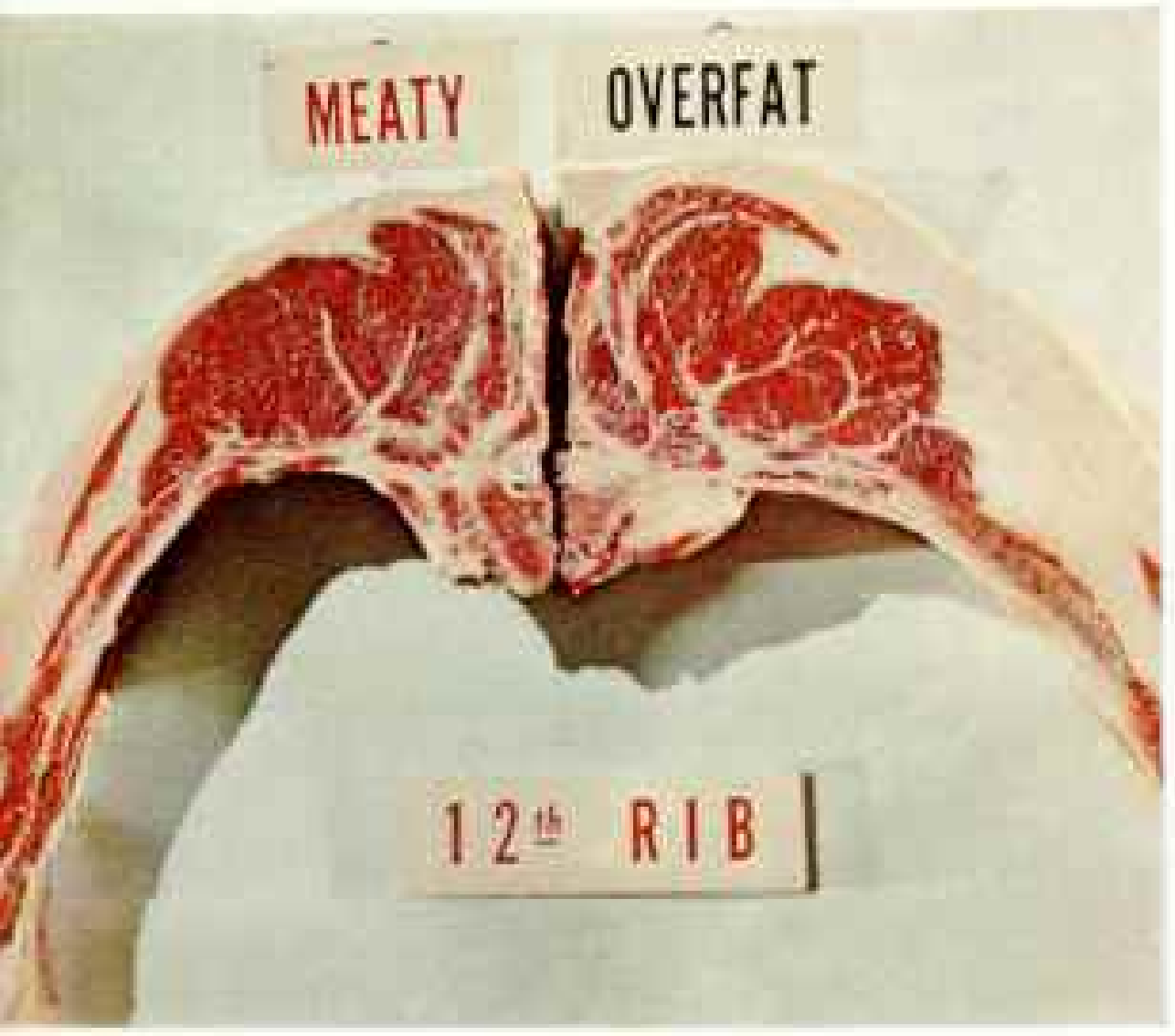
Sprawling Monfort Feed Lots near Greeley form a teeming bovine metropolis (following pages). Here 100,000 steers fatten, largely for Eastern restaurants and hotels. In a marvel of automation, computers prescribe formulas of ensilage and hot corn flakes for each pen; trucks distribute the rations into troughs lining the roads. Responding to such attention, a Monfort steer gains 2½ pounds a day during its three-to-five-month stay.



EKTACHROME (above) AND KODACHROME ©, N.G.S.

Her work its own reward, a technician at Beltsville samples beefsteak for tenderness and flavor. Red light eliminates appearance as a factor. She participates in a Department of Agriculture test to determine the effects of feeding methods and animal maturity on the quality of meat.

Fat is out, lean meat in. A demonstration at Iowa State University in Ames shows changing consumer tastes. The rib at left harbors 25 percent less fat —a result of intensive experimentation in genetics and selective breeding.



controlled ventilation I can manage four or five farrowings a year. That means labor and income spread over 12 months and a better average market price.

"My dad farrowed pigs in the spring, and they all had to go to market at the same time in the fall. When he raised 200, he was doing pretty good. I usually raise 700 to 800. But then farmers in dad's day didn't pour on fertilizer the way we do now to grow feed corn."

Farmers' Magic Touch: Fertilizer

Fertilizer has been one of the basic ingredients of the agricultural revolution. In a sense it replaces land, since it can multiply the yield of a single acre dozens of times. With more and more fertilizer, U. S. farmers reap record harvest after record harvest—and in the process get back as much as $3 in income for every $1 worth of chemical nutrients they spread on the soil. In 1968 they used nearly forty million tons—260 pounds for each acre under cultivation.

By contrast, the average cultivator in the underdeveloped nations had available a paltry five pounds. Yet American farmers aren't the world's heaviest fertilizer users. Europeans often use double what we do, and Japanese farmers four times as much.

I talked fertilizer and farming with slim, bespectacled Wayne M. Hansen while he harrowed a field near Dorchester, Nebraska. My perch on the tractor's fender made my notes a sawtooth scribble even when, out of compassion, he slowed to three miles an hour.

"You've got to keep getting more efficient to stay ahead in farming," he said. "Take that silo of mine over there."

Its vinyl-coated steel gleamed white on the brow of a hill.

"I used to have to drive from building to building picking up ingredients for the feed troughs in my cattle pens. With that silo they're brought together and mixed automatically. Takes me 20 minutes now to feed 200 head. I used to spend more time than that feeding 50.

"Of course, my feed set-up cost $30,000, and I haven't finished paying for it yet. But I'm already planning on expanding it. Perhaps I'm lazy; I use credit to save labor."

In a bustling county seat with the wonderfully rural name of Grundy Center, Iowa, I learned other things about farm credit from Wes Heckt. White-haired Mr. Heckt is board chairman of the Grundy National Bank.

"Credit has done a lot to help the farmer

take advantage of mechanization and other factors of the agricultural revolution," he said. "In 1920, when I started banking, $5,000 was a big loan, and people hesitated to borrow. Now a $40,000 loan is commonplace, and having mortgage after mortgage is an accepted thing. I occasionally wonder whether the average farmer will ever be out of debt."

With credit, daring, and managerial skill, today's farmer can build a substantial stake.

Earl Blaser started out on his father's 300-acre farm near Live Oak, California, teaching vocational agriculture in the winter and working the orchards in summer. Today he owns or leases 2,300 acres, flies his own plane to keep check on a multiplicity of crops (pages 162-3), and has at least $250,000 invested in machinery.

"Dad kept his farm records in a cigar box. I have to have an office, hire a full-time accountant, and use a computer to help me make decisions and measure my efficiency."

Deane F. Stahmann in 1932 added pecans to his cotton farm straddling the Rio Grande near Las Cruces, New Mexico.

"A nursery got stuck with a load of trees, and I couldn't resist a bargain," he explains. Now he has 200,000 trees, grows cotton in the sunny spaces between orchard rows, and raises 450,000 chickens in shaded areas. His multimillion-dollar investment includes 10 airplanes, a cotton gin, a feed mill, a pecan-shelling factory, and egg- and chicken-processing plants—to say nothing of a large maintenance shop for the farm's equipment.

John and Henry Elmore took turns in alternate years, one going to college and the other staying home to run the family farm.

Today the two towering brothers—both are 6 feet 5—work 15,700 acres near Brawley in California's sun-flooded Imperial Valley. Their fields are half a mile square, and they raise cotton, canteloupe, lettuce, and other crops with tractor-plow combinations costing $65,000 apiece. And they've turned a melon shed into a factory producing 15,000 feet of flexible plastic drain pipe a day.

BOTACHROME BY JAMES P. BLAIR © N.G.S.

Sow in surgery: An anesthesia mask on their patient's snout, a team at Iowa State University determines changes in a pig's ovaries during pregnancy. Such studies could lead to healthier litters.

Irrigated Fields That Stay Fertile

Around that drain pipe hangs a story of one of the developments in soil conservation that have highlighted today's remarkable change in agriculture.

Irrigation water carries salts. The Colorado River brings to the Imperial Valley 1.25 tons in every acre-foot. Spread over fields, the water could deposit the salts through evaporation under the hot sun, eventually turning the land to saline desert. Drains laid beneath the surface make it possible to carry off the water with the minerals still in solution.

"Growing cotton around here takes eight acre-feet of water a year," Henry Elmore said. "That means putting 1,600 tons of salts on a 160-acre field. If it weren't for the drains, we might face the same problem that helped erase ancient civilizations."

"When we began farming, drains were made of tile and spaced at 300-foot intervals," John Elmore told me. "Now the spacing is 100 feet, and in some fields, 50. It used to take six men to lay 300 feet of tile pipe, weighing more than a ton; a 300-foot coil of flexible

EKTACHROMES AND KODACHROME (LOWER LEFT) © N.G.S.

When machines displace people

Through the years, Ruth Anderson's husband had worked the sweltering cotton fields around Isola, Mississippi. In late spring Ed Anderson chopped cotton—hoeing weeds and thinning the plants. Summers he picked the cotton at $2.50 a hundred pounds. Between having her nine children, four of whom she tends above in the family's one-room shanty, Mrs. Anderson worked beside her husband. During picking season they brought home as much as $10 a day, and they got by.

Then onto the fields rolled machines (left) that harvested as much in a day as could 80 men. Picking jobs vanished. Herbicides came on the market to kill weeds; they killed the chopping, too.

Lacking a skill for steady work, the Andersons joined the hapless millions of rural refugees who, uprooted by mechanized farming, often drift to big cities seeking jobs.

To help stem this flow, civil-rights groups, foundations, and the National Council of Churches support a self-help community called Freedom City near Greenville, Mississippi. Determined to better his lot, displaced cotton worker Acie White (right) learns to read and write as he also masters the plumbing trade.

plastic pipe weighs only 65 pounds. We've developed a machine that slices the ground and lays the pipe as it goes, without digging a trench."

Other developments in soil management hold new promise for the farm. For example:

- Spraying hillsides with low-cost petroleum chemicals that prevent rainfall from soaking in, diverting it instead to reservoirs for use on thirsty fields.
- Spreading various materials in a covering layer on ponds to cut down evaporation.
- Replacing contour plowing with bench terracing that capitalizes on natural erosion to fill gullies and straighten fields, yet prevents loss of soil into waterways and streams.

I learned about another phase of soil research in the campus-quiet surroundings of the National Tillage Machinery Laboratory at Auburn, Alabama (page 155). Here USDA scientists study earth marked with telltale layers of facial tissue that show how soil behaves when turned by farm tools. Others experiment with such things as Teflon-coated plows for sticky clay fields.

Research goes on even into the side effects farm equipment has on the land—and whether fields actually need to be tilled at all.

"As farm machines become more and more powerful and grow bigger and bigger, they

increasingly compact the earth with their weight," said soil scientist Dr. William R. Gill. "This may even be offsetting the very aim of tilling—loosening the soil to promote plant growth. Hence there's a lot of interest in minimizing tillage by eliminating operations or doing several jobs with one trip through the field. And in 'zero tillage'—putting the seed in the ground amid the stubble and mulch of last year's growth."

We talked, too, about trends in farm planting, such as narrower spacing between crop rows, and precision planting—in which seeds may be placed at exact intervals on a strip of tape which dissolves after it is buried in the ground (page 153). Another innovation involves planting seeds in a capsule that releases fertilizer and water precisely when sprouting will benefit most.

Getting the prodigal abundance of America's fields onto consumer tables has seen marketing developments no less dramatic in their way than farming changes wrought by the agricultural revolution. New foods, too, reach grocery shelves. In 1900 fewer than a hundred different foods were readily available to the public. Today the number is ten times that. More are taking shape in laboratories and experimental kitchens.

Soybean Steaks Made to Order

At industrial plants in the Middle West I learned about soybean products made to look and taste like milk and meat. Highly nutritious, they worry dairymen and ranchers. An acre of grass fed to a steer can produce 43 pounds of protein; planted to soybeans, it yields 450 pounds. Ingenious machines spin the soybean protein into fibers of varying thicknesses, which in turn can be combined into textures resembling seafood, beef, ham, or chicken.

My wife finds temptation in the array of goodies on supermarket shelves. But like many a housewife, she complains about the prices. Her ire is only mildly eased by my citing the fact that, despite such prices, Americans still spend a smaller percentage of their earnings for food than any other people at any other time in history—about 17 cents out of each $1 of disposable income. And despite inflation, today's toil buys more: An hour's work buys you 25 percent more pork, 20 percent more beef, 13 percent more potatoes, 20 percent more milk, 25 percent more peas, 40 percent more eggs than it did as recently as the late 1950's.

Farmers complain that price hikes in the grocery stores seldom mean more money for them. Much goes for "built-in maid service"—processing that adds consumer conveniences grandmother never knew. Squeezed between higher operating costs and what he gets for his produce, the man on the farm must become more efficient or give up.

How many have given up can be seen in such figures as these: In 1910 our farm population accounted for a third of the U. S. total. By 1969 it was a mere twentieth. People leave rural areas at an average rate of 650,000 a year; many drift into cities where they join past migrants in the ghettos—to become addled tinder for the riots that can be labeled one of the social consequences of the agricultural revolution.

When people leave the farm, rural communities that in earlier years had come into existence to serve them likewise wither away. You see it, for instance, in Kesley, Iowa, whose crossroads store did a thriving business before highways took shoppers to bigger centers. And in Cottonwood Falls, Kansas, where I came across a hand-lettered sign on the city clerk's office saying, "Open only mornings through tenth of each month."

"More people died here last year than were born," a waitress in the town's one remaining restaurant told me as I ate a Saturday lunch. "Kids graduating from the high school

Pitting bug against bug

Meeting on a cotton leaf battleground, two larvae lock in a combat that could save cotton farmers millions of dollars. Stalking the leaf's edge, a larva of the green lacewing fly nears a bollworm (top). Suddenly the lacewing lunges and sinks its jaws into the bollworm (center). Within five minutes the attacker drains the victim's juices (bottom).

Delighted by the lacewing's rapacity, entomologists at College Station, Texas, seek ways to raise hordes for release against the bollworm, which already has developed immunity to many insecticides. Similarly, scientists battle the cattle-killing screwworm fly by releasing billions of sterilized males. Females, mating with them, lay infertile eggs, rapidly eliminating the species.

go to college and don't come back, or go away to find jobs. But Cottonwood Falls is a nice place to live, and it's hard to find a house to rent because they're all snapped up by older people moving in from farms to retire."

Not all small towns are dying. The smog and the traffic and the social unrest of megalopolis prompts a second look at advantages of living in smaller communities. Industry, freed by jet planes and superhighways from dependence on nearby markets, shifts its plants away from cities. Employees are drawn by such appeals as being able, ten minutes after leaving work, to be out on the golf course, or roaming the woods with gun and dog, or watching kids and crops grow on a handful of acres a man can call his own.

Government programs enable small communities to borrow funds for water systems, sewer plants, better schools, recreation facilities, and other modern amenities needed to hold populations. Towns are pulling themselves up by their own bootstraps—Paola, Kansas, for example.

Paola is the county seat of an eastern Kansas county, Miami, that is predominantly farmland. But Paola benefits from being near enough—40 miles—to serve as a commuter community for sprawling Kansas City.

Recreation: New Source of Income

Paola benefits, too, from being close to Lake Miola Reservoir, a recreational asset that points up another revolutionary change taking place on America's farms.

Marginal farmers, and farmers with marginal land, are turning to recreation as a new source of income. A Maine dairyman, with 230 acres, 30 cows, and no economic justification for expanding, borrowed to turn his

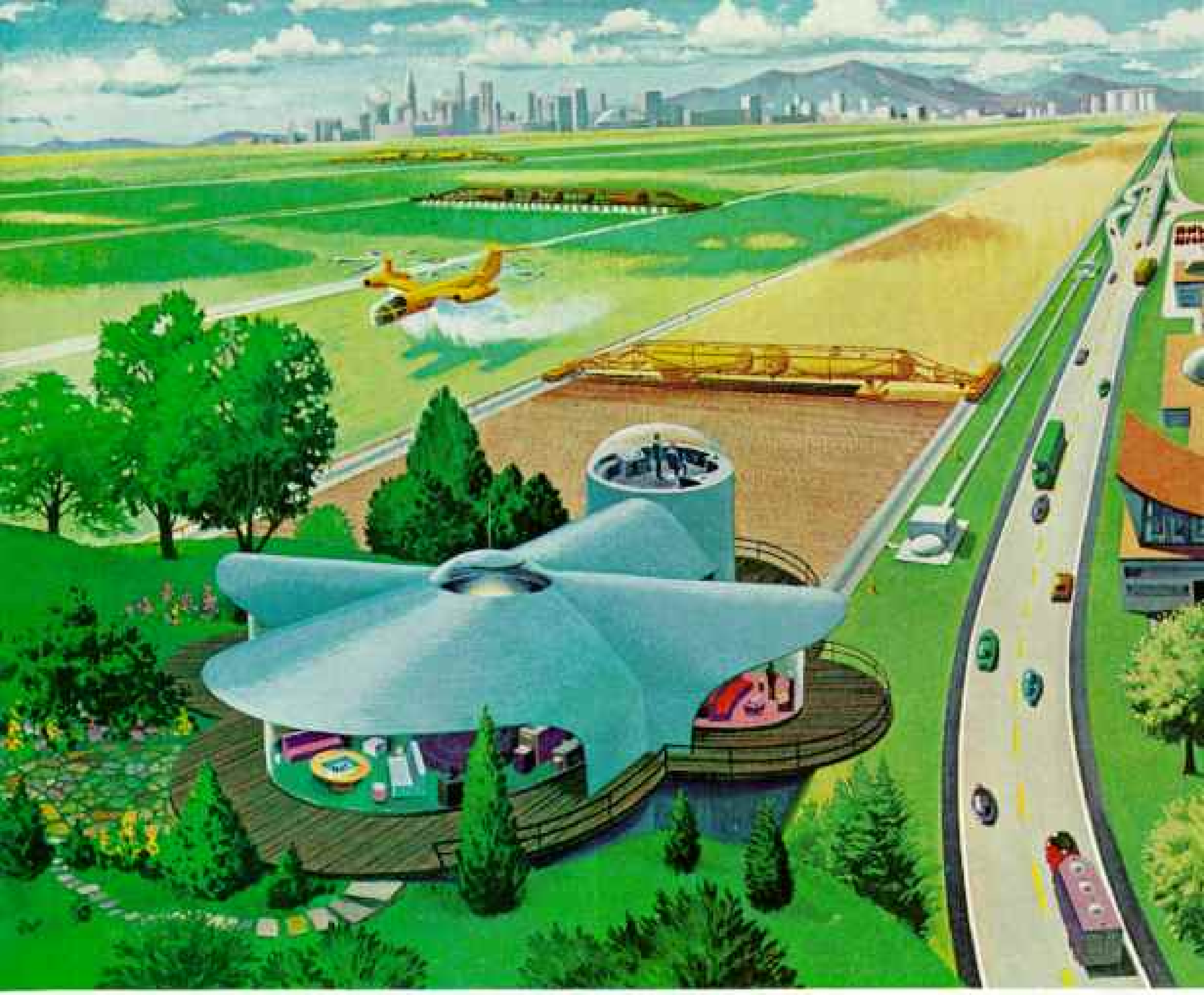
"Do I get bigger, or do I give up?"

The question rides like a shadow with Fred Terry as he drives his tractor on the 130-acre family farm at Orient on Long Island, New York (left). Like thousands of other small farmers, the Terrys stand at a crossroads: Either they mechanize and expand, or rising costs, high taxes, and big-farm competition will drive them from the land.

Each spring, 15 Puerto Ricans fly up to pick the crops. "They're good workers," observes Fred. "They start with the strawberries in June and stay on through the peas and beans [above] and then the onions, cucumbers, and fall crops." More fortunate than many migrants, they enjoy tidy, spacious quarters and good pay.

Gathered for the family's traditional hearty midday meal (below), Fred sits between his mother and his father, who still runs the farm; around the table range his wife, their two-year-old daughter, and Fred's youngest brother.

Will they grow, or will they go? "Part of this farm has been in the family since 1732," says the senior Mr. Terry. "It's in our blood—I can't imagine doing anything else."



Farm of the future: Grainfields stretch like fairways and cattle pens resemble high-rise apartments in a farm of the early 21st century, as portrayed by artist Davis Meltzer with the guidance of U. S. Department of Agriculture specialists.

Attached to a modernistic farmhouse, a bubble-topped control tower hums with a computer, weather reports, and a farm-price ticker tape. A remote-controlled tiller-combine glides across a 10-mile-long wheat field on tracks that keep the heavy machine from compacting the soil. Threshed grain, funneled into a pneumatic tube beside the field, flows into storage elevators rising close to a distant city. The same machine that cuts the grain prepares the land for another crop. A

farm into a golf course; in two years he was earning as much as he had made dairying, and without the long wintertime work. A Pennsylvania farmer, with 150 acres near the Gettysburg battlefield site, put in showers and camping facilities in a wooded corner of his land; instead of growing corn he now caters to tourists—calling square dances for them at night. A Maryland couple takes in summer boarders willing to pay to share in farm chores so that their families may enjoy the wholesomeness of life on a farm.

What will farming of the future be like? Dr. Irving, of the Department of Agriculture, summed up a few of its facets for me.

"Agriculture will be highly specialized," he said. "Farms in one area will concentrate on growing oranges, those in another area tomatoes, in another potatoes—capitalizing on the competitive advantage soil or climate gives for a particular crop.

"Fields will be larger, with fewer trees, hedges, and roadways. Machines will be bigger and more powerful and able to do more operations in fewer trips across the land (painting, above). They'll be automated, even radio-controlled, with closed circuit TV to let an operator sitting on a front porch monitor what is going on.

"It isn't difficult to visualize agricultural plots several miles long and a hundred feet wide. Equipment straddling the strip will roll

PAINTED FOR THE NATIONAL GEOGRAPHIC SOCIETY BY DAVE WILTZIK © N.G.S.

similar device waters neighboring strips of soybeans as a jet-powered helicopter sprays insecticides.

Across a service road, conical mills blend feed for beef cattle, fattening in multilevel pens that conserve ground space. Tubes carry the feed to be mechanically distributed. A central elevator transports the cattle up and down, while a tubular side drain flushes wastes to be broken down for fertilizer. Beside the farther pen, a processing plant packs beef into cylinders for shipment to market by helicopter and monorail. Illuminated plastic domes provide controlled environments for growing high-value crops such as strawberries, tomatoes, and celery. Near a distant lake and recreation area, a pumping plant supplies water for the vast operation.

on tracks or paved runways, swinging around at the end to work the adjacent plot without a wheel-touch compacting the soil in the cultivated areas.

"Weather control may tame hailstorm and tornado dangers," Dr. Irving added. "Atomic energy may supply power to level hills or provide irrigation water from the sea. Satellites and airplanes overhead will transmit readings enabling a farmer to spot diseases breaking out in his crops more surely than he could by walking through the fields.*

"Sensors buried in the soil will tell him when his plants need water, and automated irrigation systems will bring it to them. He may have at hand chemical means of speeding or slowing crop growth to bring harvests to market at optimum times. Such things sound fantastic, but already they exist in pilot form or in the research stage."

My mind churned with the implications of such developments building on the progress of the past. And a remark that I had chanced to overhear in my travels came into focus. It was voiced by an official of the Brazilian Government who had come to the United States to study our farming methods.

"We are concerned about the future of agriculture in Brazil," he said. "In your country, you *are* in the future." THE END

*See "Remote Sensing: New Eyes to See the World," by Kenneth F. Weaver, GEOGRAPHIC, January 1969.

The Danakil: Nomads

Writer-photographer VICTOR ENGLEBERT travels among

WITH CAMELS, mules, drivers, and an interpreter, I am on my way into one of the most forbidding places in the world. In the northeastern corner of Ethiopia I have joined a large caravan bound for the Danakil Depression, a terrifying land of fantastic volcanic ruins, rock, lava, dried salt lakes; of violent colors and merciless desert.

Much of the depression lies more than 200 feet below sea level. By day it is blindingly hot, with temperatures higher than 120° F. The tribesmen who roam here are not always likely to be friendly to strangers—for one more stranger means less water for everyone. And water, in these searing wastes, is a thing to fight and kill for.

As a Belgian photographer and writer, I have come to explore this land and learn about its nomadic tribesmen known as the Danakil—or Afar, as they call themselves

Suspicious of a *ferengi*, or foreigner, a woman of the Danakil peers at the author. Fashion decrees

# of Ethiopia's Wasteland

people who have learned to survive in a cruel realm of salt and sun

—a Hamitic people who have lived here for thousands of years. In Ethiopia 200,000 dwell in an area that extends from the depression southeastward to the frontier. An additional 50,000 live in the neighboring French Territory of the Afars and the Issas, formerly French Somaliland. Many of the coastal Danakil—and a scattering among the interior tribes—are followers of Islam.

Our caravan started at Makale, in the highlands; we are headed for Lake Karum in the depression, where we will pick up salt and get out as quickly as possible (map, page 194).

Now, as we near the open desert, we stop at one last watering station, a cluster of makeshift huts beside a narrow stream. While the cameleers and mule drivers fill their goatskins, I meet my first and favorite member of the Danakil.

the child's hair tuft.

BY VICTOR ENGELBERT © N.G.S.

She is a pretty little rogue, 11 or 12 years old, her dark skin and delicate features attesting her Hamitic ancestry. Her eyes, suspicious, cunning, are devoid of innocence—no innocent creature survives in her hostile world. She emerges from a doorway and sits down to watch. Soon my eyes meet hers; we are both intrigued. After many minutes she beckons me to approach.

But as I obey, she bounds to her feet, ready to run. The caravaneers laugh and reassure her. Still uneasy, she allows me to advance slowly. Watching my face from the corner of her eye, she puts a finger on my wristwatch. But it is my color that fascinates her—plainly, she has never seen a white man.

She lets her finger slip to my wrist, but pulls it back immediately as if my skin were burning. The caravaneers, amused by her reactions, encourage her to try again. Timid, she strokes my arm, then pulls at the blond hair on it. Playful, she presses her finger on my skin to make white spots appear.

She stares a long time at my blue eyes, at my nose, at my mouth. Finally she sighs, and says, through an interpreter, "You must be very young, for you have the color of newborn babies."

I realize that she means Danakil babies, who are relatively pale at birth, and I smile.

Song Celebrates a Stranger's Gift

I have an orange in my pocket. I give it to her. She has never seen one before, and she asks me to show her how to eat it. She likes it very much, and after she has swallowed the last piece and wiped her mouth with the back of her hand, she improvises a short song which she repeats several times:

The red man has given me an orange,
The red man is a good man.

But the caravan has started up again. I have to leave my little friend.

Soon we reach open ground—stony desert dotted here and there by small acacia trees. Behind us, blue in the haze, rise the central Ethiopian mountains whence we have come. Far ahead, shining like a mirror in the sun, stretch the shallow salt flats around Lake Karum (following pages).

In the late afternoon heat, the air seems to

"A landscape of terror, of hardships, of death," wrote explorer L. M. Nesbitt, who penetrated the region of the Danakil in 1928. Stark saline cliffs (next pages), left by an ancient arm of the Red Sea and carved by its waves, jut above shallow Lake Karum. The briny waters lie in a basin called the Danakil Depression, which reaches 381 feet below sea level. Salt particles lace the bluffs like snow, incongruous in an area where temperatures may exceed 120° F.

vibrate before my eyes. Even with a large straw hat and a breeze, I feel slightly dizzy. But some of the caravaneers start singing as if sun, thirst, and fatigue do not exist.

Four hours bring the sun close to the western mountaintops. The breeze becomes wind. We reach a place where other caravans have set up camp, and we join them.

Moon Reveals a Circle of Singers

Night has come. The caravaneers gather in a circle in the center of their camp, their only light that of the moon. They sing and beat time to their songs by banging on enamel pots or by clapping pairs of stones together. In the middle of the circle, two or three men dance.

My interpreter and I watch from a distance, lying on our sleeping bags and enjoying the cool night air. But now the circle breaks, and the men come to us.

"Come on," they say, "it is your turn to dance now—you must pass the test."

Since we are going to the salt lake for the first time, we must, like ship passengers on their first crossing of the Equator, pass tests for the amusement of the old-timers. They make us dance for 10 minutes before allowing us to sleep. As for them, they will sing and dance until very late and take little rest.

My traveling companions the caravaneers

His weapons a way of life, a warrior at Aisaita carries spear and broad-bladed knife. Danakil men traditionally divide time between herding and fighting—each other or neighboring tribes.

Market day brings merriment to girls buying a handful of herbs in the highland town of Batie

must reach Lake Karum, load their mules and camels with the salt mined there, and leave the same day, if possible. Salt beds do not make for comfortable sleeping, and mules cannot stay long without drinking. The camels, of course, can go several days without drinking, even in this searing desolation.

We are on the move again by three o'clock in the morning. Dawn finds us wading through Lake Karum, which is no more than six inches deep where water still exists. Elsewhere, the lake has vanished, leaving the dry, hard-packed salt.

The early light unveils an extraordinary spectacle—a red sky to the east, a blue sky to the west, a flat, glittering white lake floor in between. Across this floor, stretching from one end of the horizon to the other, wind long strands of camels, mules, and men.

We reach dry ground as the sun rises. The scene could be the Arctic wastes. As far as one can see, the land is flat and of the purest white. Houses with walls of salt blocks, stacked much as Eskimos pile snow blocks for igloos, add to the illusion.

Although Ethiopians who live on the more heavily populated plateau sometimes come down to the lowlands to mine salt, most of this work is done by Danakil, who over the centuries have grown used to the fearful heat.

Resting camels park behind them. Handsome in youth, Danakil women age rapidly under the stress of hard work and harsh climate. Caucasian features, in some cases blended with Negro, characterize the 250,000 Danakil of northeastern Africa, a Hamitic people linked by legend to the Biblical sons of Ham.

KODACHROMES BY VICTOR ENGELBERT © N.G.S.

Wresting income from a hellhole

A POLE IN EACH HAND, miners pry loose slabs of solid salt (above) from the drying bed of Lake Karum. Other crews slice and smooth the slabs into manageable bricks that lure an endless procession of salt caravans. Already laden, a train of camels and mules plods through the village of Bohale (left), bound for the provincial capital, Makale (map, next page). A water hole collects a knot of thirsty animals, background.

Periodically, torrential rains leach more salt from the surrounding hills, which once lay below the Red Sea. The salt-laden runoff floods the lake, and rapid evaporation leaves a fresh white deposit to be loosened by miners.

Scores of tribesmen work in the basin during the dry season, living in houses of salt blocks and leaving families miles away in cooler encampments; few but heat-hardened Danakil can survive the blistering temperatures day after day. Eventually their product reaches markets across much of northeast Africa.

The salt beds themselves were created over millenniums by the evaporation of sea water; geologists have determined that this area was once an arm of the Red Sea. No one has ever probed to the bottom of Lake Karum's salt deposits, but estimates of their depth run to three miles and more. They provide pure white, ready-to-use salt for a large area of northeastern Africa, and a hard-earned living for scores of Danakil salt miners.

