VOL. 136, NO. 2 AUGUST 1969

NATIONAL GEOGRAPHIC

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

Guest of honor at the world's finest dining places