The work at Lake Karum is divided among several groups of men. One group, armed with long sticks, separates and lifts the large slabs of salt from the ground (preceding page). Another group cuts the slabs roughly into manageable bricks, while a third group smooths the bricks into final shape.

For a day's work, each miner receives 1½ Ethiopian dollars (roughly 60 U. S. cents), one *ambasha,* or large loaf of Ethiopian bread, and one goatskin of water. Each caravan brings its own money, bread, and water to pay the miners, who live during long periods of work in the salt-block huts.

Quickly now my fellow caravaneers load their camels and mules with salt bricks, pay the Danakil workers, and are off on the return journey to the cool beckoning mountains in the west. In a few days' time we are back in Makale, a sizable town and the capital of Ethiopia's Tegre Province.* From here the salt will be sold throughout Ethiopia and in neighboring countries.

Seeking the Fiercest Danakil

My first encounter with the Danakil has left me perplexed, for I had read of them as a fierce, warlike people disdainful of work and not above an occasional bit of banditry. Yet the Danakil of the salt fields seem both gentle and industrious. Now, in Makale, I make plans to travel south to the Aussa sultanate, which borders on the French Territory of the Afars and the Issas (map, above). Here live the so-called Aussa Danakil, a people with a grim reputation for violence and hostility toward outsiders.

I finally catch my first sight of the Aussa Danakil in the dusty, oppressive village of Tandaho. They are lean and handsome, but

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

Domain of the Danakil swelters in a corner of Africa where nature contrives some of the planet's sternest adversities. Spilling across the Ethiopian frontier into the French Territory of the Afars and the Issas, the Louisiana-size territory lies where three rift valleys intersect, creating a highly unstable region crisscrossed by fault lines and studded with volcanoes.

The Red Sea vanished from the area as volcanic ridges gradually rose and walled the sea out. Salt deposits built up by evaporation to a thickness estimated at more than 15,000 feet.

Traveling 2,000 grueling miles among the scattered Danakil, the author had three brushes with death—from threatening bandits, political rebels, and on a trek across scorching lava-strewn desert.

Grudging goat resists a trip to the Aisaita market as the owner cleans his teeth with a frayed stick. Long skirt, trimmed hair, and cap distinguish this town-dwelling member of the Danakil from the austere nomad in sackcloth.

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

quite ferocious looking. Their costume consists of a piece of white or plaid cotton draped around the waist and falling below the knees like a skirt. Another piece of material is thrown casually over the shoulders.

In each man's belt rests a curved double-edged knife as broad as a hand and almost as long as a sword. Two have modern rifles.

The men stare at me as I step down from a bus. I stare back and try a smile, but they look insulted. I begin to feel uneasy.

In Tandaho, an official advises me not to leave the safety of the village without a letter of protection from the sultan of the Aussa Danakil (their traditional ruler under Emperor Haile Selassie). This sounds reasonable enough, but the sultan is absent. And then I meet a man who says, "The Aussa Danakil? Why, they are good people!"

I do not wait to hear any more. Before my courage wanes, I will leave on foot for the town of Aisaita, 35 miles east of Tandaho. Happily, I have found a new interpreter and companion for the journey, a 53-year-old man named Mahmud. Mahmud can speak four or five local languages.

Accompanying Mahmud and me, to care for our two rented camels and to act as guides, are two of the most undernourished and least impressive Aussa Danakil I have yet seen. They carry no weapons at all. They will not cut my throat during my sleep, I decide, but neither will they be of much help if I am attacked. As insurance, Mahmud goes to see a Danakil *balabat*, or local chief, who announces that I am under his protection.

Finally one afternoon we set out for Aisaita, observing the Danakil custom of leading rather than riding the camels. For two hours we skirt cotton fields, then swamps. Suddenly, without transition, we face the desert. Fortunately, the sun is gone. We push on in the cool of the night.

Bandits Threaten the "Foreigner"

In the early hours of morning a party of five Danakil overtakes us. They are surprised to see a *ferengi*, or foreigner. They make loud comments but seem friendly. One of them weighs my camera bag, tests my muscles and my handshake. Satisfied, he walks hand in hand with me for half an hour, chattering

Beauty in a fearsome land

OUTLINED LIKE A HERON *against an evening sky, a herdsman rests one leg by propping the foot against the opposite thigh, often done without the spear for support. "You can feel fatigue leaving the upraised leg," said the author after trying the stance.*

Green brine permeated by iron chlorides bubbles from subterranean fissures to create warm pools (left). Evaporation and oxidation leave yellow deposits that harden into a dark crust, here studied by a team of European geologists.

FOREGROUND BY SEBA SEBASTIAN (OPPOSITE) AND VICTOR ENGELBERT © N.G.S.

Marked maiden wears tattoos for beauty. Braids and ornate costume show her to be the unwed daughter of a wealthy man.

Curb service: Goats and a munching camel share a snack in Aisaita. A pedestrian's gay shawl brightens an otherwise drab street lined with homes constructed of mud, wood, and lava blocks.

happily in a language that I cannot understand. I am ready now to discount the fearful stories I have read of raiding and murder.

Our five acquaintances drift off into the night, and almost at once we encounter four more Danakil. These are young warriors, heavily armed, and in their eyes shines a menacing light as they ask for cigarettes.

As Mahmud lights cigarettes and answers questions, our guides and camels plod past us and disappear into the night. They are far ahead when we resume the march.

Mahmud is following me, and behind him come the Danakil, still pressing him with questions. The word ferengi bounces back and forth with increasing frequency and loudness.

I sense trouble, but keep walking as casually as I can. If I stop to do my part of the yelling, the situation may well explode, besides making us fall farther behind our guides. What help they might provide, I do not know, but without them, the odds are against us. Once we have caught up with them, we will have to fight only one man each.

By now Mahmud's voice is shaking with rage and anguish. "Make trouble, make trouble!" he shouts to me in his imperfect English.

"I know, Mahmud, but keep calm," I answer, trying to keep calm myself.

At last our guides and camels are visible ahead. I walk faster. Mahmud, his throat knotted with emotion, calls faintly, "Ahmadu! Ahmadu!" the name of the older guide. Ahmadu stops, suddenly realizing our situation. I am eager to see how he will deal with it.

Ahmadu's eyes burn with fury as I reach him; such a mean look would frighten the Devil himself, I think. And indeed, he so overwhelms the four men with just a few harsh words that they go their way, only laughing at us sarcastically to keep face. Has he told them about the Danakil chief who befriended us in Tandaho? I cannot tell.

When I ask Mahmud what had happened earlier, he does not answer for half an hour. Then he tells me. After having grabbed his cigarettes and a box of biscuits he was carrying for our breakfast, the four Danakil had decided to get my camera bag.

"If you touch the ferengi or his belongings," Mahmud had declared, "I promise you a lot of trouble." But they had chuckled.

"The man does not even carry a gun," they said. "We are going to cut his throat, and yours; and we promise you nobody will worry about you two." That was when Mahmud had cried, "Make trouble, make trouble!"

Nomads Resist Settlement Plan

The remainder of the journey proves peaceful, and we reach Aisaita on market day.

Market day is highly important to the Danakil. Some of them cover great distances to sell cattle, camels, goats, sheep, butter, straw mats. In turn, they buy city goods—coffee, sugar, matches, soap. Every shop is crowded with bare-breasted women trying on colorful saronglike skirts, and with men, their hair fashionably daubed with butter.

In Aisaita I meet a young relative of the sultan of the Aussa Danakil. He works for the Awash River Project, a government plan aimed at settling homeless Ethiopians, including hundreds of nomadic Danakil (pages 204-5). The plan involves the damming of

the Awash River to control floods and turn marshes and desert into arable land. Here Danakil families are to be given plots and taught farming techniques.

The project, however, encounters much hostility from the Danakil men. They fear they will lose their rights to widely scattered pastures if they settle down. Moreover, since few actually understand the project, they fear the dam may somehow deprive them of water. But the sultan is backing the plan, and he is all-powerful among his people.

Meat a Rare Treat for Danakil

Some Danakil, it is true, have been more or less settled for a very long time. Their villages stretch along the Awash River, from Aisaita to Lake Gamarri. Near Aisaita they cultivate cotton, but elsewhere along the river, cotton gradually gives way to corn and sesame.

The people here live in the same easily assembled brushwood huts as do the nomads (opposite), from whom they are indistinguishable to an outsider. Like nomads, they also own herds of cattle, camels, sheep, and goats. Both the settled and the nomadic Danakil eat meat only on rare occasions, preferring to conserve their livestock as precious capital.

From Aisaita I return to the town of Makale in the Ethiopian Highlands to join a group of European scientists on the first of several expeditions to the Danakil Depression. This team will study the origin and nature of the depression by exploring the great chain of volcanoes that divides the sunken wasteland on a nearly north-south axis.

Most scientists agree that the area, including the depression, once was a gulf of the Red Sea, a body formed as Africa and Arabia drifted apart. The research will shed more light on the geology of the region. A leader of the expedition, Professor Haroun Tazieff of the National Center of Scientific Research in Paris, welcomes me as a nontechnical addition to his eight-man crew.

We are helped over our first crisis by a distinguished Ethiopian. When our lorries and equipment are delayed in transit from Europe, the governor of Tegre Province, Ras Mengesha Seyoum, offers us Land-Rovers, camping equipment, food, and even the use of a government helicopter to help us reach

KODACHROME (ABOVE) AND KODACHROME BY VICTOR ENGELBERT © N.G.S.

Mobile home on a sea of ash: Oblivious to a kid browsing inside their house, nomads rest on a slope of volcanic debris. Goatskins and straw mats for extra roofing lie beside the brush igloo. When water and forage run short, the family will bundle the collapsible shelter onto a camel and move on.

Trailing evening shadows, goats trot purposefully past their herder, bound for a water hole. Prizing their herds as measures of wealth, Danakil eat little meat, usually dining on milk and unleavened bread.

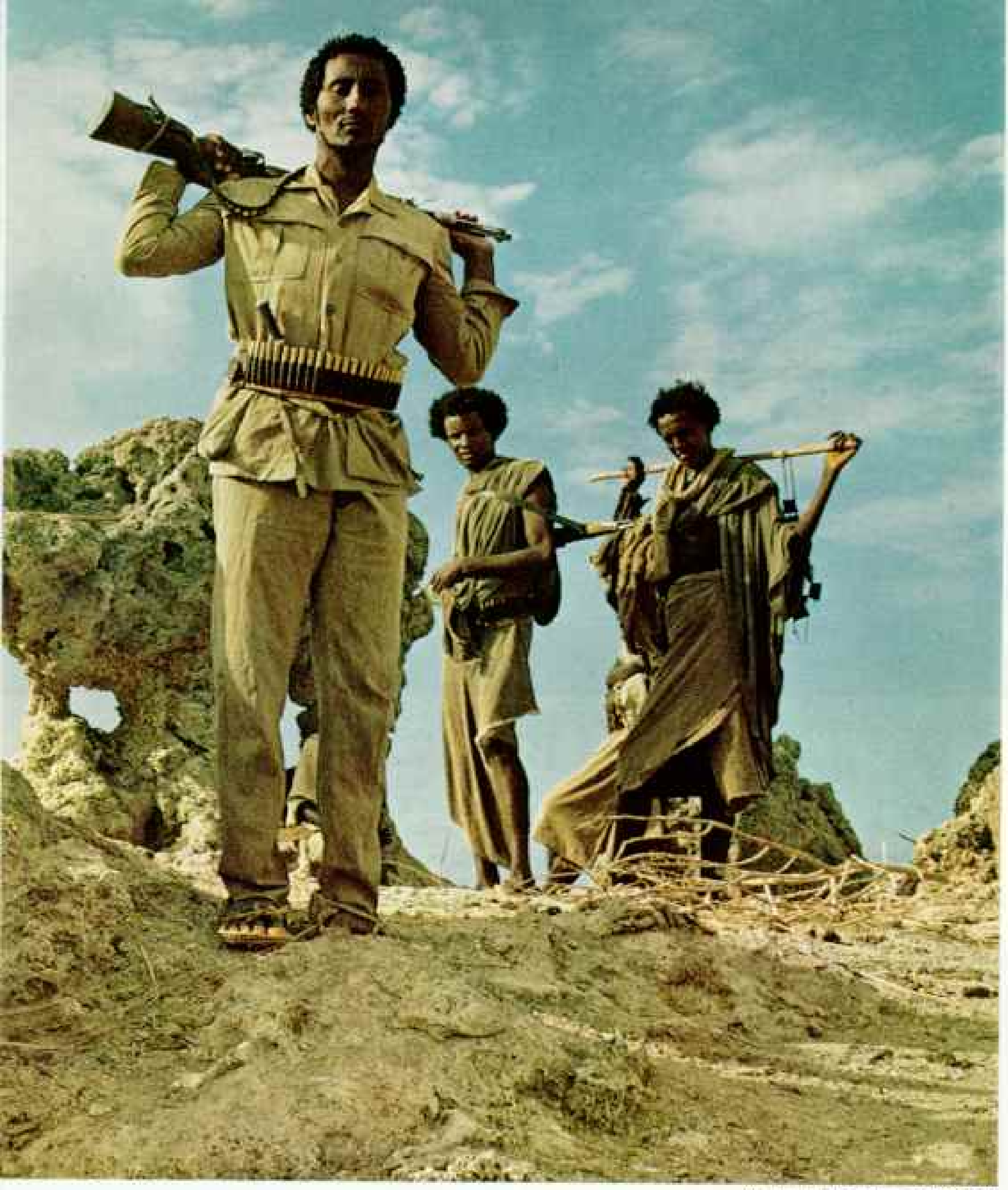
Interrupted during a palaver amid weird shapes of twisted lava, camel herders give the camera-wielding author a chilly reception. Khaki uniform identifies the leader. Rifles guard

Lakes Giulietti and Karum, where we propose to camp. We waste no time leaving Makale and make our way into the heart of the Danakil Depression.

Searing Sun Delays Travel

In the shade of a cluster of palm trees we are waiting beside our Land-Rover for the sun to lose some of its aggressiveness. My companions are Russian-born Professor Tazieff, a naturalized Belgian renowned as a volcanologist; Franco Barberi, an Italian petrologist, or expert on the origins of rocks; Marino Martini, a geochemist, also Italian; and two Ethiopian soldiers.

Around us, to the west, as flat as the hand and bordered by alluring mirages, lies a blinding, sun-devoured plain. To the east stretches a black, sterile, dreadful, immense field of lava. This we must cross on foot to reach a distant cliff of obsidian, from which the petrologist wishes to take samples.



KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

against rustlers; they also could figure decisively in a struggle to take a water hole or defend it. Danakil unfriendliness, the author noted, increased with the severity of the environment.

The heat is inhuman and we are thirsty, but we must save our water—we will soon be thirstier yet.

Three o'clock. Professor Tazieff gives the signal for departure. The heat is still unbearable, but we have only slightly more than three hours of daylight left, and we want to reach our goal and return to the Land-Rover before the heat of the next afternoon.

Walking light, we carry only water and some bread and cheese. My camera equipment adds another 15 pounds to my personal kit, yet the first hours are easy. Immense strands of lava, twisted like cordage, constitute relatively passable terrain. I dash ahead and I fall behind, exposing film. Then suddenly we face an endless expanse of scoria, a type of slaglike lava.

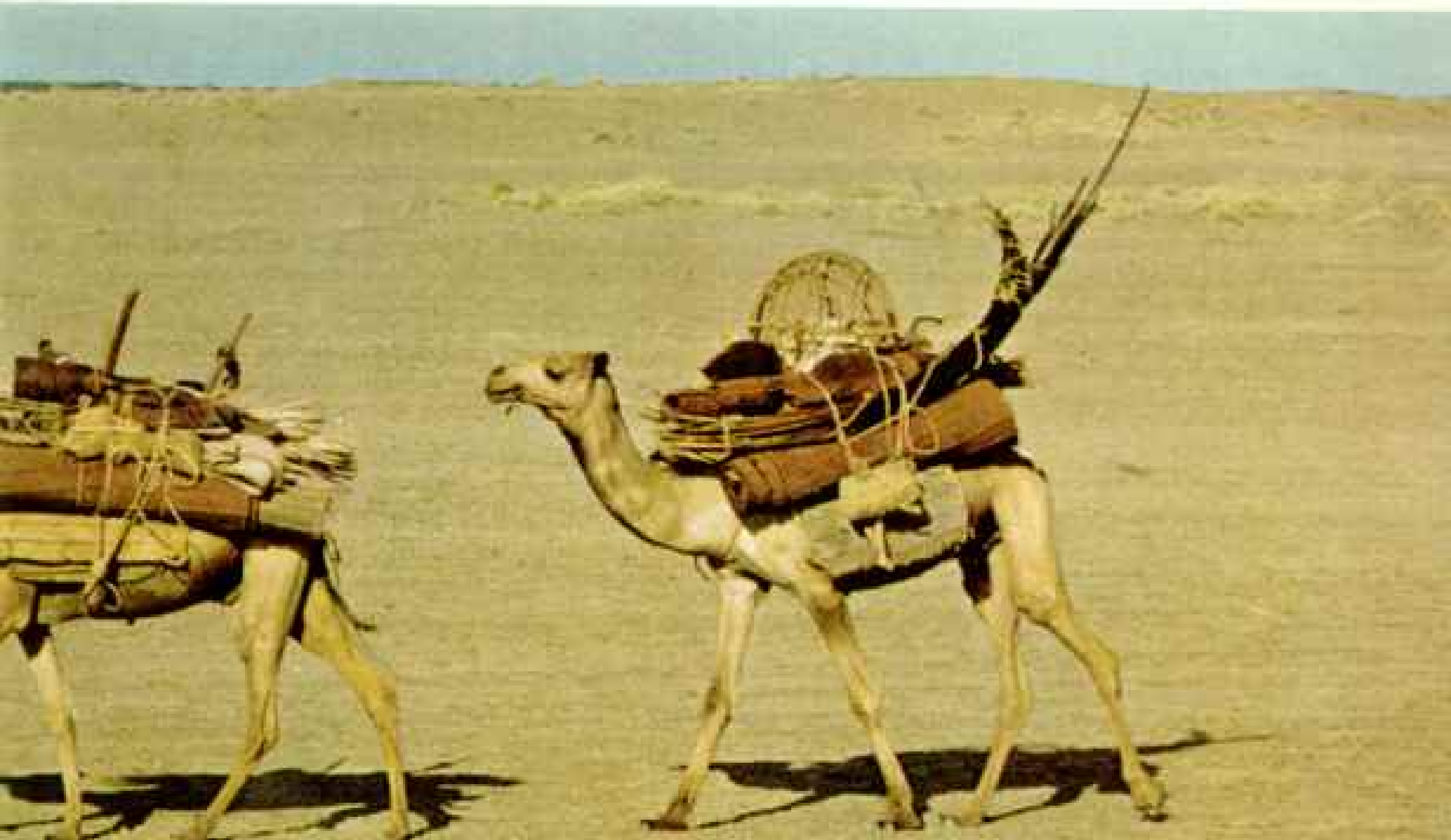
The sun rests on the horizon. In thirty minutes the sky will be as black as the lava. It is best to stop for the night. We settle down on a wide slab of basalt. The heat has killed

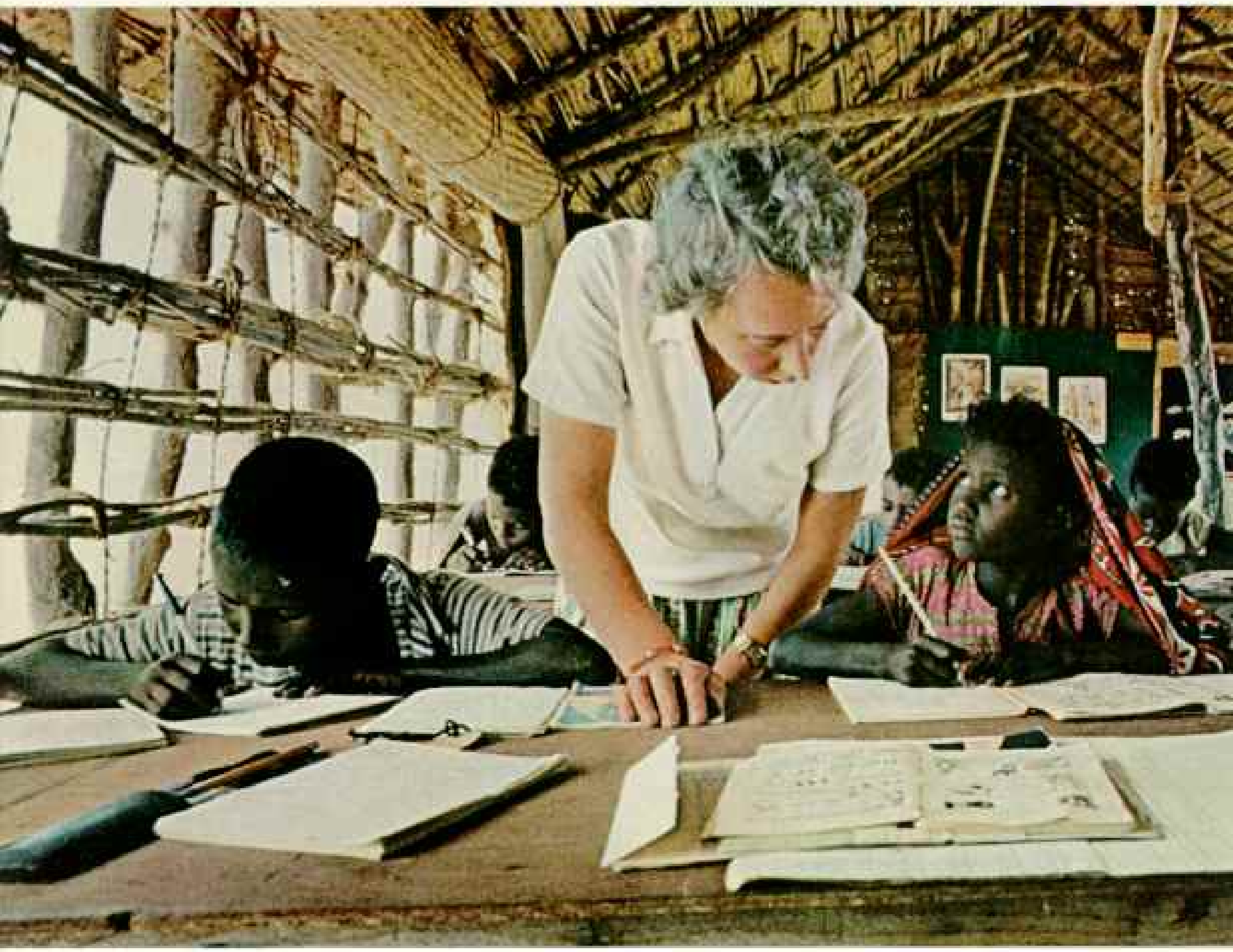
The struggle to settle a wandering people

BARREN PLAIN SPROUTS NEW HOUSES (above) near Tandaho. Each dwelling contains a kitchen, and many have baths—luxuries previously unknown. Close by, new dams will soon impound the Awash River to irrigate the thirsty land; meanwhile the Ethiopian Government holds demonstrations on cultivating cotton, already harvested in some areas (right). Houses, fields, and training may be had for

the asking by any landless Ethiopian. Yet there are few takers among the Danakil, a people unwilling to forsake the desert's hard freedom for the confining amenities of village life.

On the move in the time-honored manner (below), Danakil lead camels laden with hut poles and all their worldly goods. Wearing a pot on her head, one weaves a mat as she walks.





our appetites, and we go without dinner.

At dawn Professor Tazieff makes a decision: For the sake of speed and to conserve our dwindling supply of water, only half the six-man team will proceed. The others will return and wait at the Land-Rover. Quickly we divide up. Franco will push on to obtain rock samples. Aberrha, one of the Ethiopian soldiers, and I volunteer to accompany him.

Lava Cuts Shoes to Tatters

It is already too hot to be walking. In less than thirty minutes our shirts are soaked. The large drops of sweat that trickle down our foreheads and noses before splashing on the ground would mark our passage as surely as little pebbles—if the porous basalt did not drink them greedily.

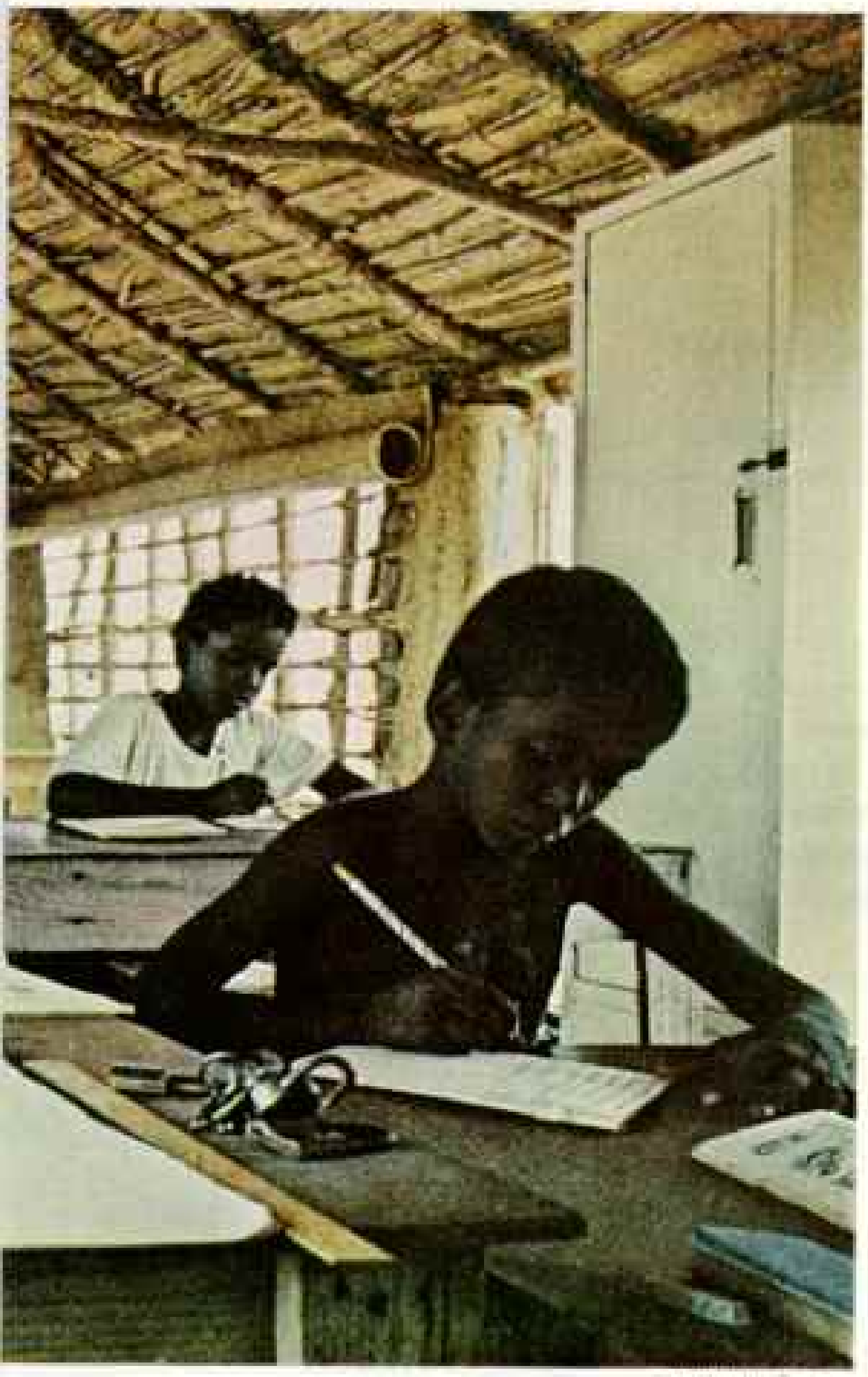
The sharp-edged scoria crumbles and crashes, tearing at our legs. It rolls under our feet, often throwing us, hands and knees forward, on countless knives and needles.

Blood mixes with sweat and dust. Although the obsidian cliff seems very close, it takes us nearly two hours to reach it.

Quickly then, Franco collects his samples. Our return trek is more painful than the journey in. The sun is rising ever higher. My shoes, new when I started, are in tatters, and I fear to lose the soles. Now my camera equipment seriously hampers me.

Franco, who has the compass, decides to leave me behind with Aberrha, for Aberrha needs no instrument to find his way. Soon Franco has disappeared in the wilderness of basalt ahead. Aberrha and I reach the Land-Rover and our companions long after he does. The sun is at its zenith.

But the Land-Rover's fan belt has broken, and we try futilely to improvise a new one. To make up for being last on the return trek, I volunteer to walk the 12 miles back to our main camp at Lake Karum and bring a second Land-Rover. Aberrha declares that it is sheer folly to walk in the one o'clock sun. But he will not let me go alone.



Taste of education has not become a feast for children in the fishing villages along Ethiopia's Danakil coast, where mission stations offer the only formal schooling. Costs and parental disinterest keep enrollment low in classes such as this one at the Red Sea English Mission in Thio. Attendance by girls remains small, because of the coastal Danakil's Moslem beliefs opposing coeducation. Characteristic of seaside dwellings, this house has straw window mats that roll down to keep out searing winds.

KODACHROME © N.G.S.

Equipped with sunglasses and water, we leave immediately, setting out across deep sand. We walk as fast as we can. The glare penetrates our glasses. The heat is that of an oven, and nature around us is at a standstill.

After an hour or two my ears are buzzing and my head whirls dizzily, but I think I can see Lake Karum shimmering in the distance. I have not eaten since noon the day before, and have taken little water.

Trek Turns Into an Ordeal

I am walking like an automaton, forcing myself to move my legs at the same pace as Aberrha. I long for rest, but there is not a square inch of shade for miles around. However, the prospect of dipping my shirt in the briny water of Lake Karum and spreading it over me stirs enough courage to keep going.

But time passes, and the lake does not seem any nearer. My feet are becoming incredibly heavy. I drop to my knees. The ground is so burning hot that I cannot stay there. Now Aberrha is too far ahead for me to keep pace with him. I walk slower, eyes on the ground.

When I look up, I see that Aberrha has entered the lake. I estimate that I shall be there myself in ten minutes. But when I look again after five minutes, the water has receded beyond him; he is on dry ground! The water was a mirage. I no longer have any idea how far the lake is.

My last ounce of energy gone, I drop to the ground and remain. It burns my skin through my shirt, but I cannot move any more. I can feel the hot earth suck my body's moisture, and seemingly my life, from underneath, while the sun does the same from above. My quart canteen is one-third full, but although I am dehydrating rapidly, I try to save it for worse moments yet. I must endure until the sun goes down.

I hear a car. It passes hardly more than a hundred yards from me. Through a blur I recognize Professor Tazieff in the front seat. My friends must have managed to repair the fan belt. But nobody sees me, and the car is soon absorbed by the shimmering horizon.

I lose track of time. I am not quite conscious, but I realize that the ground is no longer so hot.

I hear a familiar noise, seemingly advancing in my direction. I recognize the cries of caravaneers, urging their animals on in front of them. It must be late afternoon; I have been lying on the ground for nearly two hours.

Lifting my head, I see a salt caravan plodding through a mirage. But they pass far from me. Still, I feel better now. I finish my water and get up with much difficulty, but I can stand. I walk toward the caravaneers, to ask them for water.

Something interrupts the vision. Moving parallel with the caravan, a dark point grows fast on the horizon. It is a truck. On the running board, waving to me, is my guardian angel, Aberrha. In his hand is a bottle of water.

This ordeal increases my wish to leave the

dread region of salt and thirst. I have long been eager to meet yet another type of Danakil, those who fish Red Sea waters along the coast of Eritrea. I bid my scientist friends a temporary goodbye and make my way by Land-Rover to Asmara, traveling with an Italian television crew that has spent some days filming the expedition. At Asmara I rent my own Land-Rover for the journey down the coast. For a driver I engage an enthusiastic young Eritrean named Abdallah.

In Thio, a large and beautiful fishing village, I find that the Danakil houses are solid, permanent wooden structures.

Pretty little fishing boats dance in the bay, and on the beach fishermen repair giant gill nets. Nearby, piles of salted sharks dry in the sun. The fins have been cut off for export to the Far East, where Chinese pay dearly for them to make a rare delicacy—shark fin soup.

I spend a day at sea on a fishing boat with its crew of four men and two boys. We meet at dawn on the beach and wade out a hundred yards to where the boat is anchored.

At first there is no wind. The men take turns at two large oars, rowing out to sea until at last a breeze springs up and we can hoist the sail. Soon distant black spots appear, floating on the water. They turn out to be inflated goatskin bags, buoys for five or six nets.

Two or three men at the prow pull the immense nets in one by one, while the others remove the many small sharks snared in the meshes and fold the nets carefully.

By the end of the day the bottom of our boat is full of small sharks (page 210). Back on shore, they are immediately cleaned, salted, and spread out to dry.

Identity Card Saves a Wandering "Spy"

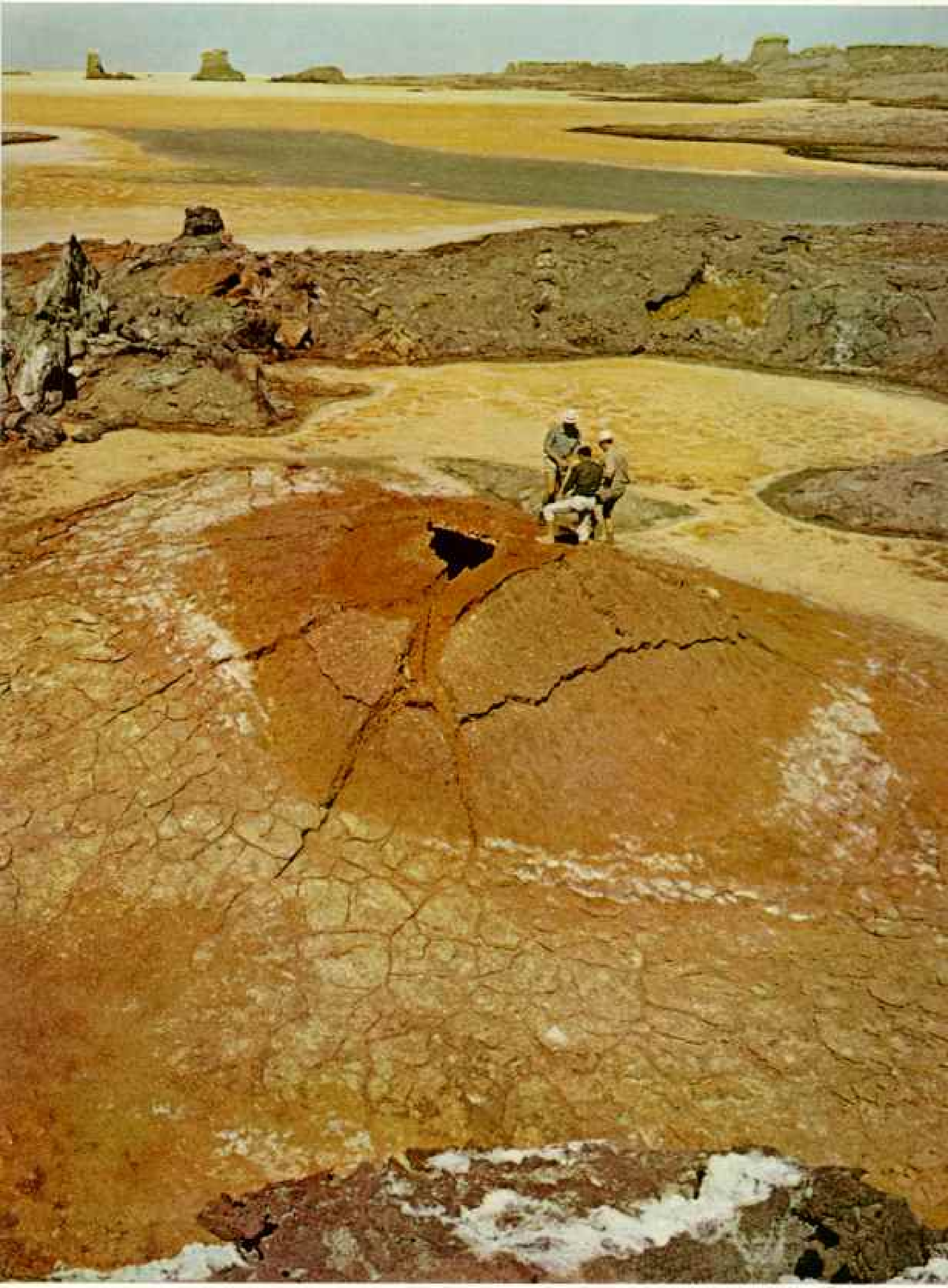
Although I know that in Eritrea I may encounter rebels who claim independence from Ethiopia, I do not believe they will resent a friendly neutral. But soon I learn my mistake. Twelve men armed with rifles and submachine guns jump from the bushes like devils out of boxes and surround the car. Abdallah and I get out, hands up. The men push us rudely toward a crazed-looking type who proves to be their leader, while the contents of the car are spread out in the mud for inspection.

The madman, with cries of rage, orders me to sit down and put my hands on my head. He then throws himself on Abdallah, beating him savagely with a heavy stick.

"Stop!" I yell. "This man is an Eritrean!"

"That is why I do not kill him!" the madman yells back. Then turning to me, he adds, "And you, you Israeli spy, give me your hand grenades now!"

Boiling point of a torrid land: Like the cone of a miniature volcano, a salt dome blasted by steaming water rises red and ruptured near Lake Karum. Taking samples, geologists on the fragile rim risk a collapse that could plunge them into a pool of scalding brine. Scientists find the depression to be underlaid with a basaltic crust, like the oceans, rather than with the granitic shield of the continents. Magma from the earth's mantle seethes upward, triggering the region's thermal activity.



ETCHING BY VICTOR ENGLEBERT © S.P.E.

Seeking small sharks, seagoing Danakil of Thio add a streaked Spanish mackerel to their haul. Shark fins find a ready market in Taiwan, where shark-fin soup is a delicacy.

Drained of harshness by a declining sun, the land cools beside the tepid Red Sea. Beneath swirling gulls, fishermen clean their catch near the tomb of a Moslem holy man.

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

I realize then that he has taken me for one of the Israeli military advisers to the Ethiopian Army. The muzzle of his pistol is an inch from my face, and his stick is swinging ominously over my head. But although his astounding accusation leaves me speechless for a few seconds, I look him straight in the eyes, and he finally puts his stick down. He does not want to believe me when I tell him that I am Belgian.

"I know Belgium," he says, which I very much doubt. "Anybody can get a Belgian passport."

Then he pulls from my passport an old Belgian identity card that I have almost forgotten I possess. "What is that?" he asks. The picture no longer resembles me, but this wild man seems to trust that little piece of faded cardboard more than he does my passport.

"I shall keep it," he says, waving the card. "Now get in your car and do not open the door until tomorrow morning. Meanwhile I shall decide what to do with you!"

Poor Abdallah. All night in the car he suffers badly from the blows he has received on the head and body. Worse, he fears being forcibly enlisted into the rebel army.

"Do you realize," he says to me at one point, "that I could be dancing in Asmara at this very moment?"

"Yes, I know," I reply. "It is my fault, and I am awfully sorry, Abdallah."

To my surprise, the apology only irritates Abdallah the more. "You are being presumptuous," he scolds. "It is not your fault. What happened was written. You were only an instrument of my fate in the hands of Allah."

In the morning the madman's fury has subsided. He talks almost courteously when he returns my identity card and tells me we can go. Happily for Abdallah, there is no mention of a manpower shortage in the rebel army.

Visits Prove Helpful to Danakil

The remainder of our journey down the coast to Assab is uneventful, and we part there, Abdallah to return to Asmara and I to rejoin my scientist friends at the expedition camp near Lake Giulietti.

Professor Tazieff and his colleagues are packing up for the return to Europe. They have made a promising start in their study of one of Africa's remote and fascinating regions, and, as their trucks roll northward, they are already talking of later expeditions.

Our visit is not without benefit to the Danakil. On our return to Makale, our friend Ras Mengesha, the governor of Tegre Province, prepares to distribute our large store of surplus food among the nomads. He also plans to appoint a full-time medical worker to travel among them.

That, of course, is only a beginning, but Ras Mengesha is a man of vision and energy. One day the Danakil Depression may draw thousands of visitors to its beautiful wastes. Some, perhaps, will follow the route of the salt caravans, and stop at the small way station on the edge of the desert. For these I have a word of advice: If you are fond of pretty girls and poetry, take an orange. THE END

White-water Adventure On Wild Rivers Of Idaho

By JOHN CRAIGHEAD, Ph.D.
and FRANK CRAIGHEAD, JR., Ph.D.

Illustrations by the authors and National Geographic Photographer DICK DURRANCE II

CAPTAIN WILLIAM CLARK, scouting the Salmon River in 1805, stared in awe at the frothing canyon torrent—and the Lewis and Clark Expedition veered north to find a safer route through the wilderness.

What would those river-wise explorers have thought of our expedition, launching tiny kayaks and rubber rafts into the turbulent current at Dagger Falls, Idaho? Ahead of our crew of men, women, and teen-agers lay a challenging 190-mile trip.

First we would travel the Middle Fork Salmon, passing through parts of four National Forests that make up the 1,250,000-acre Idaho Primitive Area. Then we would turn west onto the Salmon. Known since pioneer days as the "River of No Return" (map, page 223), it cuts one of the continent's deepest gorges.

Now slaloming between the boulders and curlers of our first major rapid, we saw John's youngest son capsize just a hundred feet ahead. How would 14-year-old Johnny react in white water with his world turned upside down?

Down a rampant river—Idaho's storied Salmon—ride John Craighead (in red jacket) and his brother Frank. Veteran white-water boaters, they made this winter run and later returned with their families in summer so that television crews could record the seasonal splendors of a wild river and dramatize the need to preserve such unspoiled wilderness for posterity.

KODACHROME BY DICK DURRANCE II © N.G.S.

A paddle blade emerged phantom-like from the seething waters and moved in a sweeping downward stroke. Johnny, sealed in his kayak by a waterproof skirt, bobbed right-side up and continued his run with hardly a break in motion.

Suddenly reservations about committing our families to this wild-river adventure were gone. We knew the Middle Fork and Salmon were ours for the taking.

TV to Tell a Wild-river Story

We had made many voyages on wilderness rivers of the West, and each new experience had strengthened our efforts to champion the cause of river preservation. Now, after two decades, the concept of saving our wild and scenic waterways had finally flowered as the Wild and Scenic Rivers Act of 1968.

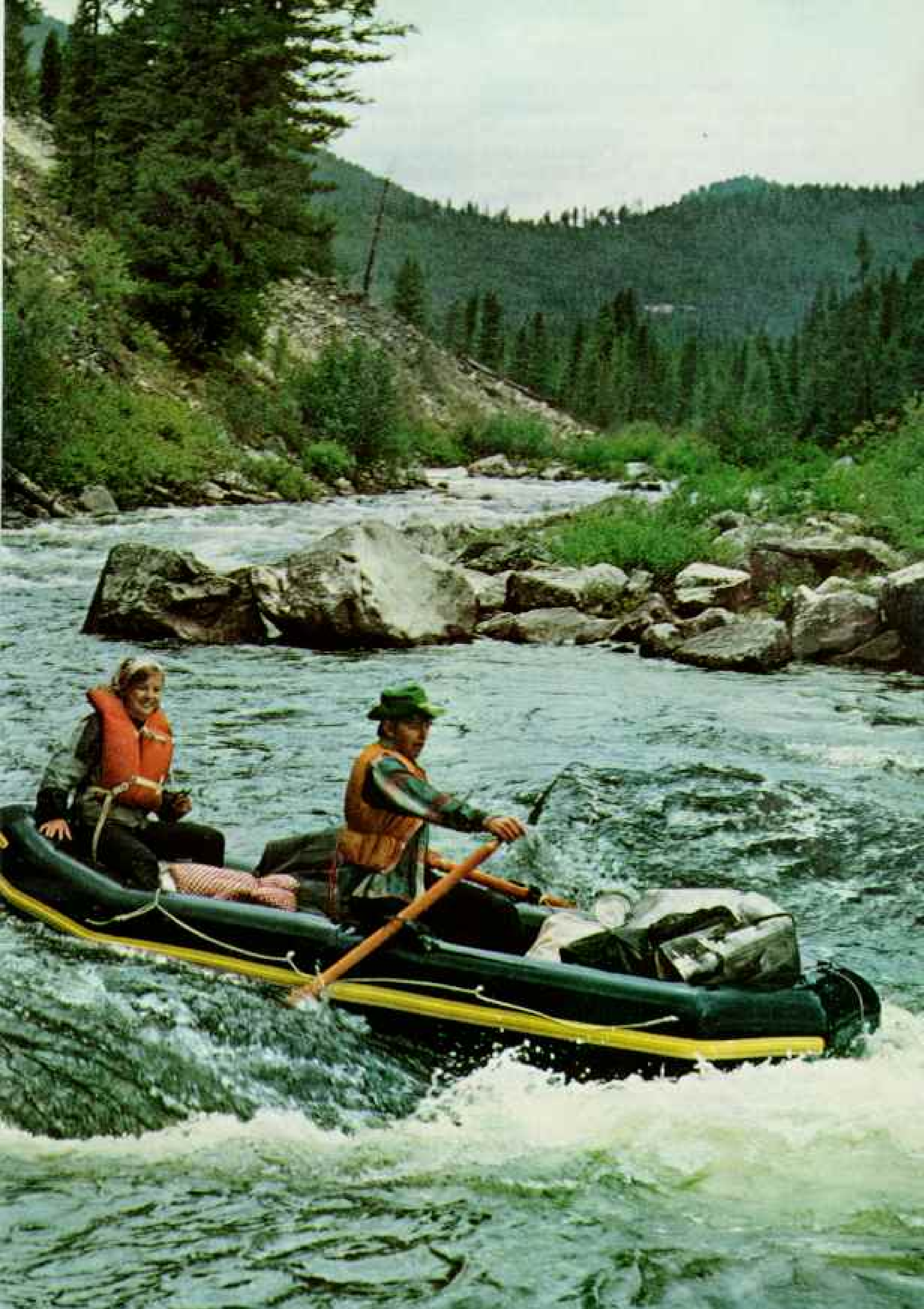
Sections of eight rivers, ranging from Idaho's Middle Fork to the Rio Grande in New Mexico, would be preserved unspoiled for posterity. And 27 others—including the stretch of the main Salmon that we would travel—are to be studied for possible inclusion in the system (map, page 222).

The Wild and Scenic Rivers Act designates how rivers shall be selected and reserved. But it is up to appropriate resource management agencies within the Departments of Interior and Agriculture to develop and implement detailed programs for their preservation. Citizens, acting as individuals or through clubs and community groups, can help by making their interest known and by watching carefully to ensure that adequate measures are taken to save our wilderness streams. Under the act, the public also can choose additional river sections that would qualify, and urge that these, too, be preserved for posterity.

The National Geographic Society, a force in conservation education for more than eighty years, believed the story should be told in a documentary television program. And so this white-water trip had been organized. Our two kayaks and six rubber rafts would be

Floating a boulder-strewn bend in the Middle Fork, a tributary of the Salmon, Karen and Derek Craighead begin a 190-mile, 23-day voyage through the mountainous labyrinth of central Idaho.

Karen, 21, Derek, 19, and 14-year-old Johnny accompanied their parents, Margaret and John Craighead. Frank Craighead brought along his three children: 21-year-old Lance, Charlie, 19, and Jana, 14.



manned along the way by as many as sixteen people, including a three-man television crew.

Perhaps we could be accused of nepotism in choosing the group, for Craigheads predominated. We each have three children—aged 14, 19, and 21. All of them were riding the white water with us.

Both streams we would travel could qualify as wild rivers—by definition, "free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted." Such rivers are rare in our country today.

It was unseasonably cold for August, that first day on the Middle Fork. The chilling rain that lashed us on the river was falling as snow on the timbered slopes above. At dusk we pitched our shelter tarpaulins on the steep canyon slopes, and soon roaring campfires were burning holes in the darkness, drying our wet clothes just a bit faster than the drizzle moistened them. The boys, working at double time to warm up, had secured the boats and gathered an evening's supply of firewood. Soon Jim Cole, an old friend who had signed on as raftsman and cook, had

Strange sounds signaling danger alert a blue grouse as it feeds amid bunchgrass beside the Salmon. Game birds abound in this isolated land: quail, partridge, geese, ruffed grouse, and several species of ducks. Golden and bald eagles roam the skies.

Ever-wary bighorn sheep dwell on the rocky slopes above the Salmon. One of the Nation's finest big-game regions, the Salmon River canyon shelters elk, deer, bear, mountain lion, and bobcat.

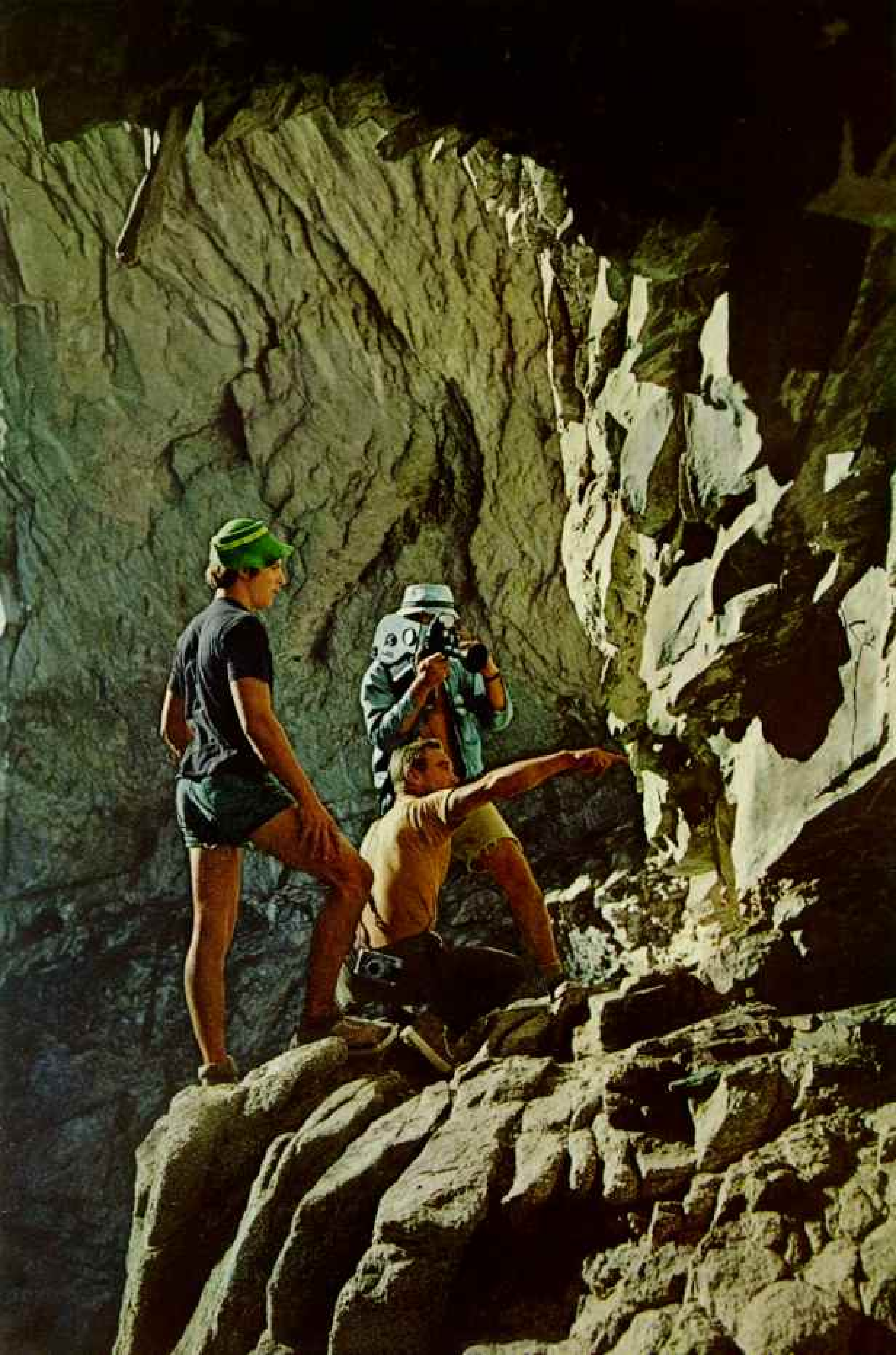
trout on the griddle and rice in the pot—and the contented look of a man who has established order out of chaos.

Reveling in our self-made comfort, we reviewed the day's events. For 19-year-old Derek, the highlight had been the sight of photographer Baird Bryant deflating his raft in midstream by sitting down with a poorly sheathed knife at his belt. Frank's oldest son, Lance, enjoyed most the opportunity to photograph his cousin Johnny's upset in the rapids.

We fathers were seriously evaluating a problem that lay ahead. The yellow surplus rafts worried us. On previous trips, we had run many rapids with them, but now they were burdened with camera equipment and sound gear. Sluggish, they would be hard to handle, vulnerable to damage in the rapids. And we faced more than eighty rapids on the Middle Fork alone! It was going to be an extended trip, with speed restricted to that of the slowest raft. We decided then to stretch our limited supply of dehydrated food with the natural bounty of stream and forest.

Sleep came early that night. We spread our sleeping bags on the few level spots, then

PHOTOGRAPHS BY DICK DURRANCE II (ABOVE) AND DEREK CHADWICK © N.G.S.



drifted off, lulled by the scent of fir, the patter of rain, and the distant call of a saw-whet owl.

A persistent drizzle bonded sky and river for the next two days, while the photographic crew captured the wild beauty through which we paddled. Finally, at Pistol Creek, we were able to stop and bare body, soul, and equipment to the drying warmth of the sun.

Stops for filming were consuming much of the time we had been able to allocate for the trip. Somehow, we must speed up. On the evening of the fifth day, our map showed no difficult rapids ahead, so we decided to break one of our standing safety rules and continue after dark.

With no halts, the miles flowed beneath us, but everyone was keenly aware of the risk involved. It was nearly pitch dark in our canyon, and only a narrow band of stars showed above the rock walls.

Drifting with the current, we listened carefully for sounds that would tell us that a rock was splitting the stream, a warning that white water lay ahead. When we called to each other, our voices seemed to cross expanses far greater than the narrow channel.

It was strange, this feeling that the river canyon was at once vast and confining. We strained to hear in the dark, alert to the very tips of our oars and paddles. Two hours of blind travel was enough; we turned our kayaks and rafts and angled toward the shore.

PHOTOGRAPHED BY FRANK CRAIGHEAD (ABOVE) AND KAREN CRAIGHEAD © N.G.S.

Diary of a hunt? Rock paintings of bighorns and an eagle may be the record of animals killed in the vicinity by Indians. Frank Craighead, with nephew Derek, climbed to a cavern (left) above the Middle Fork to point out the pictographs for TV photographer Baird Bryant.

The Tukuarika, or Sheep-eater Indians, so called because of their skill at tracking the elusive bighorns, once stalked game in this mountain vastness. But the arrival of miners and settlers touched off warfare which, in 1879, led to the tribe's eviction.

"Keep to the Right of the Slick"

We had covered 50 river miles by now. The boisterous Middle Fork had broadened and deepened; giant Douglas firs and stately ponderosa pines replaced the lodgepole pines and subalpine firs seen earlier. The canyon walls rose even higher as the river cut deep into the mountains.

On the craggy heights above us roamed mountain goat and elk. Occasionally we caught a glimpse of mule deer and bighorn sheep (pages 216-17), and golden eagles soared into sight almost daily.*

The sixth day out, we reached Tappen Falls. Beaching our boats above it to reconnoiter, we studied the sharp, rugged escarpment that jutted into the river. Foaming water dropped a sheer six feet there. We would have to "line" the four equipment-laden rafts—walk them downstream from shore, with ropes attached to bow and stern. The two kayaks would have to be carried or lined, too. Our lighter Avon rafts could probably run it.

Three of the boys—Derek, Charlie, and Lance—volunteered to man the rafts.

"Keep to the right of the slick," we warned them, for that deep tongue of the current—normally the best route in high water—terminated in a seething caldron.

Lance maneuvered his craft like an expert, and picked the proper route. But Charlie and Derek dropped precisely into that churning water hole at the foot of the falls. Their rubber craft folded in the middle; then boys and raft disappeared beneath the surface.

*For other wildlife and wilderness articles by the Craigheads, see "Sharing the Lives of Wild Golden Eagles," September 1967 GEOGRAPHIC; "Trailing Yellowstone's Grizzlies by Radio," August 1966; "Knocking Out Grizzly Bears for Their Own Good," August 1960; "Bright Dyes Reveal Secrets of Canada Geese," December 1957; "Wildlife Adventuring in Jackson Hole," January 1956; "In Quest of the Golden Eagle," May 1940; and "Adventures With Birds of Prey," July 1937.

To us on shore, it seemed minutes before the raft broke free of the falls' crushing force and surfaced with two breathless boatmen clinging to it. The ducking actually had lasted only seconds. "But I'll remember the bottom of Tappen Falls for a long time," Derek said later with a grin.

Derek and Charles had no monopoly on river thrills. A week later it was 14-year-old Jana's turn.

She and her brother Lance had rowed their raft ahead of us as we approached House Rock Rapids. They planned to pull ashore at the head of the run and photograph us as we entered the white water.

Hastening to get well ahead of us, Lance suddenly found himself caught in the powerful current; it was too late to make the shore. Now he was committed to the roaring water without being able to scout his course—our standard procedure before entering difficult rapids. With unsecured gear bouncing around the raft, he quickly became a busy young man.

Lance began stuffing photographic gear into his camera bag while trying to maneuver the raft into quiet water. Jana, in the seat behind him, tied down other equipment.

Suddenly their raft slipped into the pit of a giant curler which stopped it abruptly and sent the Middle Fork pouring aboard. Lance became even busier then, fighting his half-swamped craft toward a safer channel. Preoccupied with the quarter mile of rocks and white water ahead, he had no time to worry about Jana.

We could see only enough to know that something was wrong. There was a brief glimpse of Lance and the raft disappearing behind sheer rock walls of the twisting canyon, but Jana was nowhere in sight. Was she in the bottom of the raft—or overboard? That question gnawed at all of us during the half hour it took us to work our craft through House Rock.

PHOTOGRAPHS BY KAREN CARRIKER (BELOW) AND DICK SUHRANCE II © N.G.S.

Engulfed in white water as he perches on the brink of a rapid, young Johnny Craighead deftly balances his kayak, then rides down the wave like a surfer (below). Moments later he took a dunking in the Middle Fork. Upside down in the swirling water, Johnny attempted a roll that would right his craft, but his head hit a submerged rock, forcing him to bail out. "When he finally reached shore," recalls his father, "he grinned and said he was glad I had made him wear his helmet."

During this voyage—his first on white water—Johnny became an expert at righting the kayak, performing the feat repeatedly for the television cameras.

KODACHROME BY DICK DURRANCE II (C) N.G.S.

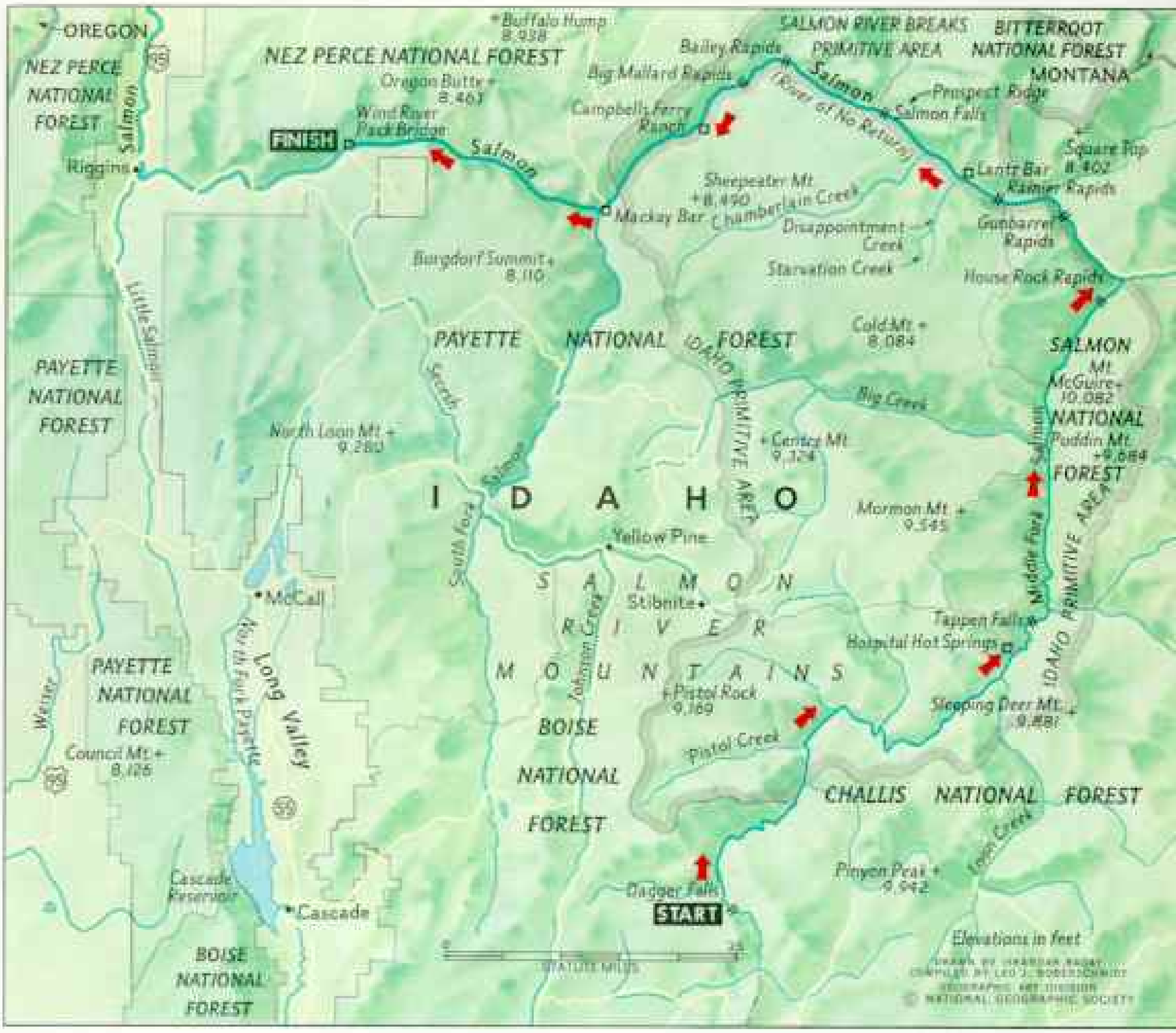
Running two untamed rivers—the Middle Fork Salmon and the Salmon—the Craigheads passed through chasms full of the tumult of roaring white water but serene with solitude and breathtaking scenery.

As the party traveled on the Middle Fork, the river dropped 2,600 feet in 95 miles. The Salmon descends less steeply, but its boiling rapids are larger and rougher. For approximately 180 miles the river cuts a gorge more than a mile deep.

On snow-buried banks of the Salmon, Frank Craighead measures condensation nuclei in the atmosphere with a Gardner Small Particle Detector. Counts on the Salmon River, which averaged 1,000 particles per cubic centimeter, provide a comparative base for checking air pollution in cities, where counts may run 250 times as high. Sun striking the camera lens causes the optical flare.

Wild Rivers

Red lines mark sections of rivers protected or proposed for protection under the Wild and Scenic Rivers Act of 1968. The eight rivers underlined are already part of the system.



Finally, a mile below the rapids, a wisp of smoke appeared on shore. There a bedraggled Jana told us her story while she huddled over the fire that Lance had built.

"Suddenly I was in the river," she said. "But Lance didn't know it."

She shivered. "I went under the raft but grabbed the safety line. Ages later, when we were almost through the rapids, Lance turned and noticed me in the water. He tried to reach for me, but I was dragged under the raft again. Finally Lance pulled me aboard."

That lesson at House Rock renewed our caution and our respect for the river.

We cheerfully accepted the rigors of boating. More exhausting was the task of documenting our journey with still and motion pictures. Our television crew exposed more than 40,000 feet of film and recorded 20 hours of sound tape to document white-water thrills, camp incidents, wildlife, and fishing.

The filming had slowed our downriver progress enough to create a food problem; so, after passing House Rock, we decided to devote the rest of the day to foraging. The young members of the expedition headed up the rocky terrain like a horde of hungry locusts.

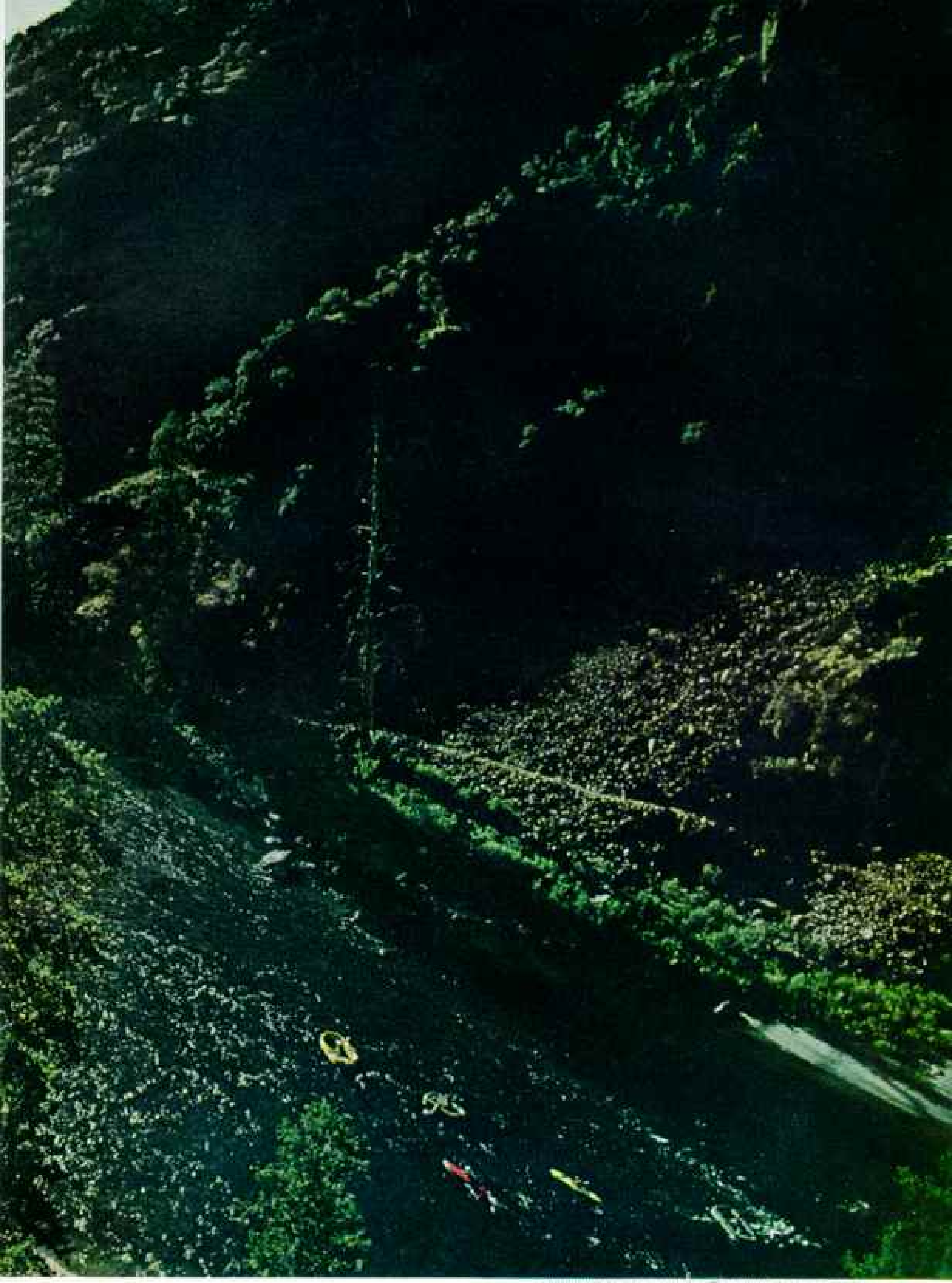
A Lesson on How to Live off the Land

Returning from our own fishing expedition, we found Jana and Karen had gathered hawthorn fruits, serviceberries, and chokecherries. Derek and Charles contributed four chukar partridges and three ground squirrels.

Our cutthroat trout were almost ready for the griddle when Lance turned up with a broad grin and a two-foot rattlesnake (page 229). Skinned, cut in sections, and dipped in flour, it went on the griddle to fry alongside the fish.

To round out the menu, we had dug camas roots, a staple food of the Indians who once

Like a ribbon of mercury in the brilliant August sun, the Salmon River wends its way westward. Weathered walls of granite, their gray faces greened with an occasional ponderosa pine and Douglas fir, tower above rafts and



KODACHROME BY DICK DURRANCE II © NATIONAL GEOGRAPHIC SOCIETY

kayaks of the Craighead party at lower right. Should the Salmon be protected under the Wild and Scenic Rivers Act, this and other spectacular regions along its course would be preserved as an adventureland for all to enjoy.

roamed this area. The sweet, mealy tubers were at a rolling boil, and the berries were simmering when Jim Cole returned with a bucket of freshwater mussels.

Except for those mussels, it was a tasty meal. We steamed some in the shell, boiled others, and even fried some of the boiled ones, but each batch was as tough as shoe leather. Archeologists have found ancient Indian camps littered with empty mussel shells. Those Indians had been hungrier than we, or better cooks.

The chukars—striking, fast-flying partridges native to the foothills of the Himalayas—had been introduced into this perpendicular country by the Idaho Fish and Game Department. They have adapted to their new home, and multiplied, but their success has been greatly aided by cheatgrass, another outsider. Traveling over from Europe in grain shipments before the turn of the century, the weed has invaded the dry slopes and provides the chukars with a year-round source of food. Even wild country undergoes change. With public support, we can keep our wild rivers largely intact, but we cannot hope to keep them completely unaltered.

On previous trips we had floated the lower sections of the Green River in Utah, an appropriate candidate for wild-river status (map, page 222). Much of the natural vegetation there has been displaced by tamarisk, a vigorous shrub which may have been brought in by early Spanish explorers. It has become so well established now that it probably can never be eradicated.

The Green River canyon is still beautiful—and chukars do furnish excellent hunting along the Middle Fork and Salmon—but it would be wise to discourage further introduction of exotic plants and animals into our few remaining wild-river areas.

We thought of these things as we traveled, for two weeks, ninety-five miles downriver to reach the mouth of the Middle Fork. Before we turned west to tackle the mainstream of the Salmon, we put new neoprene bottoms on our battered surplus rafts and replenished our food supply at the town of Salmon.

Jim Cole, Charlie, Johnny, Jana, and John's wife left for civilization at this point. In their place we welcomed Dr. Morgan Berthrong, his daughter Sonja, and another old friend, Harry Reynolds.

BOATCHANGES BY JOHN CRAIGHEAD (ABOVE), LANCE CRAIGHEAD (RIGHT) AND DICK DURRANCE II (OPPOSITE) © N.G.S.

Favorite food of Salmon River fish, a stone fly (Plecoptera) needs clean, swift water to survive. Slight amounts of pollution kill it.

Dinner in hand, Frank Craighead displays a 12-pound steelhead. Like chinook salmon, these trout swim upstream from the ocean to spawn at their birthplace; unlike the salmon, which die after spawning, steelheads return to the sea.

Still half asleep, Derek and Jana Craighead await breakfast at a sandy campsite. Lance watches his father cook oatmeal liberally laced with raisins.

BOOKSHEDWE BY JOHN CRAIGHEAD © N.G.S.

Hardy survivor of pioneer days, an abandoned homestead overlooks the Salmon near Campbells Ferry Ranch. Karen Craighead and her brother Derek inspect the cabin of hand-hewn timbers and shakes. In 1861 and 1898 the discovery of gold brought hundreds of prospectors to this craggy fastness. Both times the diggings quickly petered out, and the fortune seekers moved on. The harsh land attracted few permanent settlers.

The tumbling waters of the Middle Fork had dropped our party 2,600 vertical feet in less than a hundred miles. We'd descend more gradually—yet more dangerously—on the Salmon. This would be a more powerful river, with larger rapids and rougher water. But we knew our sturdy rubber rafts would meet the challenge, and we had complete confidence in our trim 14-foot kayaks.

Perhaps we entered the Salmon with too much assurance. Ten miles downstream, we reached Gunbarrel Rapids—not one of the river's most difficult obstacles. As John ran through, the stern of his kayak struck a rock. The jolt, followed by a slap from the fast current, flipped him over. To his chagrin, John had to swim the length of the rapids.

Shortly thereafter, as darkness crept into the canyon, we pulled our flotilla ashore on a beautiful sand beach flanked by towering ponderosa pines. The current raced past the opposite shore, but on our side of the river a calm, clear lagoon mirrored the incomparable scenery that surrounded us.

By the time the evening shadows had climbed from water to mountaintops, our camp chores were finished. Soon night shrouded our peaceful, slumbering camp. The wheezing hunger call of a young great horned owl sounded from the pines overhead, then the deep, resonant answering hoot of its parent. Few of us were awake to listen.

Pushing on next day, we spotted a small sand bar adjacent to a cliff. Water had long

ago carved out a natural shelter that would have met Indian requirements as well as our own. We went ashore to look for artifacts.

Yes, faint soot marks at the top of the shelter told us Indian cooking fires had burned here. When we scraped the cave's floor, we found layers of discarded mussel shells. This shelter could have been used by the ancient mussel-eating tribes, centuries before Christ was born.

We could see that more-sophisticated Indians had used the site, because the walls were marked with pictographs probably drawn in red ocher—earth colored with iron oxide. Perhaps archeologists can interpret those drawings for us some day—but each of us could conjure up imaginative tales from the marks that ancient man had left for us to ponder.

Game Fish Wage a Losing Fight

To Indians along the Salmon River, the chinook salmon was an important source of food. Each spring and summer the fish migrated upstream from the Pacific Ocean in countless numbers.

Only a fraction of them complete the trip today. After fighting their way up the fish ladders in Columbia River dams, they face the perils of fishermen and polluted water as they swim through the Columbia and lower Snake Rivers.

The survivors may travel almost to the Continental Divide—to the spawning redds in the headwaters and tributaries of the Salmon River. There, often in brooks no wider than the fishes' length, the journey ends. Females deposit eggs in the fine pebbles, to be fertilized by the males. Then—battered and emaciated—the salmon die.*

Along the bank one day we found a huge salmon. Apparently he had worked his way up to the spawning beds above, and had drifted downstream again, with but a vestige of life remaining. We killed the dying four-foot fish, and opened its atrophied stomach in a fruitless search for a sonar tag.

Scientists are seeking new knowledge about these migratory fish. For years Mr. James H. Johnson, of the United States Bureau of Commercial Fisheries, and a crew of scientists have been implanting sonar transmitters in salmon and steelhead trout. One object is to determine the effect of dams and impounded water on their upstream migration. This, plus

*See "The Incredible Salmon," by Clarence P. Idyll, National Geographic, August 1968.

PHOTOGRAPHED ABOVE AND OVERLEAF BY DICK DURRANCE II. © N.G.S.

How to handle a rattler: "With caution, of course," advises Frank Craighead. He grips the neck and tail of the reptile, while Lance probes its hypodermic-like fangs. Beheaded, skinned, and fried, the snake became part of a survival demonstration: a meal of partridge, squirrel, trout, wild tubers, and berries, gathered from forest and stream.

Into a surge of churning water goes John Craighead (following pages), pulling hard on the oars to avoid a boulder in the foaming caldron. "The river poured in over me," John recollects. "I saw it coming and instinctively slid down in the boat, but there was no avoiding the frigid bath. Fortunately, the air was not too cold. I've made runs in zero weather when spray coated my clothing with sheets of ice."

Spills seldom occurred during the Craigheads' winter trip, but a television producer, unused to river ways, was flipped overboard (pages 234-5).

Precarious catwalk above the swift Salmon serves as a path to the outside world for Sylvan Hart, popularly known as Buckskin Bill, who first settled on the river in the 1930's.

Living link with the lore and legend of the Old West, Sylvan Hart wears his handmade coonskin cap and buckskin jacket. "The fringes let water run off faster," he

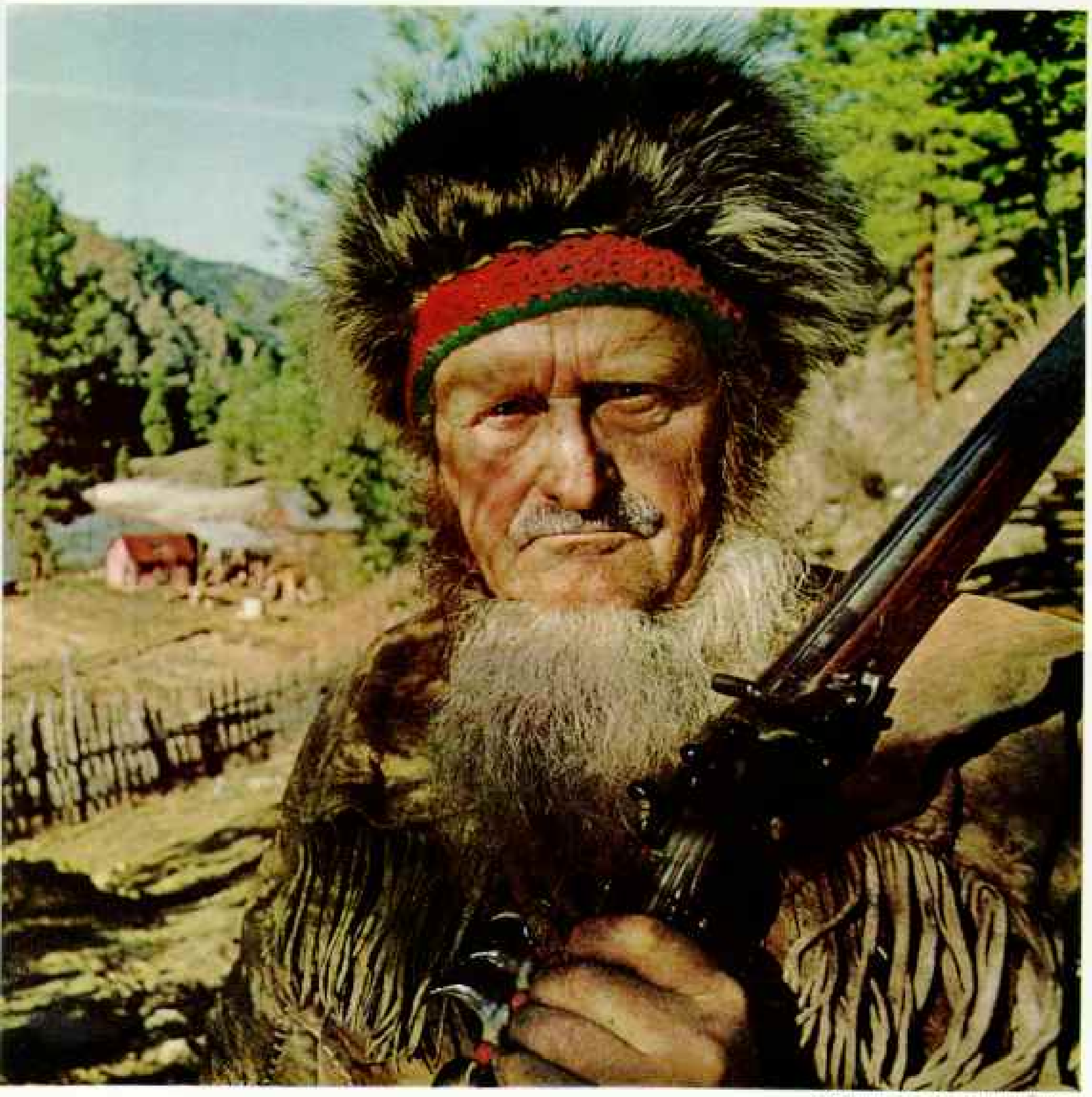
tagging and other studies by the Idaho Fish and Game Department, is helping preserve the chinook and the steelhead.

Fur, not fish, first brought pioneers to the Salmon River. Then came prospectors and a few homesteaders. Local place names describe those early days: Starvation Creek, Prospect Ridge, Disappointment Creek. You'll still find miners' cabins and sluice boxes, though no one seriously pans for gold.

Only a few of the original homesteaders remain on the river. Later arrivals, such as Don Smith, caught the gold fever in Depression days. Don arrived in 1930 and spent eight years searching the bars for "color." He, his wife, and two sons run a thriving boating and guide service now.

We met Don on the river, and soon he was teaching young John how to pan for gold. Don gently rocked the gold pan, showing us the color line.

"Things were different when I had to make a living at this," he said. "Some days we couldn't pan 50 cents' worth—but we could



claims. Shouldering a hand-bored flintlock rifle, Hart stands on a knoll overlooking his present home—which he built himself—with its spike-fenced garden. High above the secluded valley a jet plane's contrail streaks the sky, wispy reminder of the other world that this real-life Robinson Crusoe has forsaken.

live off the land and get by on $200 a year."

The Smiths now run modern jet boats up and down the River of No Return. These boats have had their impact on river life.* Even Don, who makes his living with them, admits their unrestricted use could destroy the solitude that his clients come here to seek.

Shining directly up the narrow canyon below Rainier Rapids, the sun turned the river into a ribbon of shimmering gold. We were tired and wet. The sight of Dan Lord's cabin on the river's right bank was a welcome one.

As the rest of us made the boats fast, Frank knocked on Dan's door. It opened, and a huge, bearded man, whom we had known from previous trips on this river, extended his hand.

"Meet the Lord," he growled with a glint in his eye. "Back again, eh? If you wash your feet in this river, you'll always come back!"

Warmed and rested after a brief visit with Dan, we paddled another three miles downstream to Lantz Bar. River bars—deposits

*See "Shooting Rapids in Reverse," by William Belknap, Jr., NATIONAL GEOGRAPHIC, April 1962.

Man overboard!

"Hang on," John Craighead shouts to television producer Bud Wiser, as their Avon raft starts down a green-tongued slick in the rough waters of Salmon Falls.

Midway in the chute, the stern of the raft goes down and Wiser goes out. Too busy rowing to look back, John is unaware he has lost his passenger.

Reaching calmer water, John discovers Wiser's predicament. Fortunately, the producer had kept a tight hold on the raft's rope.

Seat-of-the-pants rescue: John pulls in a drenched and shivering Wiser. Frank, standing on the shore, photographed the action.

of sand, gravel, and boulders—are tucked into the canyon walls here and there, well above the flood line, providing a few habitable sites.

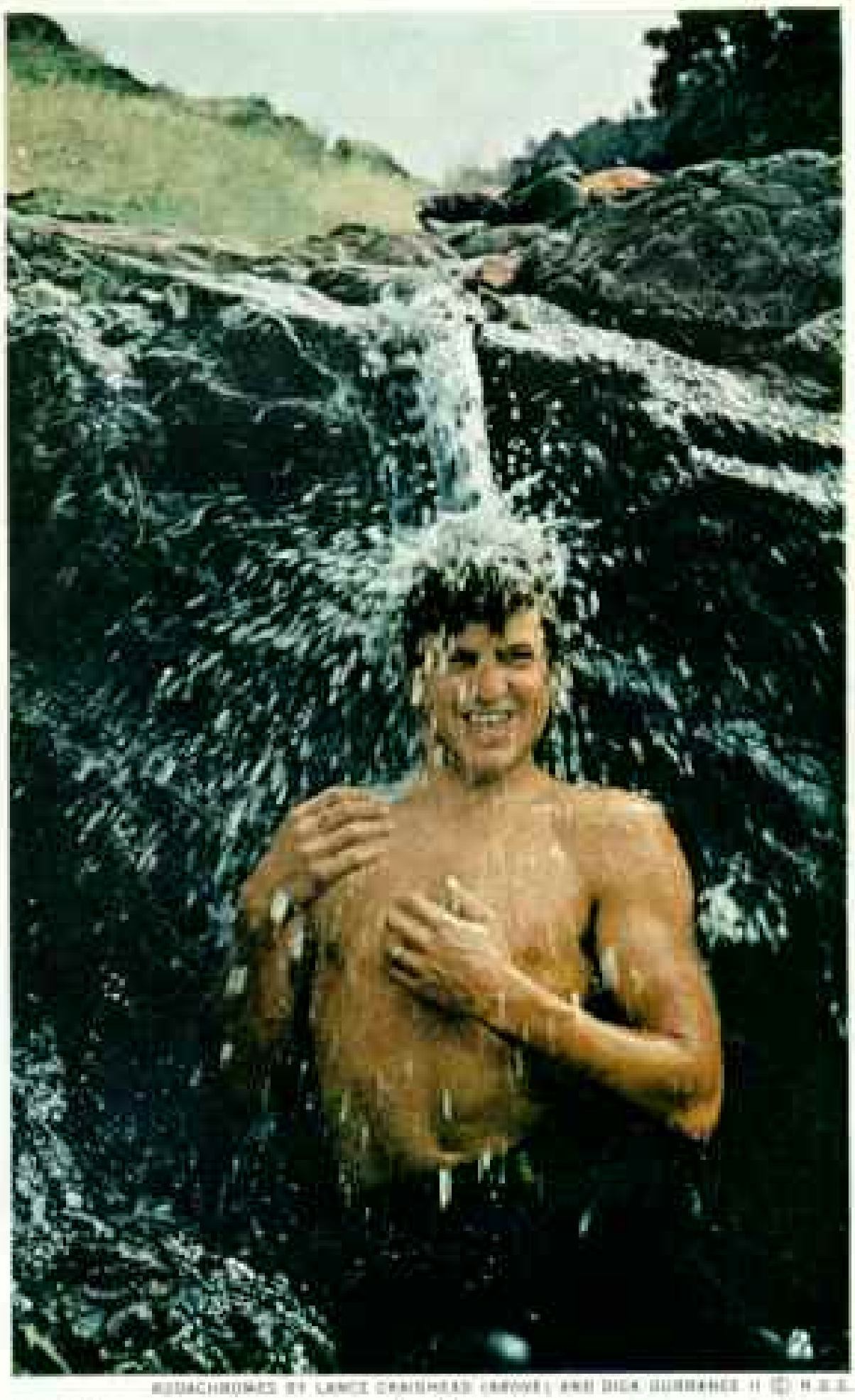
Frank Lantz was at the shore to greet us as we beached our boats. At 78 he is still spry and sharp.

We introduced Morgan Berthrong. "Why, that's the fella the eagle clawed," Lantz commented. "He was covered with claw marks in that picture!"

Our old friend was referring to a photograph in a GEOGRAPHIC article we had written in 1940. It showed Morgan's face after a golden eagle had lacerated it while the bird was being banded.

We camped on Lantz Bar that night, and our families plied the homesteader with questions.

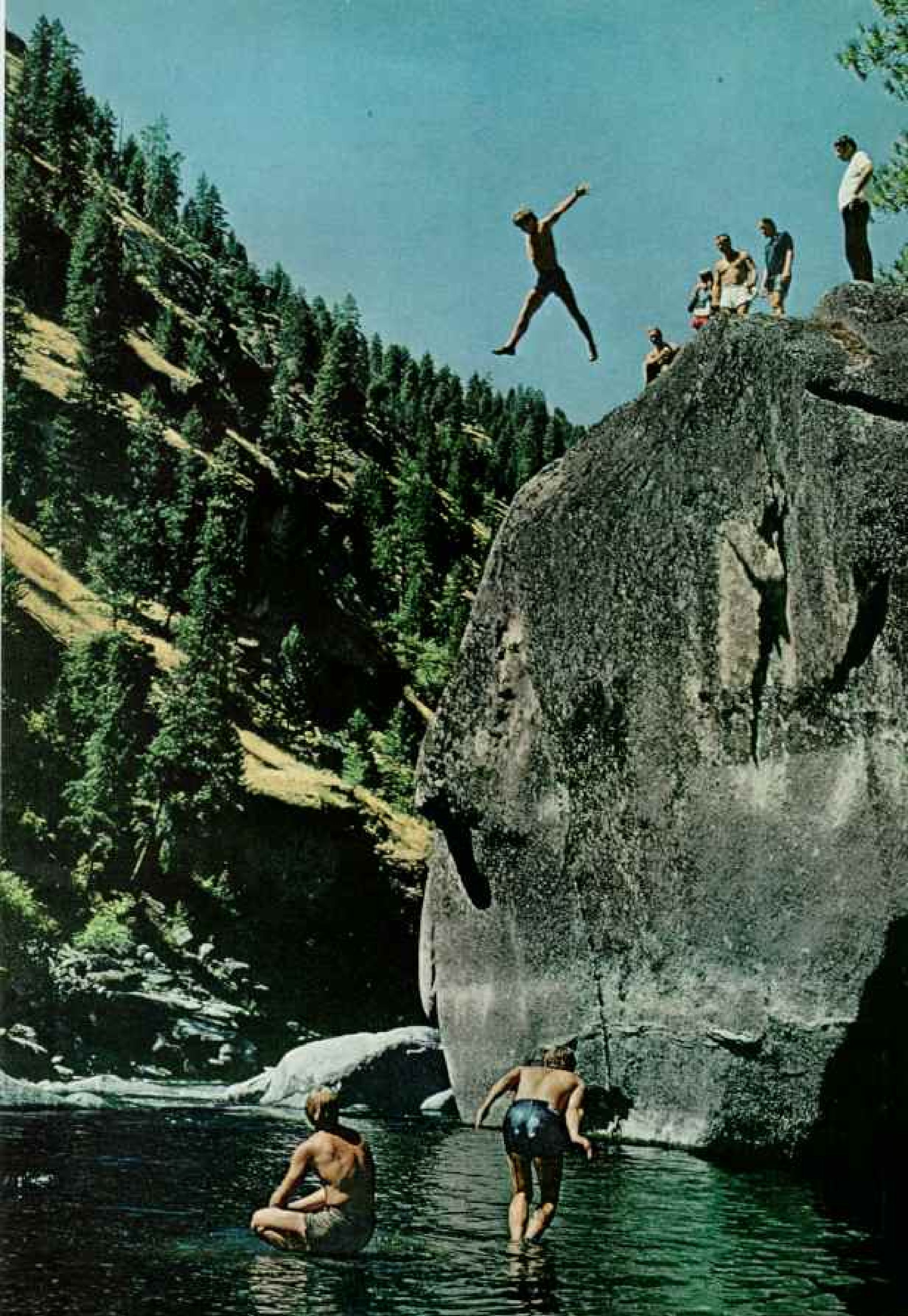
"How did I settle here?" he said, echoing Karen's question. "I dunno. Just got this far down the river and stopped. Hardly know why I picked this spot. It was as dried up as them hills, and filled with boulders. Moved some rocks off the place—some rattlesnakes, too—and greened it up. A man can't just sit down in a place like this; got to keep busy.



KODACHROMES BY LANCE CRAIGHEAD (ABOVE) AND DICK DURRANCE II © N.G.S.

Hot shower, courtesy of nature, warms Derek at Hospital Hot Springs on the Middle Fork. The water soothed chilled members of the Craighead party, which encountered spells of cold weather—even snow—on the summer run. Men and wildlife have used the region's thermal pools for ages: men to wash in and to cure their ailments, animals to drink from and thus remedy a mineral deficiency in their diet.

Walking on air, Charles takes off from a 30-foot-high rock above Salmon Falls. The pool's deep water cushioned the plunge, but his feet still struck bottom. After taking their turns, Lance and Derek rest in the shallows.



"I came here first in 1916. Went back to West Virginia in '21, but the river was all I could think of. One day I was seeding oats, and decided. After chores I told dad, 'I'm Salmon River bound.' Been here ever since."

There was respect in our eyes as we waved goodbye next day to this wonderful old man, who had traded the comforts of civilization for more primitive pleasures. We were glad our children had had a chance to meet him.

Pulse Rate Races in White Water

Even an experienced riverman feels excitement, exhilaration—and often apprehension—when running white water. Because we wanted to see how those emotions would alter a human heart rate, we included an electrocardiograph in our gear.

Just above Salmon Falls, we attached the transmitter to Dr. Berthrong and fastened the electrodes to his chest. The doctor would ride as a passenger with John through Salmon Falls, while Frank remained on shore to monitor the signal on an oscilloscope.

Morgan's heart rate was 64 beats per minute before the run. It rose to 76, then 80, as John approached the white water. In the worst of the rapids, Morgan's pulse rate reached 112.

This unusual exhilaration, coupled with pride of achievement, is reason enough for men to seek the challenge of wild rivers.

Another item of scientific equipment in our gear was a Gardner Small Particle Detector, designed to measure condensation nuclei in the atmosphere. A count of submicroscopic particles recorded by the device provides a measure of air pollution (page 222).

We had used the counter in other wilderness areas—even here on the Salmon during a winter float trip. Our readings went to Dr. Vincent J. Schaefer, renowned atmospheric scientist at the State University of New York

Squatting on the sands of the Salmon, Derek shucks freshwater mussels. Indians ate the shellfish, but the Craigheads found them "tough as shoe leather."

The clean, sparkling stream, aglow in late afternoon sun, flows through pristine wilderness, epitomizing the wild-river legacy that the authors have so long fought to preserve for future generations. "They are entitled to such a heritage," says John Craighead, "and we must do everything in our power to give it to them." EKTACHROME BY DICK DURRANCE II © N.G.S.

at Albany, where he is conducting a comprehensive study of air pollution.

Particle counts along wild, unmodified rivers are important; they are part of a comparative base against which the air of our cities can be judged now and in the future.

The comparison is interesting and depressing. Our readings on the Salmon averaged 1,000 particles per cubic centimeter of air. Atmospheric counts in busy cities can run 250 times as high—a noteworthy indication of our deteriorating urban environment.

Sixty-six miles down the Salmon from the Middle Fork, the canyon walls rise steeply. Stretches of deep, relatively slow-moving water are interspersed with the rapids. It reminded us of the gorge of the Potomac that we knew as youngsters some thirty years ago.

In those days, the river in that area—less than twenty miles from the heart of Washington, D. C.—was a clear-running stream. Peregrine falcons hunted over the gorge. Raccoons, red and gray foxes, and mink were common sights. Bald eagles nested in the large sycamores of the islands.

Fishing was fabulous. The big sturgeon had already disappeared from the Potomac—a forecast of changes to come—but we caught plenty of smallmouth black bass and channel catfish. Each spring, shad and herring moved up from tidal waters to spawn, and were snagged and netted by the thousands.

The deterioration there today is disheartening. Fishing has suffered. The clear water we used to swim in and drink now smells of sewage and industrial refuse. It was this progressive destruction of the Potomac and other cherished rivers that stimulated us to try to help save the few remaining pristine streams.

New Law Only a First Step

After 23 days afloat, we beached our boats on a sloping sand bar and crawled into sleeping bags for the last time.

Close to our ears ran the river, whispering of things we had seen and done. It spoke of fighting fish, hooting owls, and frolicking otters, of the steady dip of oars and paddles, sore muscles, blistered hands, and tired bodies. It was comforting to think that this unique natural area, with its vast diversity of plant and animal life, could be forever protected by the Wild and Scenic Rivers Act.

This act of Congress, signed into law on October 2, 1968, provides the means—"It is hereby declared to be the policy of the United States that certain selected rivers of the Nation . . . shall be protected for the benefit and enjoyment of present and future generations."

Recognizing the accelerated pace of environmental degradation and the rapid exploitation of our resources, Congress went on to promise that "Every wild, scenic or recreational river in its free-flowing condition, or upon restoration to this condition, shall be considered eligible for inclusion in the national wild and scenic rivers system. . . ." Thus the Salmon River qualifies.

Public Should Express a Choice

Problems will arise, however, for there are other interests that conflict sharply with the preservation concept. Special interest groups can make legitimate claims on the water, timber, and mineral resources of the areas. Because our wild rivers are so precious, we should weigh those claims carefully—balance them against the cultural, esthetic, recreational, and scientific values that derive from an unspoiled river. And then the public must express its choice, acting through civic and conservation groups, and by making its wishes known to Congress.

All of us lying there on the sand bar beside the Salmon fervently believed that a substantial stretch of this wild river should be held in trust as a place where men could seek adventure, find freedom, meet physical challenges, and escape from the pressures and complexities of urban life.

Next day we came ashore near Wind River Pack Bridge, about twenty miles above Riggins, Idaho (map, page 223). Our 190-mile voyage was over. As air hissed out of our deflating rafts, we were already talking of future float trips. For our families hadn't seen all of the Salmon's beauty; some stretches farther downstream, we know, are as spectacular as the ones we had just navigated.

Perhaps we will take another two-family flotilla down there. If not, our children will run the Salmon on their own, for all of them are capable river travelers now. It has been satisfying to watch them pit their growing skills, strength, and endurance against the water and the wilderness.

With public interest and support, the few remaining pristine rivers can be saved, so that each generation can experience the natural environment that has shaped man down through the ages. A sojourn in unmarred wilderness country gives a perspective that is desperately needed in our rapidly changing world.

THE END

Tear out the attached page and keep it near your TV as a reminder. 239

Wading icy waters, a bull elk forages for food. Wild-river preservation will save some of the animal's shrinking habitat.

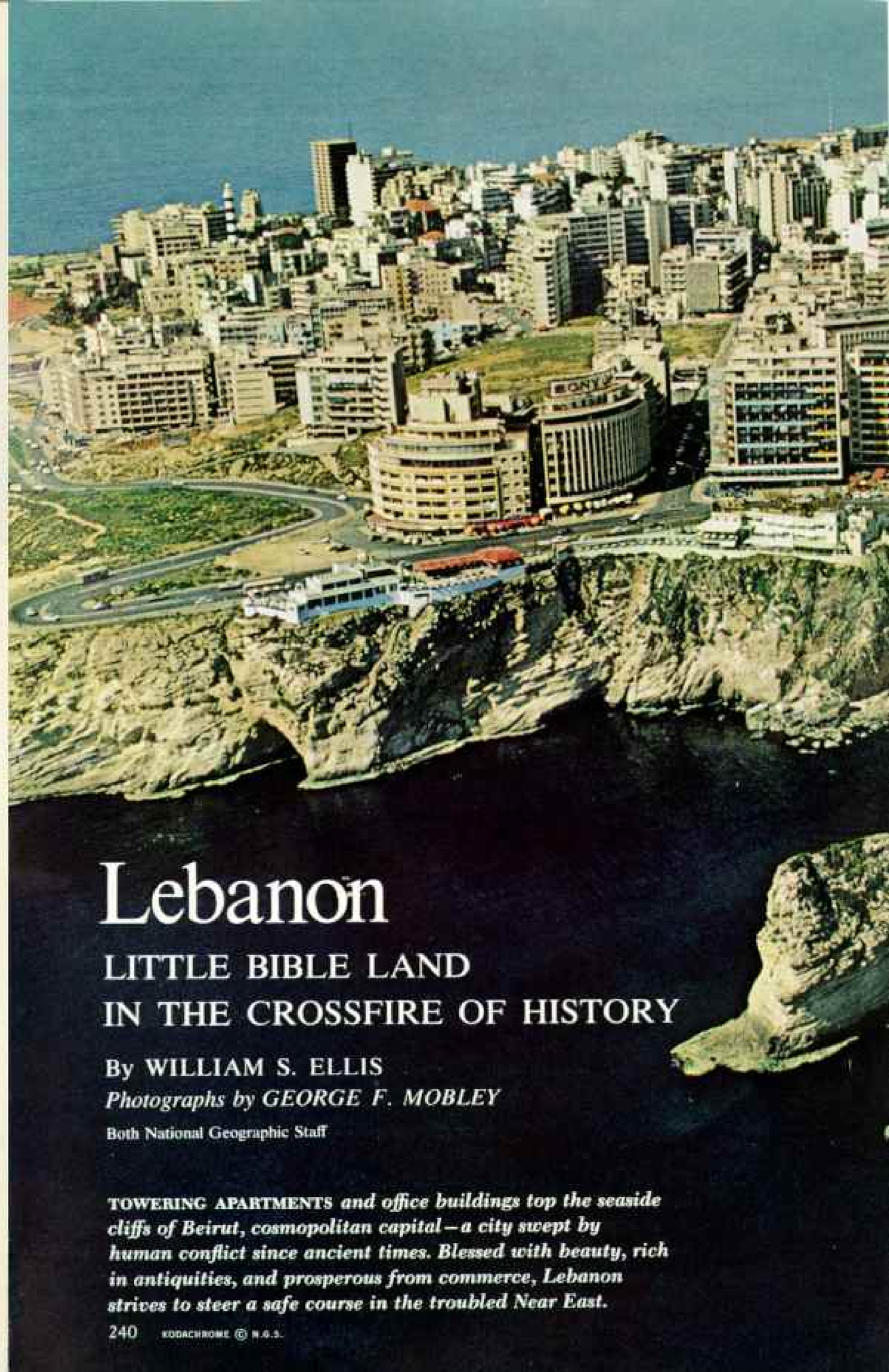
Chokecherry harvest, gathered by Jana Craighead and boiled to a syrup, spiced pancakes for riverbank breakfasts.

Crackling campfire warms members of the Craighead party during an overnight stop on their late-winter run down the Salmon River.

Sunlit crags spike the sky above the Middle Fork Salmon, as a lone kayaker paddles a stretch of placid water flanked by lofty pines.

Wild River

SEE IT IN COLOR, TUESDAY, FEB. 10



Lebanon

LITTLE BIBLE LAND IN THE CROSSFIRE OF HISTORY

By WILLIAM S. ELLIS

Photographs by GEORGE F. MOBLEY

Both National Geographic Staff

TOWERING APARTMENTS ***and office buildings top the seaside cliffs of Beirut, cosmopolitan capital—a city swept by human conflict since ancient times. Blessed with beauty, rich in antiquities, and prosperous from commerce, Lebanon strives to steer a safe course in the troubled Near East.***

"THERE IS MUCH TENSION in the city," Mustapha Khalil told me. "Look around you. People are whispering. They usually shout."

Mustapha, a young Lebanese printer, leaned over the oilcloth-covered table of a Beirut coffeehouse, where we had been sitting for more than three hours, drinking green tea and puffing on *narghiles*—water pipes.

"I hope I'm wrong," he continued. "Maybe it's just the weather, all this rain we've been having."

He wasn't wrong.

Trouble began less than a week later, on one of those days peculiar to the eastern Mediterranean, when the setting sun reaches under low-lying storm clouds to skip its light across the surface of the sea and engulf the coast in an orange-gold glow.

Commando Issue Topples Cabinet

The violence occurred in a Moslem quarter of this capital city. I could hear the sporadic firing of rifles and the excited shouts of people scurrying for cover. The stench of burning rubber filled the air as flames devoured overturned army vehicles.

On that April day, Lebanon counted more than 15 dead and 100 injured in demonstrations over the government's attitude toward

Expert with an eagle feather, Dicran Nadjarian uses the quill to pluck his *oud*, a pear-shaped instrument similar to the lute. Mr. Nadjarian, one of 85,000 Armenian residents of Lebanon, both makes and repairs musical instruments in his tiny Beirut shop.

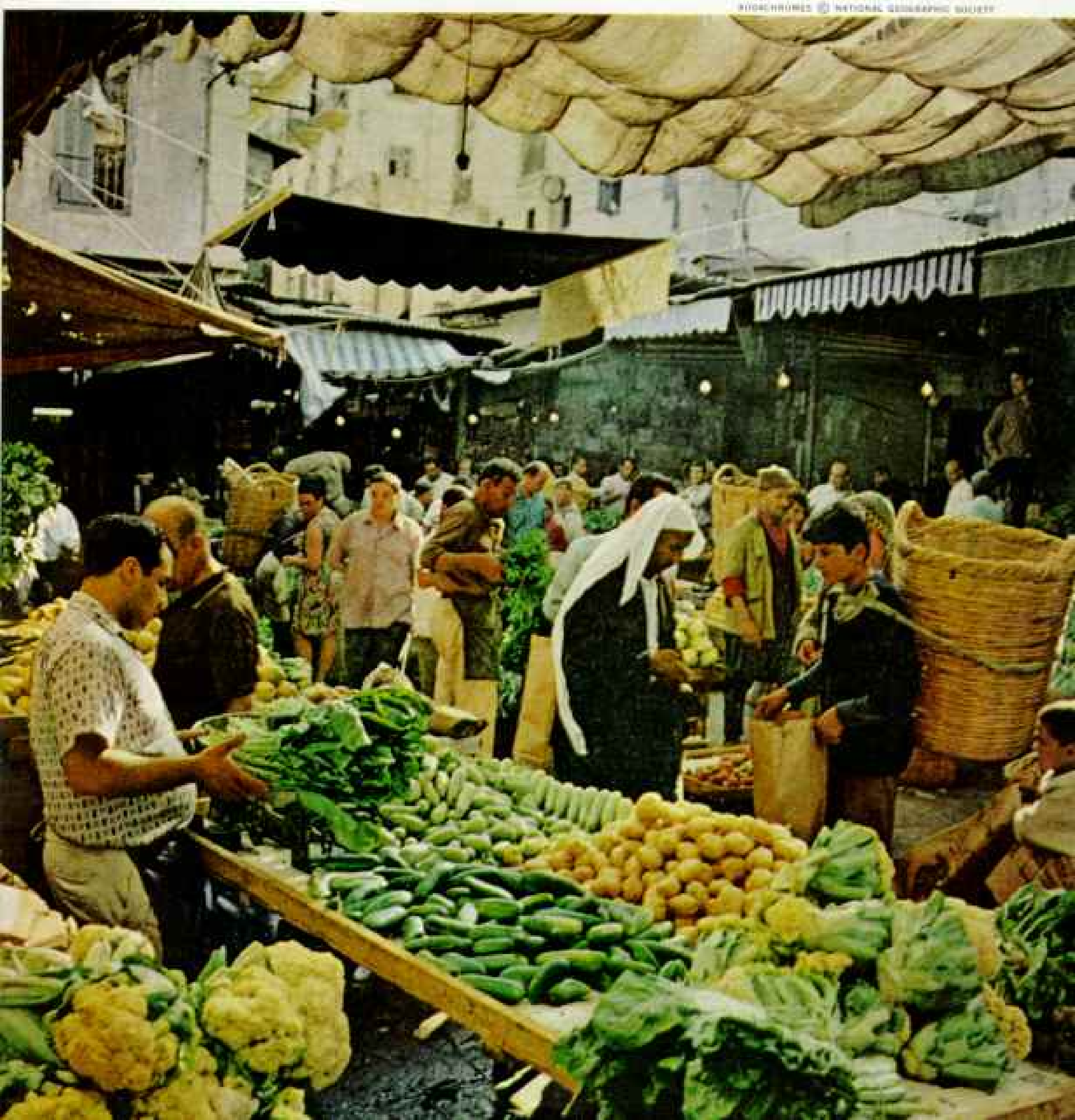
Largess of a bountiful land fills a vegetable and fruit *suq* in Beirut's old quarter. A hodgepodge of awnings shields produce from the midday sun. Nearby streets hold shops specializing in gold and antique jewelry, brass, crystal, and leatherwork.

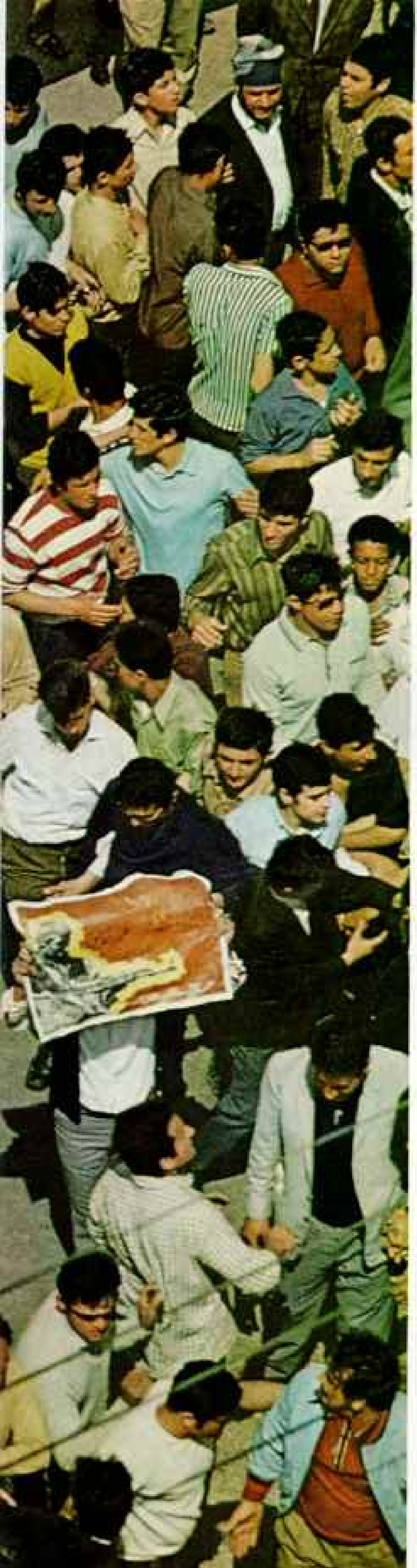
Arab commandos, including members of the ultramilitant Al Fatah guerrilla force, who are pledged to work for the destruction of Israel. Government security forces clashed in the streets with those who demanded that the commandos be allowed freedom to conduct raids on the Jewish state from Lebanese soil.

The cabinet fell. A curfew went into effect over much of the country. Soldiers patrolled city streets. Newsmen from around the world converged on the seaside terrace of Beirut's famed Hôtel Saint-Georges, a favorite journalistic vantage point on the Arab world. Lebanon, only 26 years old as a fully independent republic, came face to face with a threat to its survival as an enclave of individuality in a section of the world where Arab nationalism tends to transcend borders.

Much of the agitation in Lebanon centered in the Palestinian refugee camps in which recruitment of commandos was being carried out by, among others, Syrian Army regulars. I visited one of these camps, Burj al Barajinah, on Beirut's outskirts (map, page 250, and pages 272-3), and found it seething with explosive anger directed as much against Lebanon's indecisiveness as against Israel.

One of the refugees, a man ill and aged far beyond his years, beckoned me into his tin-roofed shack. He was born in Palestine, he





told me, and, like 800,000 other Arabs, left his home in 1948 when his country became Israel. He showed me a crudely made bomb. I asked him if he would use it in the streets of Beirut in support of the Arab commando cause.

"I have the will to use it," he replied, "but not the strength."

Later that day, after obtaining a special pass from the army, I walked through the empty streets of Beirut. It was midmorning, and under normal conditions the city throbs with activity at this time. But not with the curfew on. A soldier confronted me and asked to see my pass. Then we walked into an alleyway, where he retrieved a brass pot from a shoe box and started to brew thick Turkish coffee over a fire in a large can. I asked him his thoughts on the troubles.

Perils Threaten From Both Sides

"We have very special problems in Lebanon," he said. "If we let the commandos do as they want, then we open ourselves up to attack from the other side, from Israel. But if we tell them they can no longer carry out their raids from here, then we anger those of our people who feel that Arab unity must come before all else."

He handed me an egg-size cup of the coffee and suggested that it tastes best when slurped.

"We Lebanese are skillful in the use of compromise for survival. We've had to learn to do that, to zig and zag, to give a little and take a little; and we've always managed to hold on to our identity. But this time I don't know, I don't know. There's an old Arab saying that goes, 'My brother and I against our cousin; my cousin and I against the alien.' Right now we can't tell our brothers from our cousins. Everyone seems to be a mother-in-law."

The end of summer brought new violence to the country, as commandos sought to escape the cold of their mountain retreats by moving into some villages of central and southern Lebanon. Again

Marching with mounting fury, mourners bear the body of Mohammed Ali Musa through Beirut streets. The flag of old Palestine drapes the coffin of the Arab commando, killed last April in a skirmish near the Israeli border. Members of a crowd of 8,000 shout quotations from the Koran and brandish placards showing machine-gun-carrying commandos. Marchers threw stones and chased the photographer, who escaped down an alley and over a fence.

Fearing Israeli reprisals, Lebanon tried to stop commando raids from its soil, triggering protests last fall that toppled a premier, drew attacks from Syria, and threatened war, Arab against Arab.

KODACHROME BY GEORGE F. MOBLEY @ N.G.S.

there were deaths and injuries and political upheaval. This time the guerrillas made daring attacks against government installations. In neighboring Syria, a large force of armed men, backed by tanks and artillery, massed along the border, raising the specter of a full-blown war among Arabs.

Lebanon accepted an offer from the United Arab Republic to mediate the troubles, and a fragile, skirmish-marred calm settled over the country. Almost a year after the first outbreak of violence, Lebanon remained burdened with a terrible uncertainty about the future.

But for all that—the rifle fire, the bombings, the tragedy of Arab fighting Arab—spring had come to Lebanon that troubled year as it always had, amid the fragrance of the budding jasmine. On one of those perfumed days, in May, my cousins and I left the Beirut-Tripoli road at a place where it lies wedged between the sea and the shadows of purple mountains, and there we listened to a wandering man make music on an ancient instrument.

Zeek—Zuuk—Zeek.

The plaintive screech seemed to invoke all the sorrows of Lebanon's dilemma. But the man—he was short and squat and wore an old military garment with torn epaulettes—smiled as he sawed a bow across the single string of the *rabab*. He asked where we were going, and I told him to Tripoli, to visit the house where my mother was born.

"Ah, your mother is from Lebanon, and you are here to see the places she knew as a child. For that I make happy music."

Zeek—Zuuk—Zeek.

In one respect, my journey to Lebanon was indeed a quest for the settings of an immigrant parent's remembrances. And, searching, I found them all—from the piece of Mediter-

Puffing patiently, prosperous Lebanese await a horse race at the Beirut track. Men take as much care preparing their water pipes as their wives do brewing coffee for guests.

Grand and not so grand: Rolls-Royce and donkey cross paths on a seaside street in Beirut, marking the sharp contrast between rich and poor.

The 1950's saw the beginning of the building boom along the waterfront (pages 240-41). Many of the new apartments rose with financing by Arab oil millionaires.

ranean beach where she once played, digging Roman coins from the sand, to the dock in Beirut from which she departed on the long, one-way voyage to America.

Few countries of comparable size lose as many of their sons and daughters through emigration; more than 100,000 live in the United States. It is often said that Lebanese living outside the country outnumber those living in it. Khartoum or Kansas City, São Paulo or Sydney, they are there.

Some emigrants return in later life for a visit. Most do not. Almost all, however, retain strong emotional ties with the country. They remember the soft, green look of the land, for, unlike its Near Eastern neighbors, none of Lebanon is given over to desert. Rather, there are mountains, high and cool and flogged with horsetail waterfalls. There are valleys gone lush on the sweet soil. And there is the bay-scalloped shoreline, where the long corridor of the Mediterranean comes to a close with a warm purl over golden sand.

Jesus walked amid these surroundings (Matthew 15:21; Mark 7:24, 31). Here, too, in mythology, Venus met Adonis and St. George slew his dragon. Many Lebanese even assign their country a role in the Old Testament drama of Jonah and the whale; the prophet, they say, was cast up on the beach about twenty miles south of Beirut.

Despite all its pastoral qualities—the villages, the stream-veined scenery, the shepherd-in-the-field tranquillity—Lebanon is best known for the caldron of tireless vitality that

is its capital city. Cosmopolitan and chic, sophisticated and sinister, restless and resourceful—Beirut is all of these and more, a city where the life not only of Lebanon but of much of the Near East boils and bubbles.

About a fourth of Lebanon's 2,700,000 residents cluster in Beirut (map, page 250). And it seemed that all of them were up and out before dawn on my first morning in the city.

Knots of traffic filled the intersections, and the ceaseless blast of horns cleaved the air like karate chops to the ear. Pedestrian traffic spilled from the sidewalks into the gutters, making it necessary to walk sideways, using the shoulder as a wedge, to keep moving through the crowds.

Over the city climbed jets from the fleet of Lebanon-based Middle East Airlines, one of some 30 carriers serving Beirut International Airport. Down at dockside, hundreds of trucks waited to take on shipborne cargo being routed overland through Beirut to Saudi Arabia as a result of the closing of the Suez Canal by the Israeli-Arab war.

Royal Exiles and Intriguers Rub Shoulders

I sat with two of my cousins, Nicholas Fadel and Robert Mouchbahani, at a sidewalk cafe on Rue Hamra, Beirut's Via Veneto, and felt the vigor and intrigue of this young-old city ooze through its steel and concrete pores. Among those who strolled past our table were men with secrets to sell, and women of international society fame. A slender, casually dressed young man stopped at a newsstand to scan headlines of some of Beirut's 24 daily newspapers, and I recognized him as the son of a deposed king.

"Lebanon has always been a favorite place of exile," Robert said. "I remember my father telling me that not long after the Russian revolution he went to a restaurant here in Beirut and the waiter who served him was a former admiral in the tsar's navy."

Both Robert and Nicholas speak nearly flawless English. However, we often spoke in Arabic, a language I learned more through osmosis than through study.

On such thoroughfares as Rue Hamra, Beirut shows itself as a capital of worldly ways, of smartness and cultural richness. Among institutions of higher learning is the renowned American University of Beirut, now beginning its second century of educating leaders of the Arab world. Beirut also prides itself on its cinemas, its fashionable dress shops, its velvet-padded cubbyholes brimming with golden trinkets for sale, its flower stalls, and its restaurants running the gamut of international cuisine. It has many nightclubs and cabarets, but for entertainment on the grand scale, none can match the Casino du Liban.

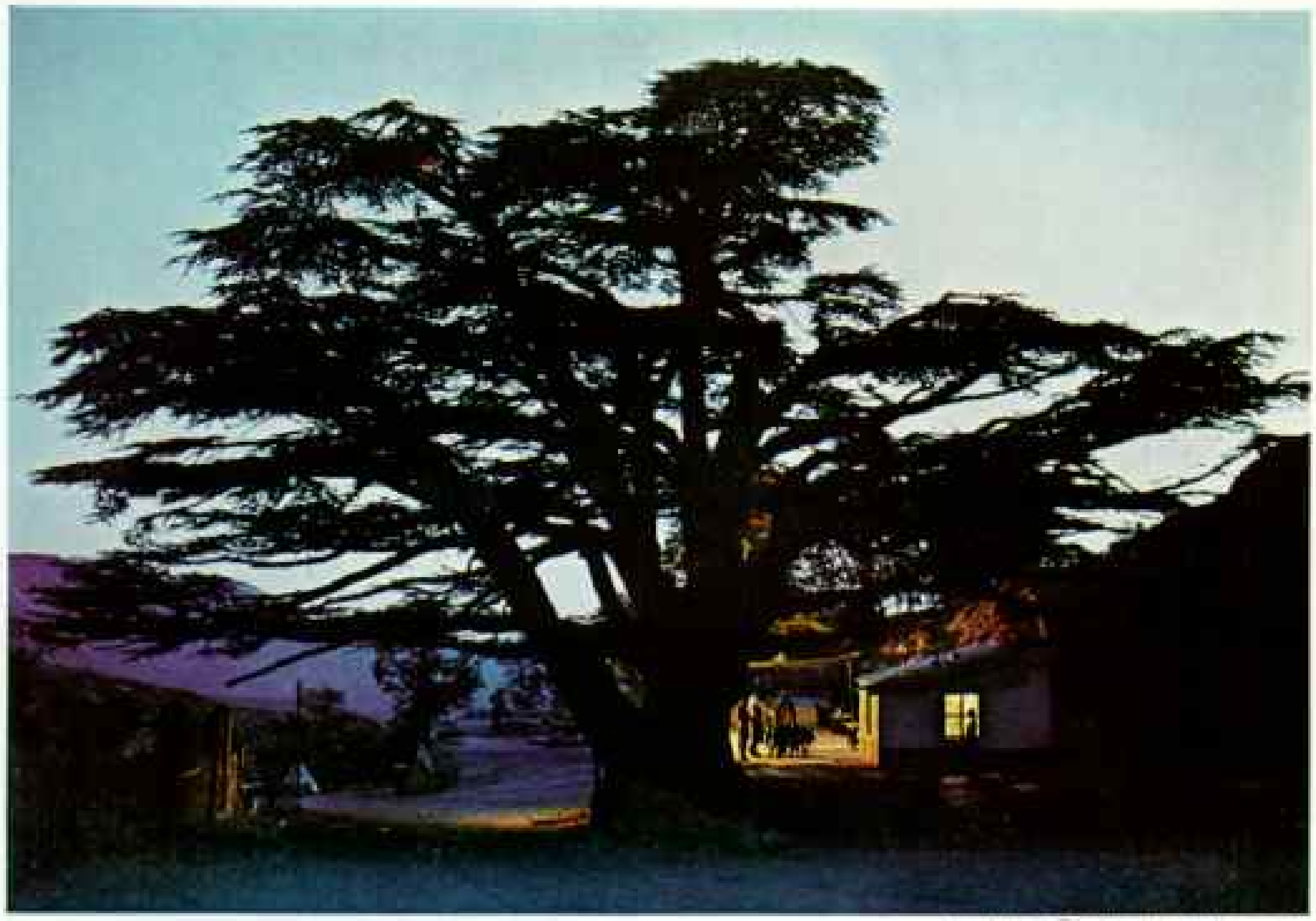
Extravaganza in crystal astounds patrons of the Casino du Liban near Maameltein, north of Beirut. A giant glass flower descends from the ceiling, and its petals open to reveal show girls painted gold and silver—one of dozens of sensational scenes that unfold in dazzling sequence. The national treasury receives approximately half the profits from the casino, the most popular tourist attraction in Lebanon. EKTACHROME © N.G.S.


TURKEY
CYPRUS
SYRIA
LEBANON
IRAQ
Mediterranean Sea
ISRAEL
JORDAN
SAUDI ARABIA
SINAI
U.A.R. (EGYPT)
Areas occupied by Israel since June 10, 1967
This "Capital of the North" grew from the federation of three Phoenician cities—hence the Greek name Tripoli. The Great Mosque once served Christian worshipers as a cathedral, St. Mary's of the Crusader's Tower
SYRIA
LEBANON
Aridah
Halba
Homs
Kadesh
Al Qusayr
Al Mina
Tripoli
Zagharta
Al Qalamun
Shikka Jadidah
Anfah
Kusba
Amyun
Al Batrun
Bsharri
Cedars of Lebanon
Qurnat as Sawda
Al Harmal
Al Qa
Ras Baalbek
Al Fakyah
Al Labwah
Duma
Amshit
Jubayl (Byblos)
Al Aqurah
Qurtaba
Afqa
Dayr al Ahmar
Yunin
Buda
Ayat
Baalbek (Heliopolis)
Maameltein
Juniyah Bay
Ghazir
Rashin
Juniyah
MOUNTAINS
Commercial center for much of the Arab world and pleasure port of the eastern Mediterranean. Beirut began as a Roman settlement in Christ's time. Crusaders built a great church here and dedicated it to St. John; today it is the city's principal mosque.
Beirut
Antilyas
Shamistar
Canaanite founders honored their sun god Baal with the place name; Greeks called it Heliopolis, "City of the Sun." Its temple remains are the most imposing of the Roman world, not excluding Rome itself.
Burj al Barajinah
Babda
BEIRUT INTERNATIONAL AIRPORT
Zahle
Shtawrah
Alayh
Ash Shuwayfat
MEDITERRANEAN SEA
Ad Damur
Jisr al Qadi
Dayr al Qamar
LEBANON
SYRIA
Al Qutayfah
Saydnaya
Az Zabdani
Inviting arcades and galleries, spacious terraces, and rooms decorated by Damascene artists distinguish this summer home of Lebanon's president; it is a 19th century example of the elegance of Arab architecture.
Bayt ad Din
Al Mukhtarah
Kufriya
Shahim
Qaraoun Reservoir
(Sayda) Sidon
Ad Dimas
Duma
Though eclipsed by Tyre, its own colony, this patriarch of Phoenician ports remained important under the Persians, Greeks, and Romans. Paul, on his way to Rome as a prisoner, was given liberty to visit his friends here (Acts 27:3).
Jazzin
Naccache Dam
Damascus
Pipeline Terminal
Elijah found refuge (1 Kings 17:9)
Kafr Hunah
Rashayya
Thought by some to be the scene of Christ's Transfiguration; also claimed for Mt. Tabor in Galilee
(Zarephath) As Sarafand
DAMASCUS INTERNATIONAL AIRPORT
Dayr az Zahrani
An Nabatiyah al Fawqa
Hasbayya
Mount Hermon
Al Kiswah
Jesus visited the region of Tyre and Sidon (Mark 7:24).
Marj Uyun
(Beaufort) Belfort
Astride the mountainous Sidon-Damascus road, Crusaders erected a massive castle on an earlier Roman site
During Tyrian sailors scouted pre-Roman Britain for tin and carried dyes to Rome, where the deep purple became a badge of rank that produced a phrase to describe royal blood—"born to the purple."
Tyre
Metulla
Abel-beth-maachah
Baniyas (Caesarea Philippi)
Dan
CARTOGRAPHIC DIVISION
© NATIONAL GEOGRAPHIC SOCIETY
0 5 10 15 20
STATUTE MILES
Qana
Tibnin
Qiryat Shemona
Oil Pipeline
Quneitra
Bint Jubayl
Golan Heights area, occupied by Israel since June 10, 1967
Roads
Railroads
Places with Scheduled Air Service
Elevations in Feet
An Naqurah
LEBANON
ISRAEL
Rumaysh
Jordan
ISRAEL
SYRIA

As in the days when Jesus taught near prospering Tyre and Sidon, Lebanon's busy coast contrasts with pastoral mountains. Paul sailed these shores while preaching a new faith.

THOUGH POOR in natural resources, Lebanon serves as the financial center for much of the Arab world. Even in ancient times, commerce was the lifeblood of the land. Lebanon then belonged to the Phoenicians who, faced with mountain barriers inland, turned to the sea for livelihood and forged trade links to distant lands. Geographically, Lebanon unfolds a panorama of startling—and often spectacular—contrasts, as mountains, creased with lush valleys, press down against a jagged shoreline. A highly literate nation, Lebanon has 10 institutions devoted to higher education, including the renowned American University of Beirut.

GOVERNMENT: Republic. **AREA:** 4,015 sq. mi. **POPULATION:** 2,700,000. Mostly Arabs; small numbers of many nationalities. **LANGUAGE:** Officially Arabic; French widely used. **RELIGION:** About equally Christian and Moslem. **ECONOMY:** Hub of Near East commerce; agriculture; tourism. **MAJOR CITIES:** Beirut, capital, port, first in population with 700,000; Tripoli (pop. 127,000), port. **CLIMATE:** Coast hot, humid in summer; cool and damp in winter. Beirut warmest in August, 89° F. average high; coolest in January, 51° F. average low.



"Cedars of the Lord," Lebanese call their most celebrated symbol, and use it as a proud emblem on their national flag (opposite). This venerable monarch stands among 400 on a slope near Basharri, one of the few groves surviving from vast forests of old that provided wood for Egyptian pharaohs' palaces and funerary boats, and paneling for Solomon's Temple.

As a tourist attraction, the casino, which looks down on the sea from a hill 15 miles north of Beirut, outdraws all else in the country. It dazzles visitors with marble and crystal, fountains and flowers, and the suave busyness of tuxedoed croupiers. It is also the place where an extravaganza to boggle the eye unfolds each evening. Packaged in Paris at a cost of $1,500,000, the three-hour show features a whole menagerie as well as 110 human performers.

Elephant Joins the Audience

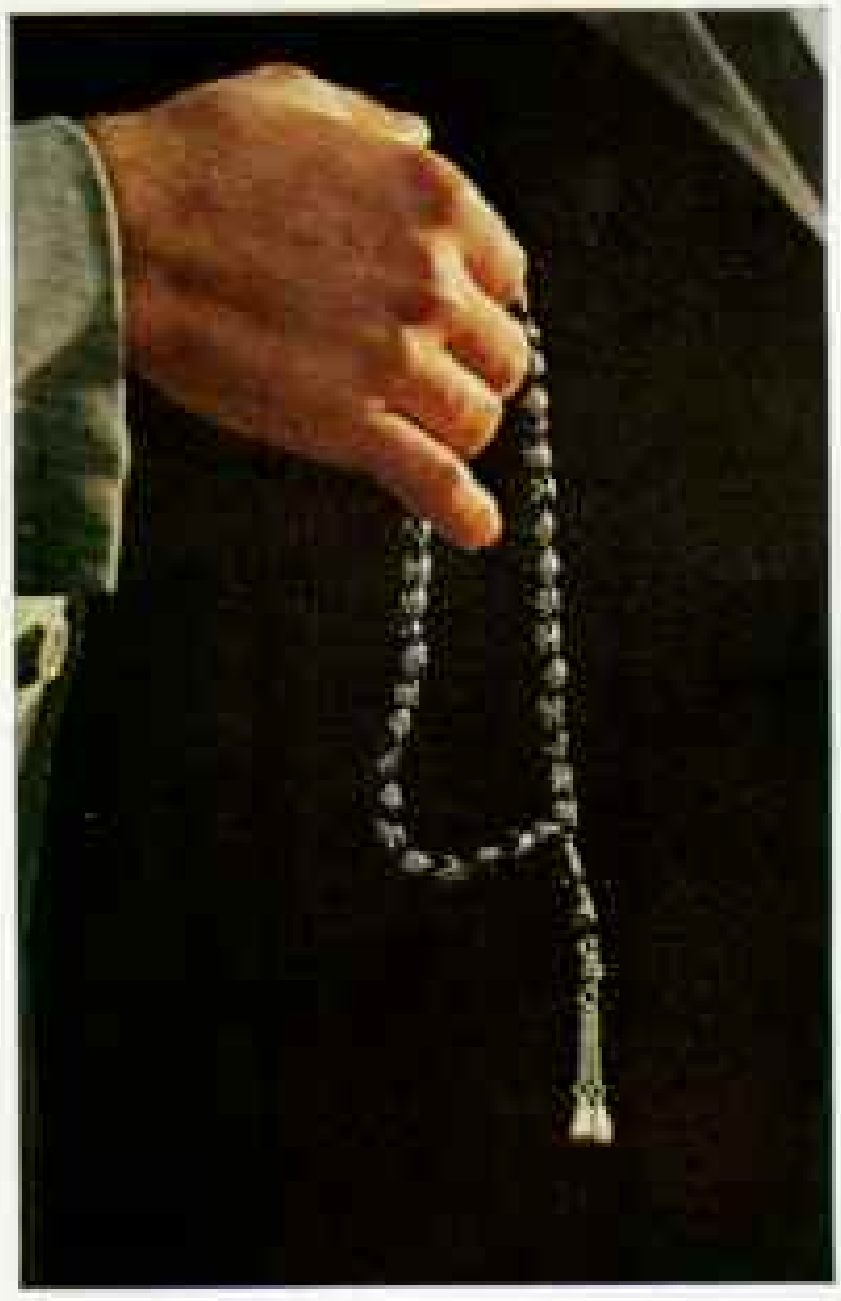
White stallions gallop across the stage; attendants lead an elephant through the audience. The floor in the spectator section suddenly separates to reveal a flowing stream on which an authentic jungle steamboat appears —fire, smoke, and all. Performers, their bodies painted gold and silver, descend from the ceiling in huge cagelike crystal ornaments (pages 248-9).

A great transparent ball rose up from the depths of the stage, and, as I watched it, I thought that this was tame indeed compared to what had gone before. But then I noticed a man inside the ball—riding a motorcycle.

"Well, how do you like it?" asked Saad Kiwan, a casino official. I told him I was overwhelmed.

But for every muted click of a casino roulette wheel, hundreds of dice tumble across backgammon boards set up on boxes on the street corners of Beirut; and for every Rue Hamra, there are dozens of streets such as Rue Ghalghoul, an alleylike passageway in an old quarter where lamb carcasses hang in the doorways of butcher shops. Flies own the air there, and garbage fills the gutters; the sidewalks are communal beds, and the coffeehouses are breeding grounds for political coups.

Lebanon, then, is a nation of sharp contrasts and delicately balanced compromises. By tradition, the population is regarded as more or less evenly divided between Christians and Moslems, and an unwritten covenant decrees the presidency to a Maronite Christian and the premiership to a Sunni Moslem. Cabinet posts and seats in the 99-member parliament are likewise filled on a basis of religious as well as regional apportionment.



Land of two faiths

THOUGH A MEMBER of the Arab League, Lebanon divides its religious allegiance between Islam and Christianity, a complicating factor in politics. Thus it traditionally has a Maronite Christian president and a Sunni Moslem premier.

Like Old Testament patriarchs, priests (right) worship in St. George's Greek Orthodox Cathedral in Beirut.

Both Moslem and Christian carry *misbaha* beads (above), known in the West as "worry beads." Intended to help count the number of times a prayer has been recited, they also tell the mood of the holder. The rhythm of their clicking can express boredom, nervousness, impatience, or hostility.

In most foreign affairs, neutrality is such an unimpeachable virtue that an ex-premier once declined to endorse a course of action because, as he claimed, "That would be *positive* neutrality."

Lebanon's devotion to neutrality springs in large measure from the country's role as the commercial, financial, and transportation capital of most of the Near East.* The profit motive is strong. In offices all through Beirut, men are forever picking up telephones and concluding transactions of such complexity and boldness as to give pause to even the most audacious of entrepreneurs.

Consider, for example, the Lebanese trader who sold some French-made pianos to a Brazilian merchant, accepting a shipment of peanuts from Senegal as payment. He then sold the peanuts to a German firm with the stipulation that he be paid in U. S. dollars.

Such are the wheelings and dealings which long ago gave rise to a proverb about the

*See "Young-old Lebanon Lives by Trade," by Thomas J. Abercrombie, NATIONAL GEOGRAPHIC, April 1958.

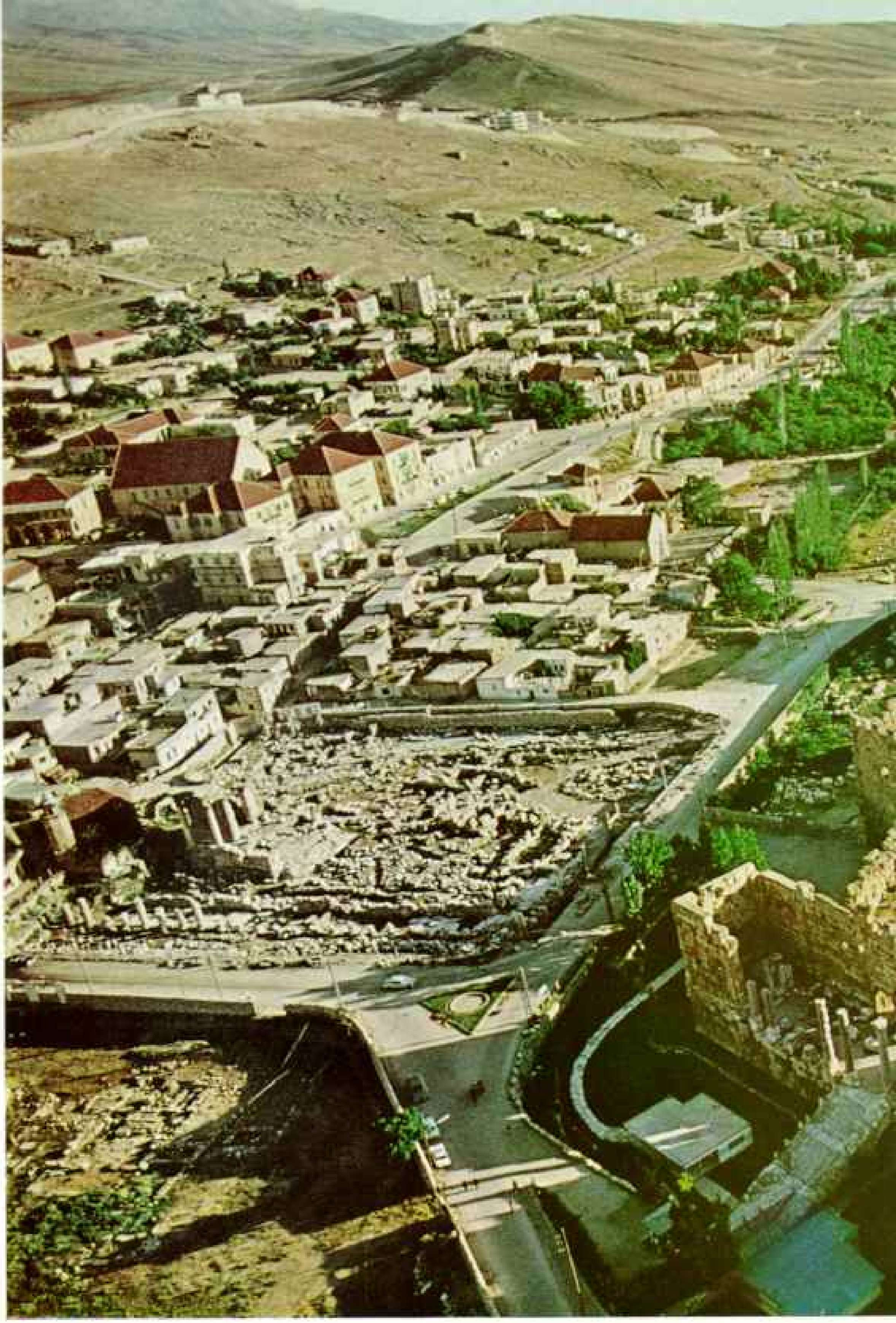
EKTACHROME (ABOVE) AND KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

Lebanese businessman: "He can make a wine cellar out of one grape."

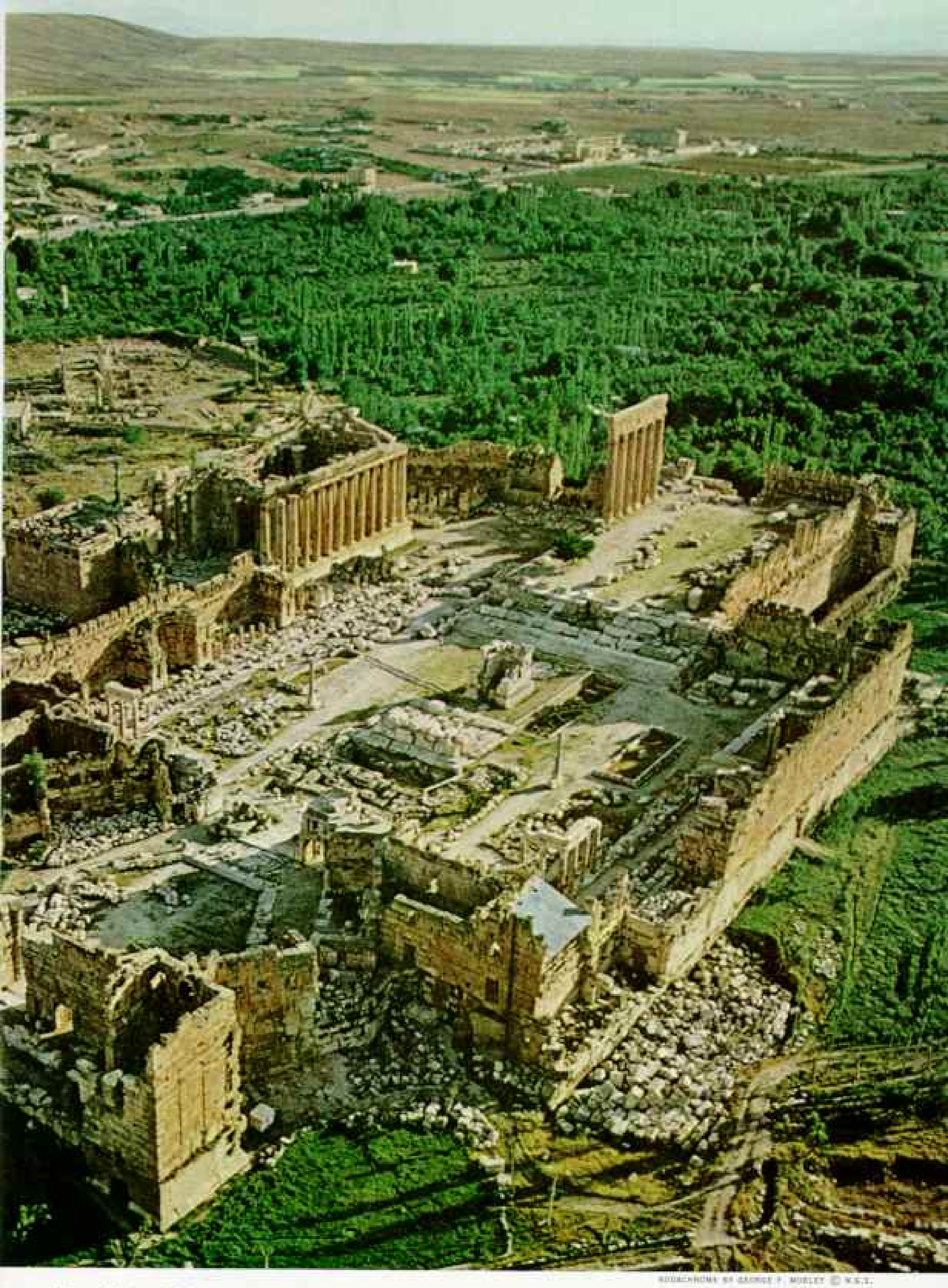
"This instinct for business is something we develop at an early age," one of my cousins told me. "A foreign lady once visited a kindergarten here and asked one of the youngsters, a boy, how much is two and two, to which he replied, 'Are you buying or selling?' "

Unlike many Arab states, Lebanon has no oil, although it does play a vital role in this trade because two oil pipelines, one from Saudi Arabia and the other from Iraq, terminate on its coast. With meager natural resources and almost no heavy industry, the country sustains its prosperity on what economists call "invisible income." On paper, there is scant economic justification for Lebanon's existence. Imports outrank exports in value by as much as five to one.

"It's a miracle," declared Paul Van Zeeland, an economist who was invited by the Lebanese Government to study the country's fiscal structure more than a decade ago. "I can't understand it. But my advice to you, since



Awe-inspiring even in ruin, the splendor of Baalbek must have defied description in its time of glory. Rome began erecting the huge sanctuaries in the first century A.D., on a site previously dedicated to the Canaanite god Baal. The Temple of Jupiter towered over the surrounding



Bekaa Valley. Of the 54 columns that supported the edifice, only six remain, upper right. To their left, the smaller Temple of Bacchus still has much of its colonnade. Centuries of war, earthquake, and mining by villagers to build their houses (left) have reduced most of the complex to rubble.

things are going so well, is don't ask too many questions or try to do anything about the situation. Let it go on."

And so it has continued—Lebanon, with more than seventy banks, acting as clearing-house for a great flow of surplus capital from nearby oil-rich states; Lebanon, where Kuwaiti and other Arab millionaires have invested more than $85,000,000 in new apartment buildings (no matter that many of the units, with rentals ranging up to $1,000 a month, remain vacant); Lebanon, the not-forgotten homeland to which emigrants send back about $120,000,000 each year, mostly as gifts to relatives; and Lebanon, international transfer point for goods that fetch more than $50,000,000 in customs receipts annually.

Strife Sends Tourists Elsewhere

Tourism also makes a major contribution to the financial well-being of the country. But when trouble erupts, such as the crisis at the time of my visit, the tourists stay away.

"No one wants to spend a holiday in his hotel room, wondering when the curfew is going to be lifted," said Tony Assad Aoun, a trilingual taxi driver who claims to have 50 relatives in Brooklyn. He speeded up the cab so that I would not be late for an appointment with His Excellency Charles Helou, President of the republic since 1964.

As President Helou talked to me about the troubled situation in his country, he was gently critical of what he feels is Washington's pro-Israel stance in the Arab-Israeli conflict. He warned that this could endanger the close ties between Lebanon and the United States.

"Many of our students go to the States," he said, "and many American companies invest in Lebanon. But cultural and economic cooperation cannot exist without political cooperation." Still, he went on to speak glowingly about the United States as "a country of great hospitality, a country open to many."

And when an aide whispered to the president that my mother was born in Lebanon, he smiled as if to reassure me that Lebanese-American relations were in no danger of imminent collapse.

The hotel elevator operator offered me greetings of the morning, and then said, "Calm has returned to the land of your mother's birth. The curfew is lifted. Lebanon is still Lebanon, *ilham'dilla* [praise God]."

Outside, from the fashionable Avenue de Paris to the muddy, fetid paths in the refugee-occupied shantytowns, activity on the streets was revving up to its normal frenzy. From the sea and from the air, tourists once again began to descend on Lebanon.

As long as 4,000 years ago, people were coming into the country from other areas. At that time they came from somewhere on the Arabian Peninsula. They called themselves Canaanites; the Greeks called them Phoenicians. They settled along the coast, in the great city-states of Tyre and Sidon and Byblos, and set out from there in their cargo vessels to engage in trade as far away as Africa and the British Isles. From these Semitic-speaking people, who carried the wood of Lebanon cedars to Egypt, the world obtained its first truly phonetic alphabet.

The Lebanese, I found, cherish this heritage. Many speak of themselves not as Arabs or Moslems or Christians or even Lebanese, but, with emphatic pride, as Phoenicians.

Could I then claim to be "part Phoenician," linked ancestrally perhaps to one who manned an oar on a swift penteconter—a 50-oared galley—or faced the wind on the swan's-neck poop of a beamy merchantman? A heady thought indeed.

Procession of Invaders Begins

With their civilization flourishing along the coastal strip of Lebanon, the Phoenicians by the ninth century B.C. had established colonies in the western Mediterranean; Carthage was the most famous. Within a hundred years, however, Phoenicia was conquered by the Assyrians, and the march of invading armies started. Next came the Babylonians, followed by the Persians, Macedonians, Romans, Byzantines, Arab caliphs, Crusaders, Egyptian Mamelukes, and Ottoman Turks.

The French, who had occupied the country since World War I under a League of Nations mandate, proclaimed Lebanon an independent state in 1941, but then suspended the action until 1943. Not until 1946 were all French troops withdrawn.

With a mustache to match his sartorial splendor, Mouhammed Hammad serves as aide to the minister of defense. Volunteers make up the small Lebanese Army, some 15,000 strong.

"In their fear your forefathers gathered you too near together," wrote Lebanese poet Kahlil Gibran. The red-roofed homes of Hasrun, foreground, and Gibran's birthplace, Basharri,

KODACHROME © N.G.S.

beyond, still cling to rocky heights in the tradition of protection. "Would that I could gather your houses into my hand, and like a sower scatter them in forest and meadow," sang the poet.

The Romans, more than all the others, erected structures to match the beauty of the land. At Beirut they established a law school to rival those in Athens and Alexandria, and the city became known as the "Nurse of Laws." But their finest monuments were raised at Baalbek, about 40 miles northeast of Beirut. There, at that heathen stronghold named for the Canaanite deity Baal, the Romans built temples honoring Jupiter, Venus, and Bacchus. What remains of this acropolis today represents as handsome a collection of Roman architecture as may be found anywhere (pages 254-5).

Modern Festival Uses Ancient Stage

On a summer day in 1922, a group of Europeans who were excavating at Baalbek took time out from their work to recite poetry while gathered amid the ruins. Their words rang in the setting with acoustical clarity, so they decided to give a performance there.

Thus was born the famous Baalbek festival. Now, each summer in July and August, top companies from throughout the world, such as the Comédie Française and Britain's Royal Ballet, participate in a cultural ritual at the same place where others, in ancient times, took part in the rituals of cults. Their splendor rouged in soft theatrical lights, the ruins provide a striking setting for the arts.

Lebanon is swollen with the leavings of past civilizations. Entire cities lie buried, and under them, other, older cities. Little wonder, then, that Emir Maurice Chehab, director of the nation's Department of Antiquities, is a man submerged in work.

I talked with Emir Chehab as we walked through the ruins of Tyre, ancient city of the southern coast. As an island fortress, which the Phoenicians called "Queen of the Waters," Tyre survived a 13-year siege by King Nebuchadnezzar. Alexander the Great was able to capture it only after building a connecting causeway from the mainland.*

"We have a problem here at Tyre," Emir Chehab told me. "The Roman ruins we have excavated are too important to destroy in order to get to the even more important Phoenician ruins under them."

We stepped onto a fourth-century A.D. road of marble paving and could see, here and there, fragments of a mosaic road from an earlier period. Mr. Chehab pointed out numerous Roman thermal baths and cisterns. Stone balls made for the catapults of Alexander lay neatly stacked in pyramids.

The necropolis uncovered at Tyre held more than 300 sarcophagi, many of them made of marble and ornamented with elaborate bas-reliefs. Even now they are scattered over a large area of the ruins. And on the ground all around them is an incredible litter of skulls and bones—the sun-bleached and grim remains of Phoenicians and Romans and Crusaders and others who knew Tyre as one of the great cities of the ancient world.

In June 1967, Emir Chehab began excavating what he thought was another ancient road. He soon discovered, however, that he had come upon a Roman hippodrome dating from the second century A.D.—a massive arena capable of holding 20,000 spectators.

"It was one of the largest in the Roman Empire," he told me as we traveled in a car over the chariot track of the hippodrome. "An ancient text refers to it as the 'Circus of Tyre.'"

Excavation Bares City Elijah Knew

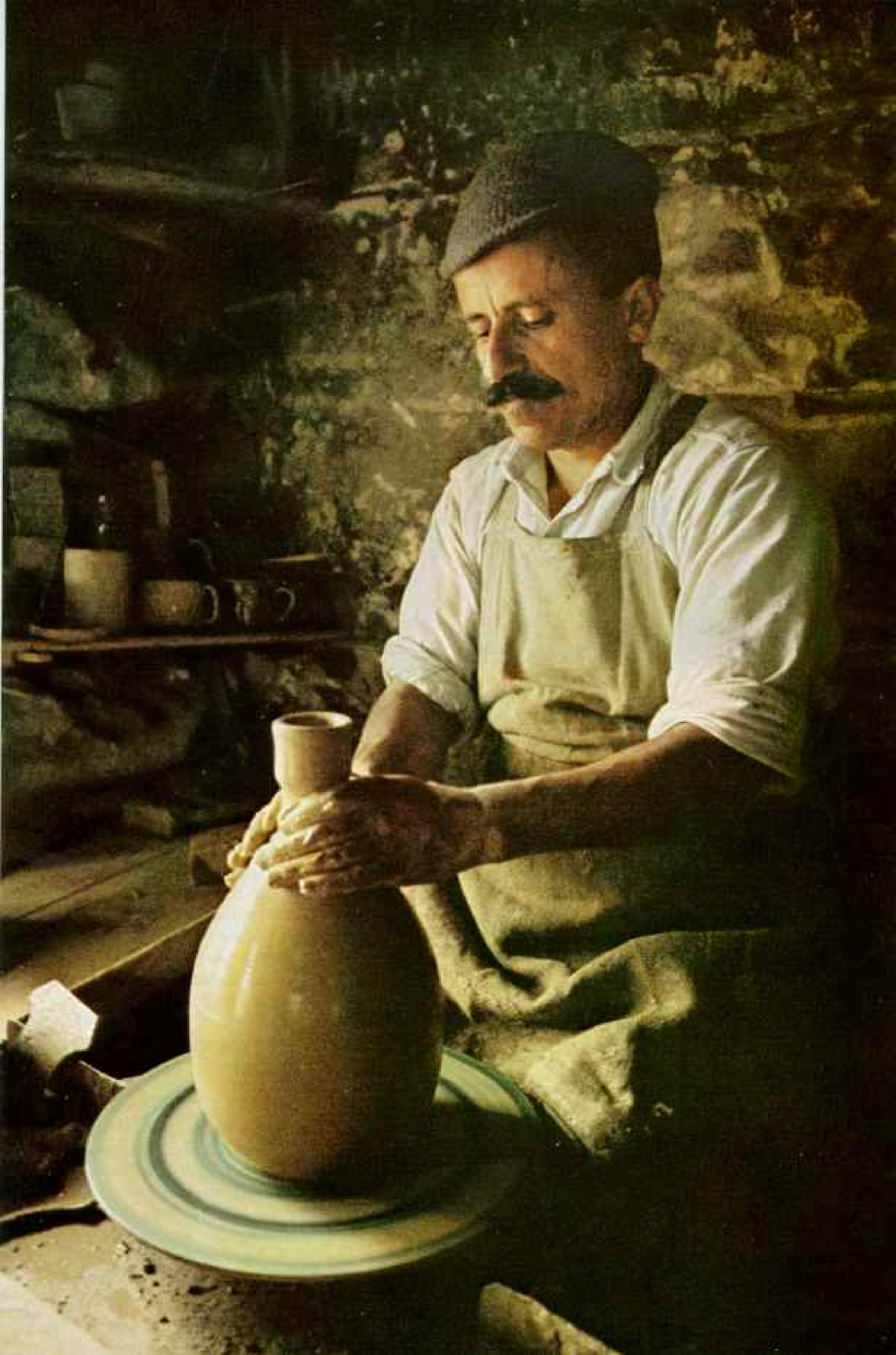
Digging at Tyre continues while 14 miles north, at As Sarafand, work is underway to uncover the ruins of the Phoenician and Biblical city of Zarephath. Supported in part by a grant from the National Geographic Society, the excavation is directed by Dr. James B. Pritchard, Associate Director of the University Museum, University of Pennsylvania. The project will probably take six years.

Zarephath was known to the Egyptians as long ago as the 13th century B.C., and in Biblical times the prophet Elijah was sent there during a great famine (I Kings 17:9-24). The long-range dig began last summer with penetration to the massive stone quay of the city's harbor as it stood in Roman times.

Antonio Assa El Attar is no archeologist,

*See "In the Footsteps of Alexander the Great," by Helen and Frank Schreider, GEOGRAPHIC, January 1968.

Precise touch, gentle but firm, creates a jug in the pottery shop of Amin Dobeicy at the village of Jisr al Qadi. Cottage industries produce much of Lebanon's manufactured goods. Village weavers still create hand-tied rugs, and coppersmiths hammer out trays and utensils. The government fosters a resurgence of the silk industry by encouraging landowners to plant mulberry trees and by guaranteeing the price of silk.



Where Lebanon stepped into history: One of the world's oldest towns, Jubayl, or Byblos, 5,000 years ago was a thriving city to which Egyptians came for cedar. They paid with gold, metalwork, and papyrus (*biblos* to the Greeks, source of the word "Bible"). Crusaders built the castle, right.

Host from the past, bronze statuettes from Byblos—three with gold-leaf crowns—date to the second millennium B.C. Archeologists believe they were offerings to Canaanite gods.

but he too works with the land—as a farmer. I met him in Basharri, a picturesque town in the north, where Kahlil Gibran, the famous symbolist painter, mystical poet, and author of *The Prophet* was born and lies buried (pages 258-9).

I was in Basharri on a Saturday morning—market day, when a festival of noise filled the narrow streets. The yelp of full-throated haggling over prices rose above the bleat of a dozen sheep being driven through the main square. Clutches of children kicked cans, popped paper bags, and fell screaming with the agony of play-soldier wounds. Many, I noticed, had blond or red hair—a revelation for one of Lebanese extraction who went through childhood longing for a freckle.

Antonio was in Basharri this Saturday to sell his truckload of vegetables. With him was one of his sons.

"It is difficult for us to make a living like this," the son said. "We have to work very hard to get this one small crop; and look, you see yourself, not many are buying today.

"I left Lebanon once to live in South America, but returned," he added. "Now I may have to leave again, and this time I will take my mother and father with me." His four brothers, he said, all live in Australia.

The father told me that never in his 69 years had he been more than an hour's drive from his village. I asked him if he could adjust to a new life in a new country. He shrugged, touched a finger to his guardsman mustache, and replied: "How can I tell? I do not want to leave Lebanon, because it is my country—a country to love. But a man cannot be happy when all his sons are away."

"Green Plan" Aids Farmers

For all its importance as a major provider of services in the Near East, Lebanon remains closely aligned to an agricultural heritage spanning 7,000 years of history. Although agriculture accounts for only 12 percent of the national income, it employs almost half the working population. There is only one Beirut, teeming with banks and awhirl in business,

KODACHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER GEORGE F. MOBLEY © N.G.S.

but the villages dependent on the soil for survival number in the hundreds.

The government in recent years has stepped in to aid this struggle for survival with programs aimed at keeping Antonio Assa El Attar and others like him on their farms. One such effort is called the "Green Plan."

The Green Plan has set as one of its goals the reforestation of much of the land. Once Lebanon was blanketed with cedar trees, from which Solomon obtained the wood for his Temple. But of these majestic giants, only a few small groves remain, the largest being a stand of 400 near Basharri (page 251). Now thousands of seedlings are being planted each year under auspices of the Green Plan.

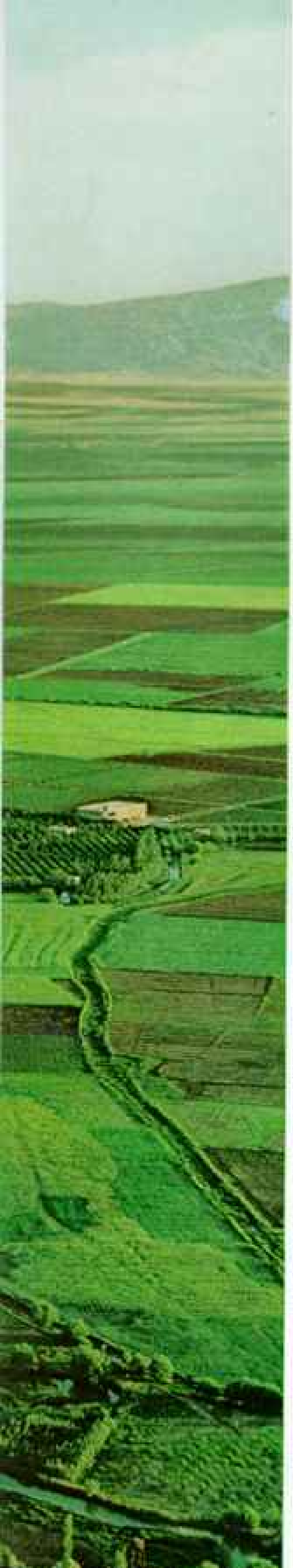
"The Green Plan has put many farmers back to work," said Najib Hamdan. "If it does nothing else, it will have succeeded. The plan has done more, though, much more."

Najib Hamdan, a prosperous and progressive young farmer, had invited me on a tour of the principal agricultural regions. Following a visit to the coast just south of Beirut, where citrus fruit and bananas are among the major crops, we turned east toward the interior. Najib shifted his car into low gear, and we climbed a mountain road kinked with nightmarish curves. We began to pass patches of snow among the juniper and almond trees, but below and behind us, only 30 minutes away, stretched the southern coast and waters warm enough for swimming.

Najib graduated with a degree in fruit production from California State Polytechnic College. He grows 150,000 pounds of head lettuce a year, and all is purchased on contract by an oil company in Saudi Arabia. He grows potatoes and tomatoes, lemons and oranges. He does this not only in the highly cultivated valleys, but also in fields once freighted with rocks, and on the sides of mountains.

Tractors Restore Mountain Croplands

Because Lebanon is a country of only 4,015 square miles—smaller than any of our 50 states except Delaware and Rhode Island—many crops are grown on the mountainsides.



Broad plain of fertility banked by mountain ranges, the Bekaa Valley yields riches of fruits, vegetables, and grain. Northeasternmost part of the Great Rift Valley, the Bekaa is watered by two rivers that rise in its heart, the Orontes and the Litani, the latter now being tamed by dams for power and irrigation (map, page 250).

Heads heavy with grain, wheat falls to the sickle near Dayr az Zahrani in southern Lebanon. The coastal plain produces citrus fruit, olives, and bananas. Although essentially an agricultural country, Lebanon tills only 28 percent of her land, since much of it is steep and rocky. The government's "Green Plan" encourages farmers to restore cultivation to the abandoned terraces of the Lebanon Mountains.

To do this, farmers began centuries ago to terrace the slopes with stone retaining walls. Some 175,000 acres of the terraced land was abandoned, however, as rural people moved to the cities or followed their sons to distant countries. The walls collapsed and the soil, accumulated through generations of back-breaking labor, washed down to the sea.

The Green Plan made tractors available to rebuild the terraces, together with counseling on land reclamation and development.

"If the farmer is too shy to come to us for help, we go to him," an official of the plan told me. "In the past four years our work has spread through almost a third of the villages of Lebanon."

Romans Grew Grain in the Bekaa

Mountain land restored to productive use rose all around us as Najib and I continued our grinding drive across the midsection of the country, heading for Lebanon's richest agricultural area.

"Down there," Najib said, nodding his head to the left. "The Bekaa."

It reached as far as I could see (to Syria, it seemed), wide and flat and stacked with the gifts of fertile earth. Lebanon's valleys are many, but it is the Bekaa that the country wears like a green sash of honor (pages 264-5).

Pushing up the back of the country for 80 miles, this northeasternmost extension of the Great Rift Valley gave Imperial Rome much of its grain. Before that, even, a long roster of conquering peoples passed through the Bekaa. Some paused, then went on; a few stayed. All tasted of its sweetness.

Each spring the Bekaa attracts hordes of Bedouin. Most of them come from the Syrian Desert, walking more than a week, almost always at night, to escape the approaching summer heat. With them come 60,000 to 70,000 Awassi sheep, a breed distinguished by its tail, which resembles a Ping-Pong paddle of fat.

Looking down over the broad sweep of the plain, I could see the black goathair tents of the Bedouin set on the fringes of the quilt-work of crops. Many of the fields were given over to cereals, others to potatoes and onions, sugar beets and grapes. And hashish.

Hashish is the dried resin of the same Indian hemp plant *(Cannabis indica)* from which marijuana is derived. It is a stronger drug, however. Hashish is an illegal commodity in Lebanon, but law enforcement measures are aimed more against the distributor than against the grower.

One objective of the Green Plan is to get hashish farmers to grow sunflowers instead. So far, this phase of the plan has not progressed as rapidly as hoped. Future maneuvers in the war against the growing of hashish may include attacks from the air—spraying the fields with an agent that renders the drug repulsive to both taste and smell.

"Hashish will grow on land that's too dry for almost anything else," Najib told me. "I know people in the Bekaa who switched to other crops as soon as they got irrigation water on their lands. I'm sure others would do the same. The key to it is water."

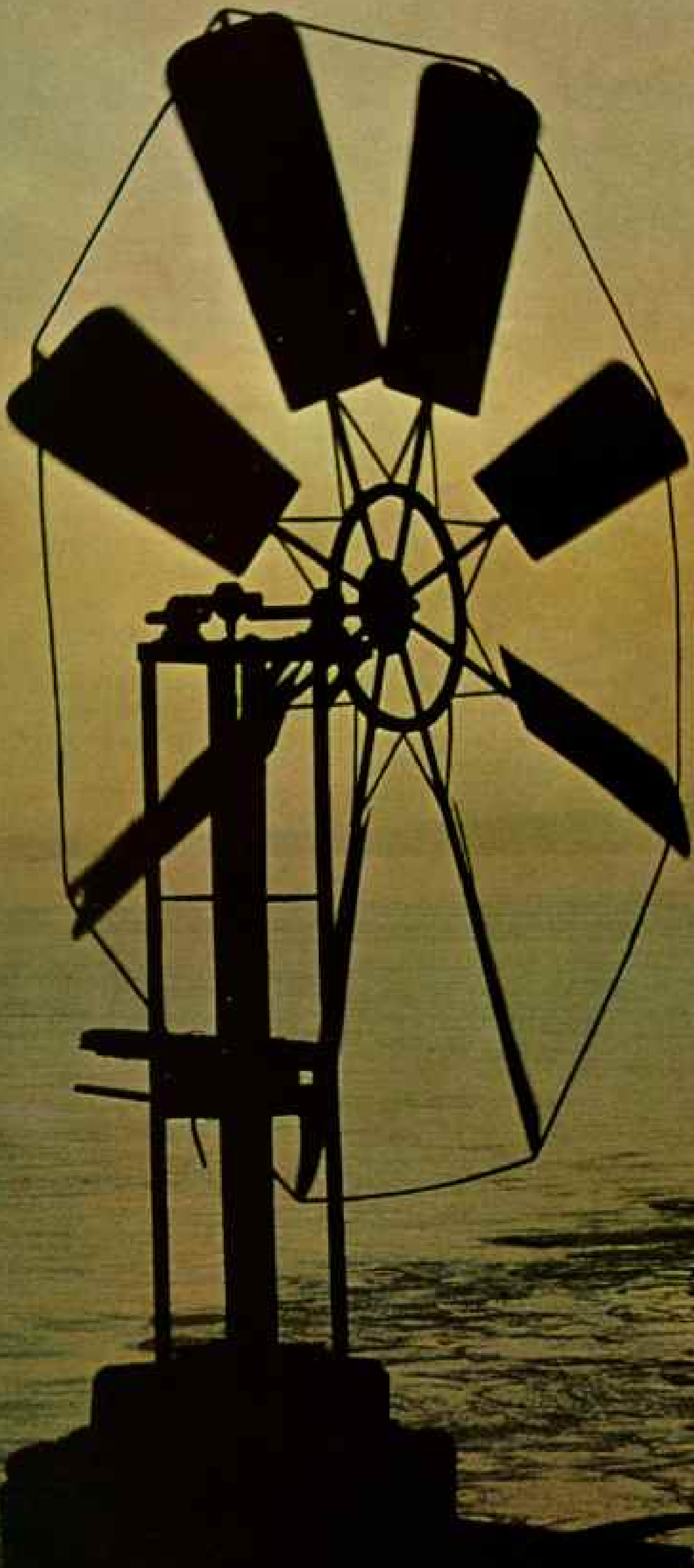
Litani Project Puts a River to Work

To help meet this need for water, work began in 1957 on a project of unprecedented scope for a country the size of Lebanon: development of the nation's longest river, the Litani. Rising in the northern part of the Bekaa, the Litani flows south and west for nearly seventy miles before prying through the coastal mountain range and giving itself to the Mediterranean. At no place does the river leave the boundaries of the country.

One phase of the project, recently completed at a cost of $100,000,000, produces hydroelectric power. A 200-foot-high rock-fill dam backs up a lake that holds nearly 300 million cubic yards of water. When released, this water plunges down through a series of tunnels and penstocks, powering turbines placed like steps on the mountain slopes. Eventually, the Litani project is expected to provide about 600 million kilowatt hours of power per year.

Even now, the work has gone far toward lighting the nation. "Of the nearly 2,000 villages in Lebanon," said Salah Halwani,

Warm hospitality of the Bedouin greets photographer Mobley on the plains near Dayr az Zahrani. While her children play in their goathair tent, mother bakes the family bread. After forming balls of dough, she deftly works them into thin cakes that are placed upon the rounded stove for baking, foreground. Fleeing summer's desert heat, Bedouin with their sheep and goats thread mountain passes from Syria into the Bekaa Valley and coastal plain.



MEDITERRANEAN ZEPHYRS *gently*
turn windmills that pattern the coast
near Al Qalamun, south of Tripoli.
The mills pump sea water into
concrete shallows where it evaporates,
leaving a harvest of salt.

general manager of the project, "about 1,500 now have electricity."

Another phase of the work involves irrigation. At present, only about 20,000 acres of Bekaa Valley land is under irrigation. Utilizing water not only from the reservoir but also from some of the many torrential springs in the mountains, a network of sprinklers and underground pipes to be installed throughout the valley will eventually bring the total of irrigated acres to 75,000.

Special Skills Win Fame for Villages

Drought has scarred some of the rural villages, and so have the many earthquakes that have struck Lebanon. Still, the residents maintain a joyous kinship with the land. No matter what village I visited, there was always someone eager to show me around. At a place called Al Fakyah, Ahmad Saleh even closed his barbershop to act as my guide.

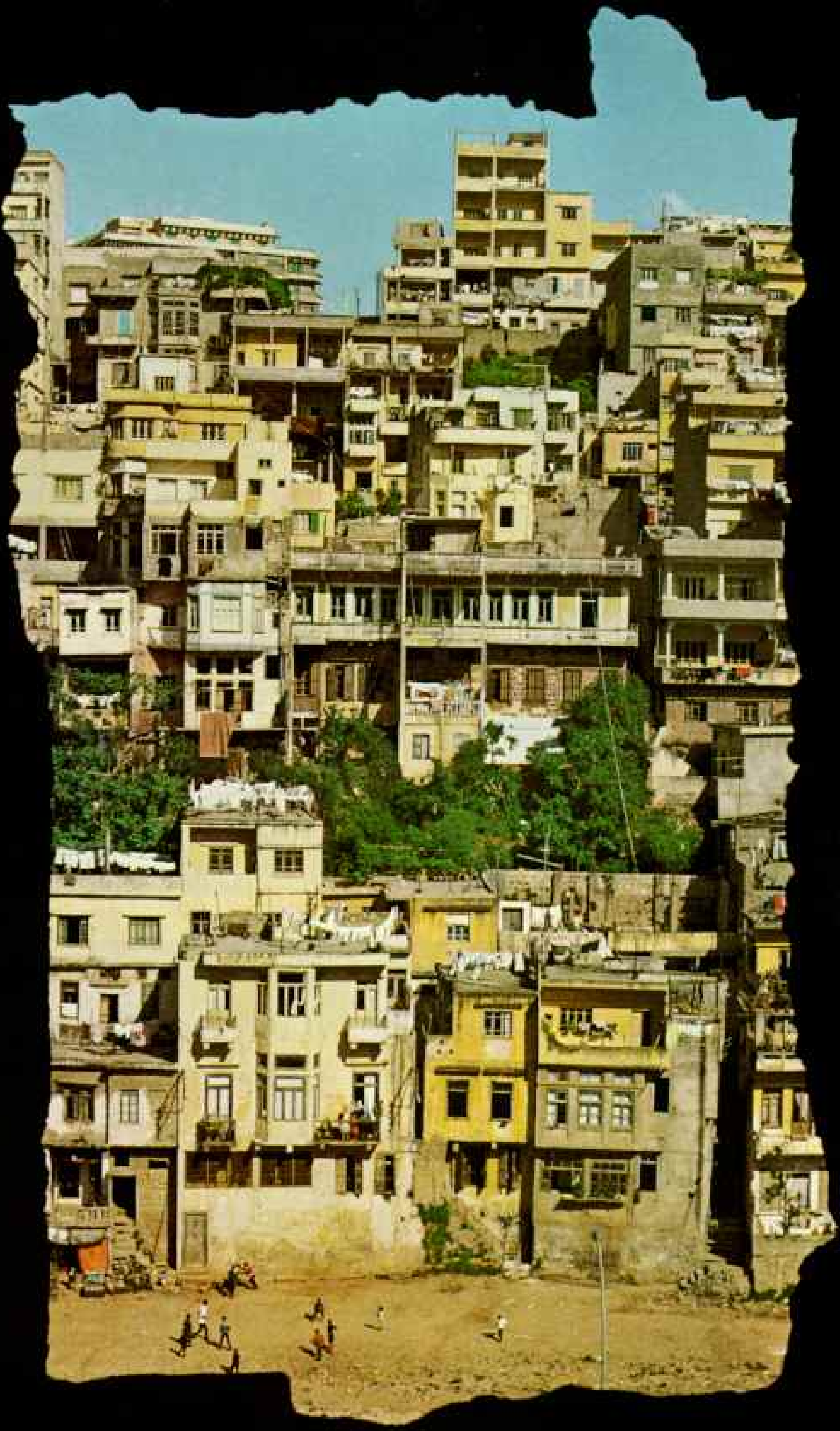
Al Fakyah nestles at the bottom of a gorge, and the old houses sit on steep slopes. Both Moslems and Christians live there, and their places of worship, church and mosque, face each other across the village's single street.

Almost all the women of the village are rug weavers. "The men do not do this work," Ahmad said. "Only the women. My grandmother is 115 years old, and she worked on the looms until two years ago."

Just as Al Fakyah is known for its rugs, so are other villages singled out for a specialty: Al Batrun for lemonade; Al Mina for fried fish; Zagharta for family feuds; Jazzin for cutlery; and Rashin for the Basbous brothers.

Michel, Alfred, and Joseph Basbous are Lebanon's foremost sculptors. They work outdoors mostly, on top of a mountain overlooking Juniyah Bay, an incredibly blue and placid pocket of the Mediterrranean. Their works, in stone, metal, and wood, are set out in the fields; some are abstract, graceful with swirls and curls of cryptic expression, and some are traditional, including life-size figures with faces upturned as if to use the nearby clouds as powder puffs. The serenity and beauty of the mountaintop setting, Michel, oldest of the brothers, told me, are as essential as the hammer and chisel in his work.

Tripoli leaps from yesterday into tomorrow. Tiered houses (right) in the old hill section of the nation's second largest city look across to the futuristic International Fair site on the plain near the sea (below). Scheduled for completion in 1971, the trade fair displays the talents of architect Oscar Niemeyer, designer of Brasilia, Brazil's new capital. Buildings include a pyramidal interdenominational chapel, a cylindrical space museum capped with a heliport, and two domed theaters—the one in foreground an open-air amphitheater. The soaring arch is reminiscent of Gateway Arch in St. Louis, Missouri. Last fall Arab commandos seized control of the labyrinthine Old City for several hours in street fighting with government forces.



ADDRESSING AND SKETCHING (LOWER LEFT) BY GEORGE F. MOBLEY © N.G.S.

People without a country

WITH THE PARTITION of Palestine in 1948, Lebanon—like other Arab nations—took in refugees who fled from what was to become Israel. Today in Lebanon alone some 90,000 live in camps administered by the United Nations. The children (above) at Burj al Barajinah (right), a shantytown on the outskirts of Beirut, present their cards to be stamped for a food ration that averages 1,500 calories daily. Youngsters at another camp, Jisr al Basha (left), play a mechanical soccer game in which contestants manipulate wooden figures to drive the ball toward goals at either end of the board.

Despite more than 20 years in exile, many refugees hope to return. Their militant feelings support the cause of the Palestinian commandos.

As sculpture and the Basbous brothers are associated with Rashin, so is *kibbeh* with the town of Zahle. Considered the national dish of Lebanon, kibbeh consists basically of lamb and *burghul*—crushed wheat. And the finest kibbeh of all is made and served in the restaurants of Zahle.

The lamb and wheat are pounded for about an hour in a large stone mortar, then kneaded and seasoned. I asked the waiter to bring me *kibbeh nieheh*, meaning I wanted to eat it raw, like steak tartare.

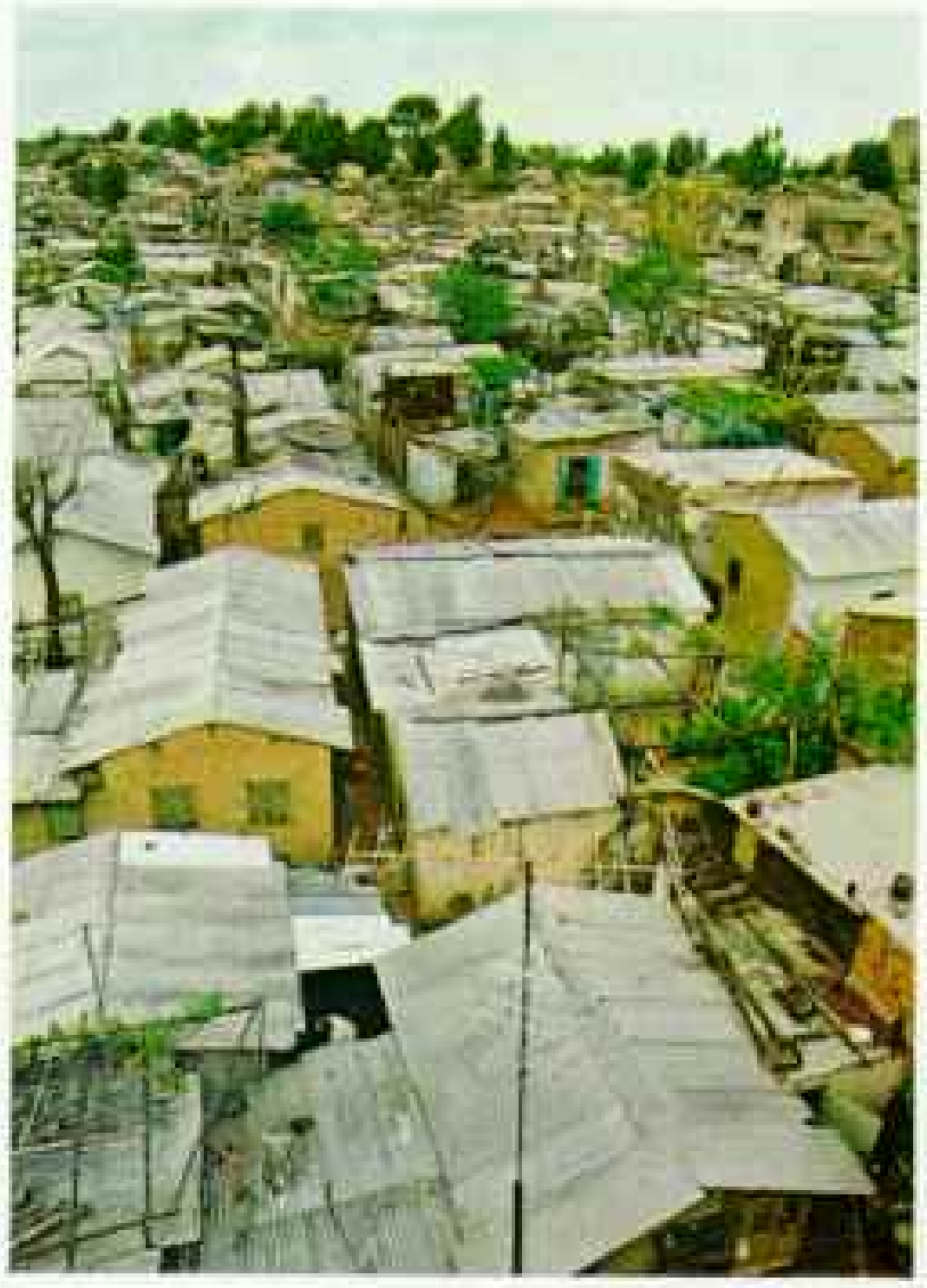
"Then you know kibbeh," he said, smiling.

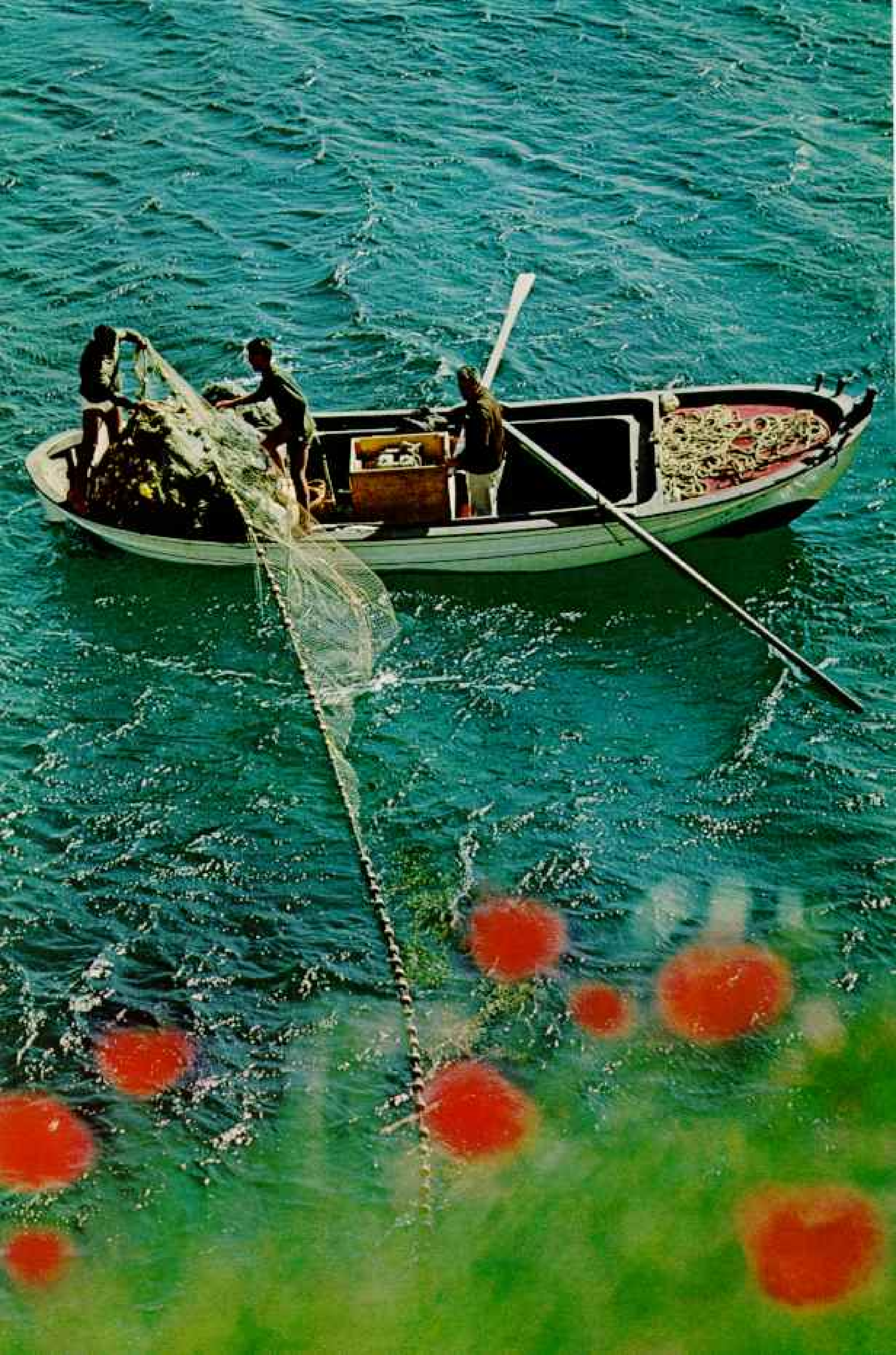
I know, and have known ever since that day long ago when, packed off to a Boy Scout outing with a mother-made meal, I munched on kibbeh beside a campfire while a fellow trooper unglued a mouth full of peanut-butter sandwich to ask, "Say, whatcha eatin'—some kind of scrapple or somethin'?"

Secrecy Shrouds the Druse Religion

Seldom was I invited to dinner in Lebanon when kibbeh wasn't served. At the village of Al Mukhtarah I ate the national dish at a long table in a large drafty room of a very old castle. Al Mukhtarah is the seat of power of Lebanon's Druse community—a fierce mountain people who practice a unique religion.

My host at the castle was Kamal Jumblatt, political leader of the approximately 140,000





Druses in the country. Parts of the Jumblatt castle date from the 18th century, when much of Lebanon was ruled by the Druses. Down through the years, decay has outpaced remodeling and additions, and as I sat in a reception hall of the great house, flakes of plaster fell from the ceiling.

The Druse religion combines elements of Christianity and Islam, but for the most part it is shrouded in secrecy and mysticism.

"Our religion is unknown to many," Kamal Jumblatt told me, "even partially unknown among us. To understand it, one must relate it to the whole sweep of history."

A spare, angular man with brooding eyes, Mr. Jumblatt finds inner strength in the teachings of Mohandas Gandhi. His political views gain little favor among the Christian population, but few deny that he commands widespread support from the Druses, the most colorful of Lebanon's mountain people.

I ate kibbeh, too, while dining with Feyrouz, Lebanon's leading singer. Earlier, I had heard her sing at an outdoor religious service in the village of Antilyas. Though the program was not to begin until six in the evening, people began to arrive shortly after noon. One woman told me that she had come from Cyprus just to hear Feyrouz. Others came from throughout Lebanon, and by the time the program started, more than 10,000 persons were jammed into the village square.

Feyrouz draws such crowds wherever she performs. Her voice is possessed of a crystalline purity, and somehow she has managed to exorcise the shrillness from Arabic music.

Intake of Kibbeh Raises Concern

But most of all I ate kibbeh at the homes of my relatives—ate it and ate it until one day, when I could eat it no more, I heard one cousin whisper to another, "I think he broke his stomach."

Three of my cousins accompanied me on the journey from Beirut up the coast to Tripoli, and the search for the house where my mother was born. Children by the road waved for motorists to stop and buy daisies and other wild flowers fashioned into necklaces.

Tripoli, Lebanon's second city, is often referred to as the "Capital of the North." It stands as a showcase of Arab architecture spanning many centuries. But the dominant structure of this ancient city, founded about 800 B.C., is the magnificent Crusader Castle of St. Gilles, erected in the 12th century.

Guided by the recollections of a cousin who thought he knew the location of my mother's birthplace, we walked through an old casbah-like section of the city. Then, from an alleyway where two girls were playing hopscotch on a 1,500-year-old piece of Roman mosaic flooring, we stepped into a courtyard taken over by weeds. The house stood before us, tall with towers and balconies, but drab and musty with age. Worn stairs of purple-veined marble and an oriel window of stained glass told of past elegance.

A woman wearing a long black dress and a man's double-breasted suitcoat appeared in the doorway and invited us in. She was born in the house, she told me, and had lived there all of her 80-odd years. She too was a cousin.

A Moment for Sharing Silences

From the top of the house I looked out over the ancient city, across a great sweep of orange groves reaching to the sea. The sun was high and warm, and from where I stood, Lebanon seemed at peace: no demonstrations, no traffic jams, no swirling eddies of political intrigue.

The old woman joined me on the roof, and, in the manner of elderly Arabs, she hunkered down. I hunkered beside her, and together we shared a delicious silence. When she did speak, she said she would like to fix me something to take on the plane going home.

The next day, after watching the coastline of Lebanon fade from view in the window of the airliner, I settled back and looked at the package she had prepared for me. Somehow I knew what it contained.

I put the package aside and tried to occupy my mind with other thoughts. No use. Kibbeh, I found, tastes just as good at 37,000 feet as it does around a Boy Scout campfire or in the dining room of a run-down castle in the mountains of Lebanon. THE END

The churning deep and its bounty still beckon to these sons of ancient Tyre—a "city renowned, that was mighty on the sea," in the words of the prophet Ezekiel. The Phoenician port in its days of glory sent mariners farther than man had ever ventured before. Here fishermen haul in their nets near Shikka Jadidah, south of Tripoli, beneath a shore set ablaze by poppies. [illegible]

In pink-cloud colonies, sometimes numbering a million pairs, two species of flamingos breed on desolate alkaline lakes in the Great Rift Valley. Here, gaining speed for take-off, greater flamingos race across the shallows of Lake Elmenteita.

East Africa's

ARTICLE AND PHOTOGRAPHS BY M. PHILIP KAHL, Ph.D.

Majestic Flamingos

THE GABBLE of a thousand voices grew louder as I pushed my floating blind toward the flamingos. Suddenly a corner of the blind struck a submerged rock with a thud, and at once a blizzard of pink wings surrounded me.

Holding my breath, I stopped. Waist-deep in the water under the burlap-covered blind, I felt as if I were hiding inside a basket.

Then, after a few moments' hesitation on the brink of panic, the birds swept back to their nests. My presence swiftly forgotten, the breeding colony of greater flamingos returned to the business at hand.

At least 6,000 nests spread before me on the small islands near the deserted western shore of Kenya's Lake Elmenteita (map, next page). For an ornithologist this was a thrilling sight indeed, for it was not until 1954 that the first definite breeding of the greater flamingo in East Africa had been recorded by naturalist Leslie H. Brown of Nairobi.

Rocky Start to a Hazardous Life

The scene was bedlam. With the first eggs starting to hatch, the colony's activity had reached a peak. I could see tiny blobs of gray fuzz moving weakly among the parents, through a forest of pink legs, as each pair of adults tended a single chick (left) or white egg. The mud mounds so typical of flamingo nests elsewhere did not appear in this colony; there was no mud with which to build them. Instead the birds laid their eggs on the bare lava rock, padded with a few feathers.

By nesting on the offshore islands, the flamingos had escaped terrestrial predators that either could not swim or did not wish to risk a swim in the strongly alkaline waters of the lake. So far the birds' luck was holding. If the colony could just survive a few more weeks, a large crop of new flamingos would be added to the population.

These birds often suffer heavy casualties among their offspring, if not complete nesting failure, owing to predation or to droughts or floods. In some years conditions are apparently so unsuitable they do not even attempt to breed. In other years they run afoul of adverse weather, and infant mortality soars. In his noted monograph on the family, the late Robert Porter Allen, Research Director of the National Audubon Society, wrote, "Few birds seem to have such repeated difficulty as do flamingos in completing the full repertoire of their breeding cycle, from beginning to end."

From fossils we know that flamingos were once found in North America (page 294) and on all the other continents except Australia and Antarctica. Today, however, the six living flamingo forms occur mostly in isolated areas in or near the tropics (next page).

Of the estimated six million flamingos in the world, more than half live on the alkaline lakes of the Great Rift Valley in Africa. Two species range there—the tall, regal greater flamingo *(Phoenicopterus ruber roseus)*, a pale-pink relative of the brilliant American flamingo;* and the smaller but more numerous lesser flamingo *(Phoeniconaias minor)*.

Unlike many of Africa's conspicuous wild creatures, the flamingos are almost unaffected by modern civilization. Because their natural habitat is of little use to man (the alkaline lake waters support few fish and cannot be used for irrigation or human consumption), and also because their nesting areas are usually inaccessible, the birds are seldom disturbed.

Although the ancient Romans considered flamingo tongues a delicacy, and people in other parts of the world still eat flamingos and their eggs today, Africans do not often take the birds for food. And fortunately not many people inhabit the breeding areas frequented by flamingos in the Rift Valley.

Soda Lakes Fizz With Life

East Africa has about 3,000,000 lesser flamingos and perhaps 50,000 greater. They can exist in such numbers since in the soda lakes they have a rich food source that no other large creatures utilize. When a million or more lesser flamingos and thousands of greater flamingos congregate on relatively small bodies of water, such as Kenya's Lake Nakuru, they may consume 200 tons of food a day.

How does a small lake like Nakuru—four miles by six—support such heavy feeding? Wading in the lake, I found the answer obvious. Each cubic inch of the mineral-laden

*See "Ballerinas in Pink" by Carleton Mitchell, NATIONAL GEOGRAPHIC, October 1957.

"Keep off my land." A greater flamingo ruffles feathers as a warning to would-be intruders on its patch of territory. Three-day-old chick shelters under the adult's 30-inch stilt legs. Other birds sit on their single eggs near the end of a month-long incubation period; egg in foreground lies abandoned. Some 6,000 pairs on islands of Lake Elmenteita nest on bare volcanic rubble. Flamingos band together in huge flocks for safety and for the courtship display necessary for breeding.

No harm done by a parent's misstep. The chick's pink legs will turn dark gray, then pink again by adulthood.

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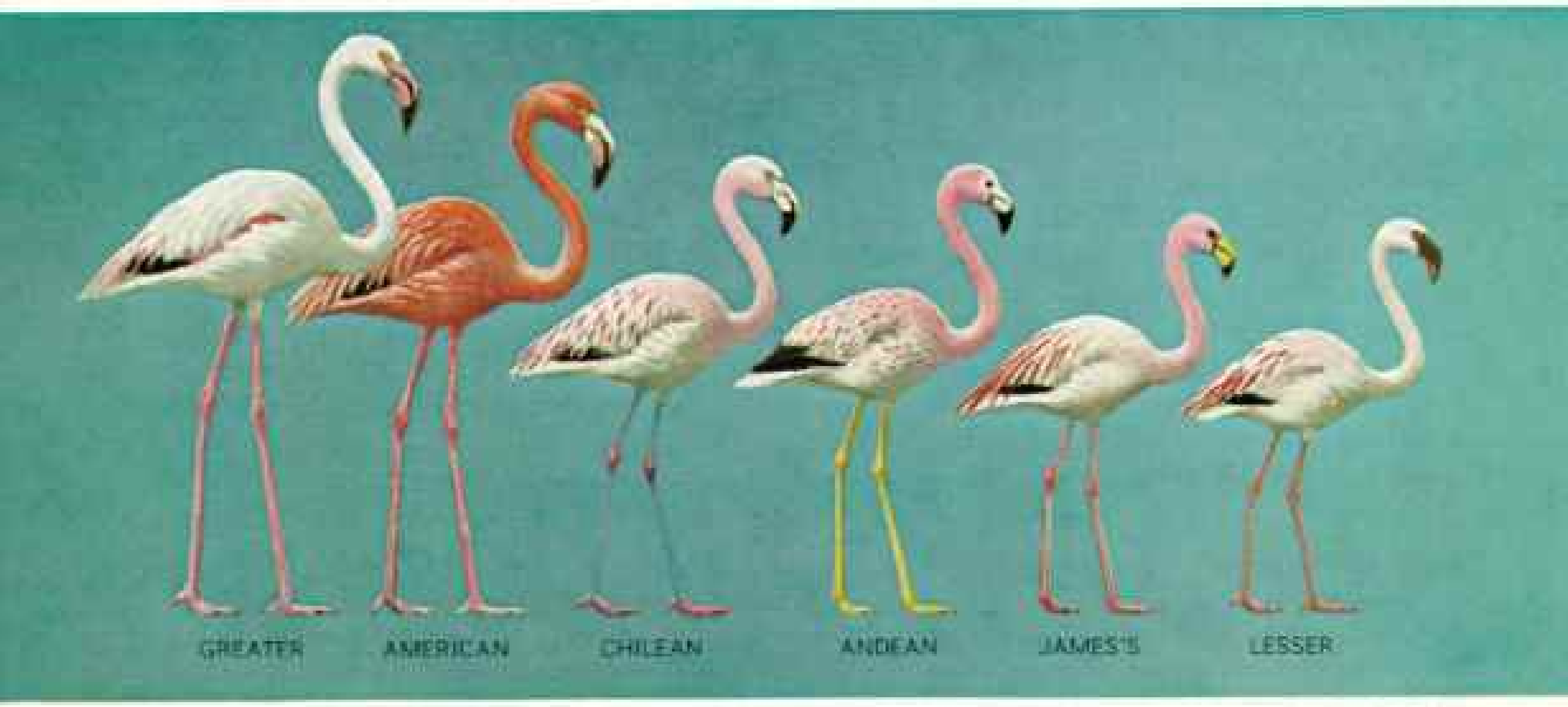
Once widespread, flamingos now seek survival mainly in inhospitable corners of the earth. Of six flamingos extant, the largest *(Phoenicopterus ruber roseus)* and the smallest *(Phoeniconaias minor)* roam the Old World, notably East Africa (above). The remaining four inhabit the New World. The American variety ranges from the Bahamas to the Galapagos; the other three live in South America.



GREATER FLAMINGO STANDS MORE THAN FIVE FEET TALL; THE LESSER BARELY THREE FEET. PAINTING BY WALTER WEBER, NATIONAL GEOGRAPHIC STAFF © N.G.S.

PHOTOGRAPHED BY M. PHILIP KAHL © N.G.S.

His floating blind a Trojan horse, Dr. M. Philip Kahl hid inside to walk through shallow lakes into the midst of flamingo cities. To protect himself from soda burns in the alkaline waters, he wears hip boots. An authority on avian behavior, the author has studied long-legged wading birds of Africa and Asia for five years, aided since 1966 by a National Geographic Society grant.

lake abounds in nutrients—microscopic algae and other organisms that color the water pea-soup green. The minute creatures in this living broth—lake-fly larvae, copepods, and such—were so abundant that by putting my ear to the water I could actually hear their movements. It sounded like the fizzing of a gigantic glass of champagne.

The flamingo's bill makes the perfect serving spoon for the fare of the alkaline lakes. Greater and lesser flamingos have different bill designs, although both hold the bill upside down when feeding.

The greater has coarse toothlike projections along the inner surface of the bill and on the tongue, and is thus adapted to strain the larger items from the water. The bird stirs up the bottom mud with stomping feet to force insect larvae and other aquatic organisms into the souplike suspension. Then it sucks up a billful of the broth, sluices out the water and algae between its "teeth," and retains creatures up to the size of a small snail behind the barrier.

The bill of the lesser flamingo contains thousands of tiny fringed brushes on its flattened inner surface. When the bill is closed, the brushes on the upper and lower mandibles come together, forming a mesh. Small "teeth," called excluders, along the opening of the bill prevent particles larger than about 1/50 of an inch from entering, and the internal mesh retains particles down to about 1/1250 of an inch.

The lesser flamingo feeds mainly on algae in the upper two or three inches of the lake, using its tongue as a piston to pump the green soup in and out. On calm days the

lesser swims far out in the lake and filters the upper layer of water continuously, keeping the bill submerged almost to the nostrils. The buoyant head floats corklike at the end of the sinuous neck, bobbing up and down with each gentle wave. When the water turns rough, the birds band together in tight rafts, which produce conditions calm enough for feeding in the center.

Hot-water Drinking Fountains

Since the lesser flamingo is mainly a vegetarian and the greater mainly a carnivore, they do not compete for food and thus can live in ecological harmony on the same lake.

As for water, both have the same problem. The highly alkaline lake water, if taken in quantity, might be toxic; thus both birds efficiently strain food from water when feeding.

Greater flamingos apparently get adequate moisture from their food itself, but lesser flamingos often congregate to drink where fresh-water streams or springs enter a lake. At Lake Hannington, about 40 miles north of Nakuru, where hot springs dot the shore, I saw huge ghostly flocks waiting at dawn in clouds of steam for their turn to drink (above). In spite of their distaste for wading in hot water (it makes them dance uncomfortably), the flamingos would rather drink water that is hot, but also nearly fresh, than the cooler but alkaline lake water.

Though one can observe great flocks of

(Continued on page 287)

PHOTOGRAPHS BY NORMAN MYERS (ABOVE) AND W. PHILIP BAHL (INCLUDING FOLLOWING PAGES)

Setting suited to devils appeals to creatures that might have stepped from the Garden of Eden. Fetid alkaline lakes produce tons of algae, the main food of lesser flamingos. But for drinking, this flock seeks fresher though fiercely hot water from steaming springs of Lake Hannington.

Bent bill, held upside down when feeding, filters food from brackish waters. Fringed strainers within the mandibles of the lesser flamingo catch algae. Red eye and dark bill identify the species.

Courting in a crowd, lesser flamingos work themselves into a breeding frenzy at Lake Nakuru (following pages). Honking and jostling, displaying birds parade stiff-necked through a throng of half a million spread over half a mile. The fandango continues intermittently for weeks, even months.

nonbreeding flamingos on easily accessible lakes like Nakuru, a breeding colony of flamingos is a rare sight. In East Africa, the only breeding ground of the greater flamingo that is relatively easy to reach is Lake Elmenteita, but since it is on private land, it is not open to casual visitors. The main nesting sites of the lesser flamingo are on the vile mud flats far out in Tanzania's Lake Natron. To reach the nests, one would have to struggle for miles across soft mud overlaid with a brittle soda crust. From the shore the glare and heat haze make the colonies invisible. A more inhospitable environment would be hard to imagine.

Caustic Crust Traps the Unwary

Masai tribesmen in the area believe that young flamingos are not hatched from eggs like other birds, but arise fully grown from the waters of the lake. This belief stems from the fact that the Masai first see young flamingos when flocks of them come trooping ashore from their nesting colonies.

One of the few people adventurous enough to try to reach these colonies on foot, Leslie Brown was lucky to escape alive. After slogging out onto the treacherous mud flats, the Nairobi naturalist became mired in a soft patch. In the struggle to free himself, he got soda crust in his boots and then made the arduous journey back to shore without removing it. He nearly lost both feet from soda burns and was disabled for weeks. Obviously Natron's breeding flamingos are safe from disturbance by land animals—including man!

The far more accessible breeding grounds of the greater flamingo at Lake Elmenteita lay only an hour's drive from my doorstep in Nakuru, a modern town of 40,000 people. If I approached slowly and carefully, concealed in my floating blind (page 281), I could sit within a few feet of dozens of nests, amid brain-numbing noise and confusion. Every adult kept up a constant gooselike honking, while the small young, standing between their parents' feet, begged loudly for food.

The parents feed the newly hatched chicks a bright-red fluid, drooling it into the young birds' open bills (page 289). The fluid contains about 1 percent whole red blood, and its chemical composition indicates it is not the contents of the parent's stomach but rather an exudation from the upper digestive tract.

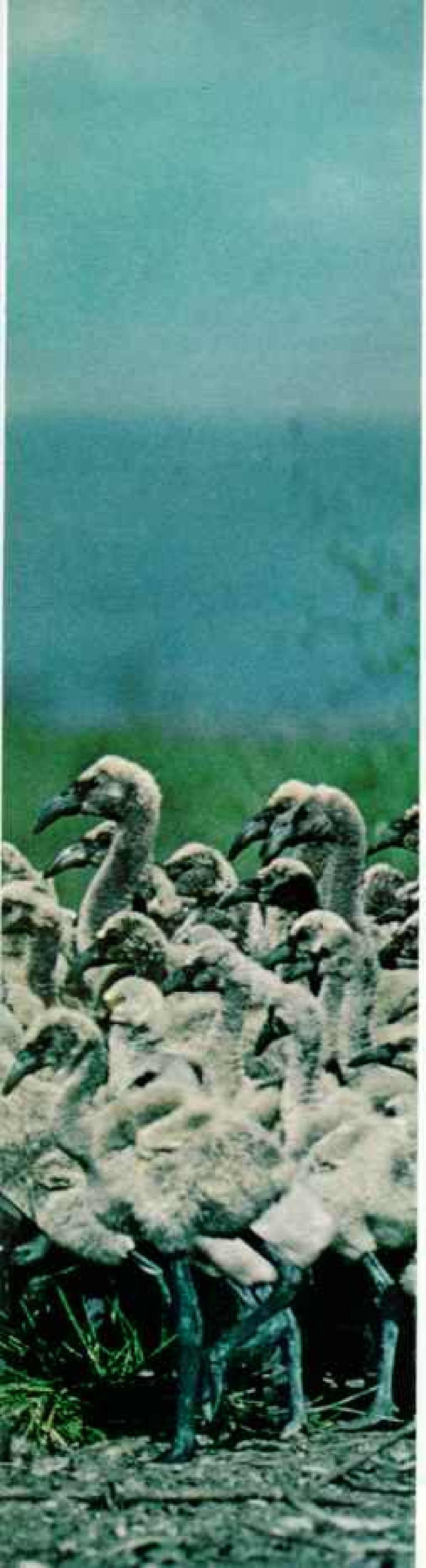
When the young reach about two weeks of age, they leave the nest sites and band together with other chicks of about the same age. Great crèches of young, usually tended by a few adult "nursemaids," move about the colony like woolly gray amoebas, treading on and over everything that lies in their path (next page). Their food demands are enormous, and both parents continue to feed the fledglings for about seven weeks more.

An adult returning to the colony is confronted by a horde of seemingly identical young. Which shall it feed? Ornithologists

Strutting suitor, a lesser flamingo shows his colors in a wing salute during courtship on Lake Nakuru. Only behavior and a slightly larger size set male apart from female. Parents share all chores, from nest building to incubating and feeding the young.

Playing house, immature lesser flamingos construct conical nests like those of their parents. With their bills they dribble soft mud onto the mounds. When environmental conditions fail to trigger mating, even adults build such "play nests."

BUCKGROUNDS BY W. PHILIP KAHL, JR. © N.G.S.



ILLUSTRATIONS BY M. PHILIP KAHL © N.G.S.

Fairy-tale transformation

FROM UGLY DUCKLING to handsome prince, a greater flamingo must wait two to three years to attain full adulthood. Clear yellow eyes and pink-and-black bill distinguish this species.

Under the wing of a parent (above), a week-old nestling barks like a puppy for a meal. The adult responds, doubling its pliable neck into a figure eight. Out flows a red fluid secreted by the upper digestive tract; rich in fat and glucose, it contains 1 percent whole blood. At about two weeks, the chick joins a nursery band, but parents continue to feed it for seven weeks more.

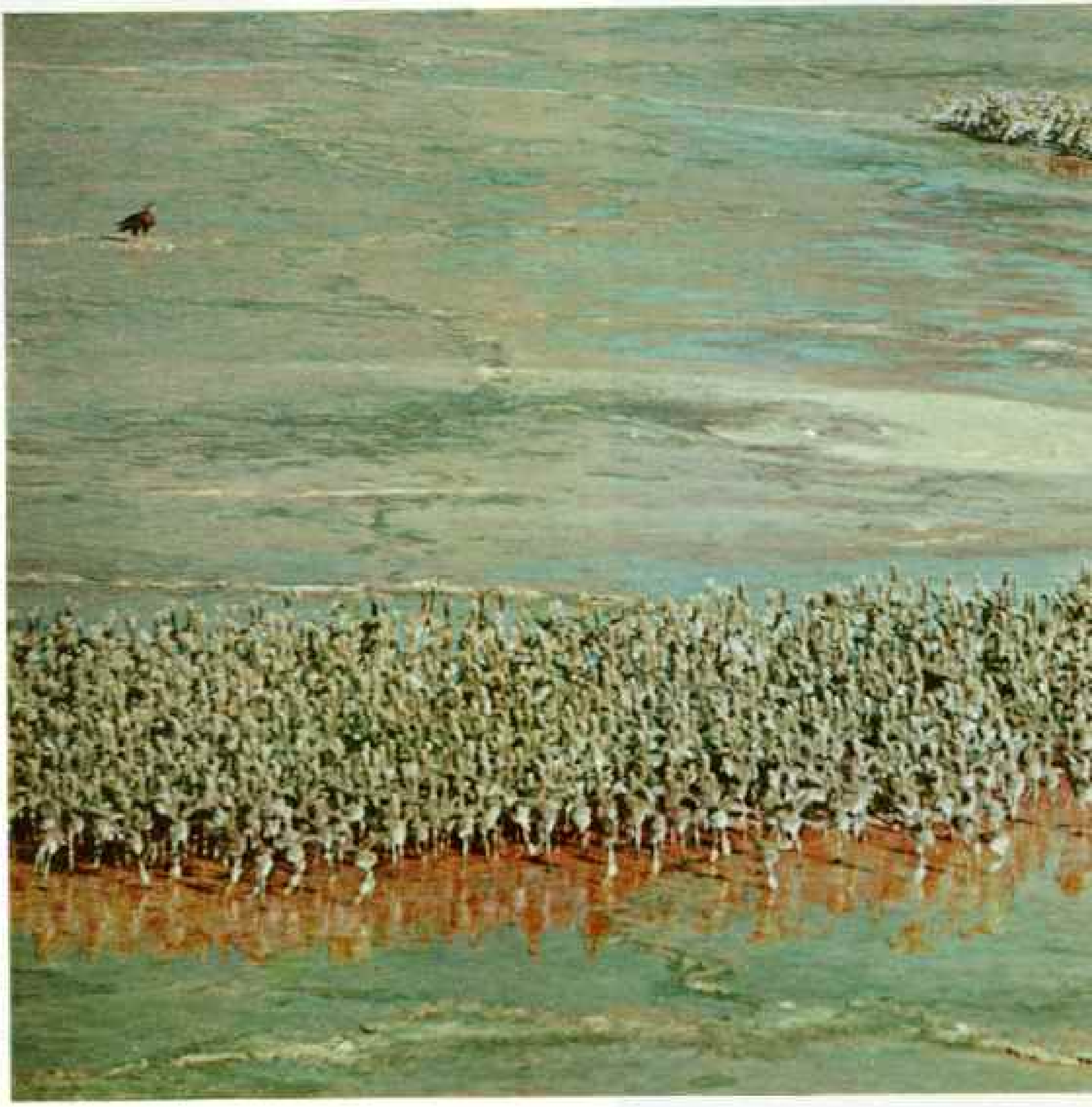
This flock of month-old juveniles (left) walks, swims, and gabbles under the eye of a baby-sitting adult who marshals them with calls. Meanwhile other adults feed, submerging their heads to scour edible organisms from the muddy bottom. Some observers think a returning parent recognizes its own offspring, perhaps by its voice; others hold that it simply feeds the handiest chick. By 11 weeks the youngster can fly.

do not agree whether the adult finds and feeds its own young amid the squirming mass, as seems probable, or feeds any young at random. A water pistol loaded with dye could solve the puzzle. If adults and young were color-marked during a feeding, an observer could determine at subsequent feedings whether the same adults fed the same young.

Chicks that survive to become independent of their parents can probably look forward to a long life—as long as 80 years, one observer has estimated. Food shortages would seem seldom to be a problem, and flamingos have few natural enemies. In general, the only predators an adult flamingo need fear are the fish eagle *(Haliaetus vocifer)* and the marabou stork *(Leptoptilos crumeniferus)*.

The fish eagle, a relative of the American bald eagle, regularly kills flamingos on lakes such as Nakuru or Hannington, where fish are rare or absent. But since the prey outnumber the predators by thousands, or even hundreds of thousands, to one, the eagles take only an insignificant proportion of the flamingos.

The marabou, a large, hideous stork and a familiar scavenger over most of tropic Africa, is common around the flamingo lakes. An inherently lazy bird, it usually prefers dead or moribund flamingos to healthy ones. At Nakuru I once watched several marabous stalking along the shore at dawn—like ghouls searching a battlefield. As the marabous drew close to a flock of flamingos, the pink birds moved away in panic.



Shackles of hardened soda doom a chick at Lake Magadi, where a colony nested in an unusually alkaline area. Even in lakes with less mineral content, such fetters sometimes accumulate.

Skirting danger, a gray mass of several thousand young lesser flamingos gives wide berth to a tawny eagle on Lake Natron. The predator waits to pick off any weak or soda-laden chicks that fall behind. Fetters show as white anklets on legs of chicks in foreground.

Marabou storks sometimes panic breeding colonies into abandoning eggs. Flamingos select nesting sites in terrain so treacherous that flightless predators cannot reach them.

Elegant sojourners on a mysterious timetable, greater flamingos with their young underfoot cast a snowy reflection on Lake Elmenteita. They may breed at any time of year and may settle on different Great Rift lakes from season to season for reasons not fully

In the rush the throng left behind a lame flamingo that could neither walk nor fly. With one good leg and one good wing, it floundered in the shallow water, trying desperately to rejoin the retreating flock. One marabou changed course and headed for it, slightly quickening its gait.

The grim, ungainly chase went on until the marabou was almost upon the stricken flamingo. Then, as the stork approached within ten yards of its quarry, the flamingo reached deeper water and began to swim frantically.

With only a little additional effort the marabou could easily have overtaken the cripple and dispatched it with its mighty bill, but, obviously preferring an easier meal, the stork turned away and resumed its methodical stalk along the shore with its companions. Soon the marabous came on the carcass of a dead flamingo and enjoyed the effortless breakfast they had been seeking.

The flamingos, however, do not know of the marabous' laziness. The mere presence of the ghoulish birds can cause an entire colony

KODACHROME BY M. PHILIP KAHL © N.G.S.

known. Food and water supplies, predators, and weather may influence their movements. The concentration of flamingos in East Africa—some 50,000 greater and 3,000,000 lesser—is, says the author, "the most spectacular show in the entire bird kingdom."

of flamingos to desert their nests and leave their eggs and young to destruction by sun, starvation, or predators.

At irregular intervals, flamingos are given to sudden, puzzling mass movement from one lake to another. Since all the lakes appear perennially rich in food, why do the birds move? An interesting suggestion is that they may have a communication system like that reported for honeybees, by which individuals can transmit information to their companions on conditions at distant points. Thus a few birds might bring the news that circumstances are favorable for breeding at Lake Natron or Lake Rudolf and induce a million birds to migrate there at once.

Movements from one lake to another generally take place at night. From our apartment in Nakuru, my family and I often heard flamingos passing overhead at night—gabbling to each other like geese. And once when camped on the Serengeti Plain, in northwestern Tanzania, I lay in my tent and listened to flock after flock winging southward in the

darkness. Whence they had come and where they were headed is anybody's guess, for that part of the Serengeti is not on a direct flight line between any of their favorite haunts.

No successful nestings are known from Lake Nakuru in recent times, though the birds go through weeks of courtship displays that apparently serve to work them up to breeding frenzy. Occasionally the Nakuru birds build "play nests" in the mud (page 287), and sometimes even lay a few eggs.

Once a friend of mine collected some abandoned eggs from such play nests and took them home. Planning to clean the eggs later and save the shells, he placed them in his refrigerator. Next morning he found on his breakfast table a plate of brilliant orange pancakes.

"Ulu," he asked his African cook, "where did you get the eggs for these pancakes?"

"From the fridge, *bwana*," Ulu said.

His curiosity aroused, my friend ate his breakfast. Flamingo pancakes, he reported, are quite palatable despite their bizarre appearance.

My own fond memories of Lake Nakuru's birds involve photographs rather than pancakes. The easily reachable flocks of lesser flamingos (just a 10-minute drive from our apartment in town) are ideal subjects for the nature photographer. I will never forget my first afternoon in a photographic blind at the end of a muddy point along Nakuru's south shore.

Through the peepholes I could see the pumping movements of the flamingos' throats as the birds filtered the food-rich water through their bills. Occasionally two stopped to bicker, grabbing ineffectually at each other with their leathery-soft and clumsy bills. Now and then hundreds of birds gathered in a dense cluster, with their necks extended upward and their heads bobbing in a jerky rhythm. This group of displaying birds—so tightly packed that it appeared as a darker pink patch in the midst of the larger flock—paraded pell-mell through the surging throng, attracting recruits as it went (pages 284-5). In a prenuptial frenzy, its members were working themselves up to mating.

To see lesser flamingos on their actual breeding grounds, one must use a small plane. On such a flight—over the lonely soda flats of Lake Natron—a friend and I discovered several large groups of half-grown birds. We took care not to fly too low, for flamingos panic easily and a stampede in a colony with eggs or small young could mean disaster. It was not until later, therefore, when we examined our photographs closely, that we realized we had been recording details of a somber drama—the flamingo's struggle for survival in a hostile environment.

For millions of years, flamingos have inhabited the earth. One prehistoric bird left foot and dotlike beak prints while feeding some 50,000,000 years ago. Dr. Bruce R. Erickson of the Science Museum in St. Paul, Minnesota, made this cast after finding the fossil tracks in Utah. Dr. Alexander Wetmore of the Smithsonian Institution identified them as a flamingo's.

Deadly Leg Cuffs

As the flock of young ran from our plane, a few birds with soda encrustations on their legs lagged behind (pages 290-91).* With their legs so encumbered, they could not keep up with the others, and they would no doubt eventually drop out of the long march across the lake. Standing on the soda flats around the flock, a number of tawny eagles (*Aquila rapax*) ominously awaited this eventuality. The eagles kept their distance, apparently not wishing to attack the tightly packed mass of several thousand young, but patience would soon reward them with isolated and defenseless chicks.

Young flamingos with large soda anklets probably have little chance of survival unless they can reach fresher water, where the deposits may eventually dissolve. In the strongly alkaline regions of the lake, the anklets grow larger while the young carrying them grow weaker. Such is life—and death—in the harsh but beautiful world of the flamingo.

*See "Freeing Flamingos From Anklets of Death," by John G. Williams, GEOGRAPHIC, December 1963.

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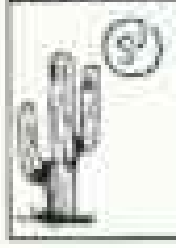

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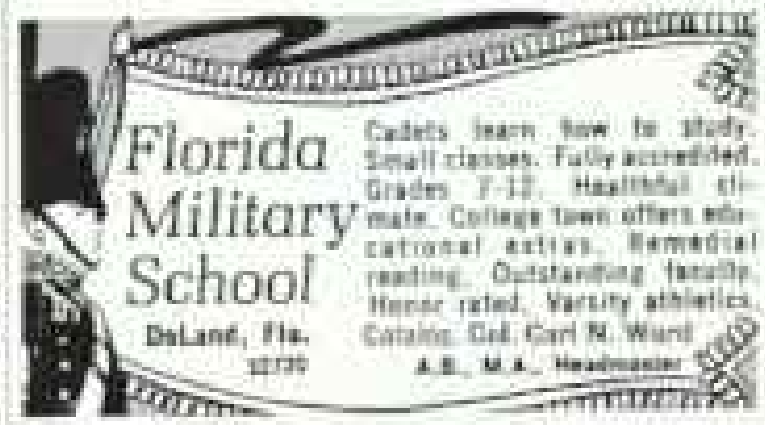

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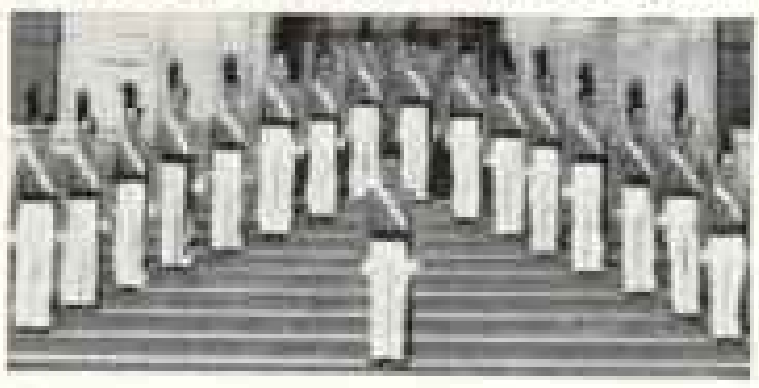

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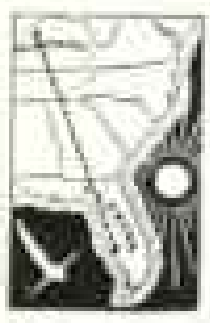

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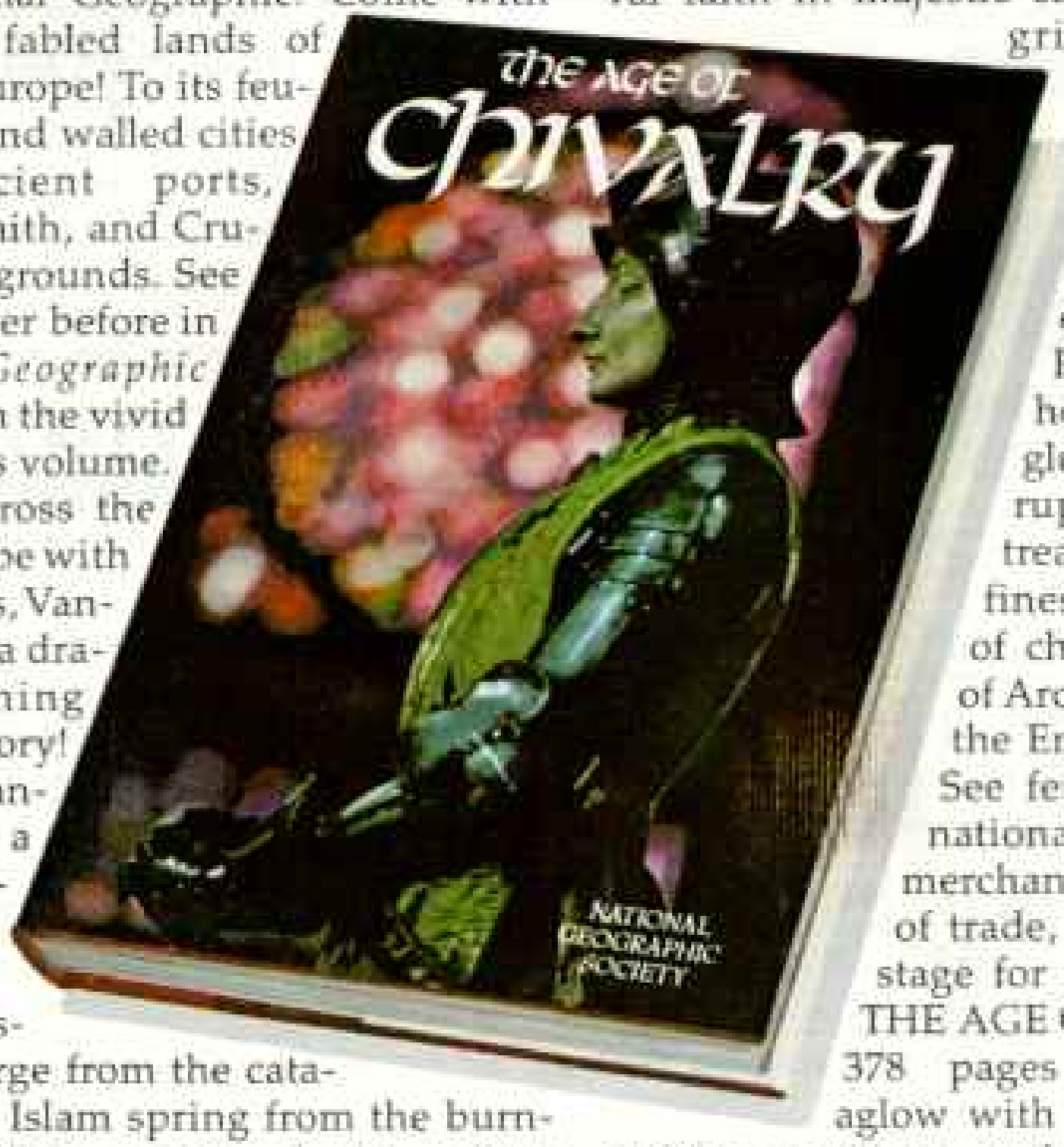

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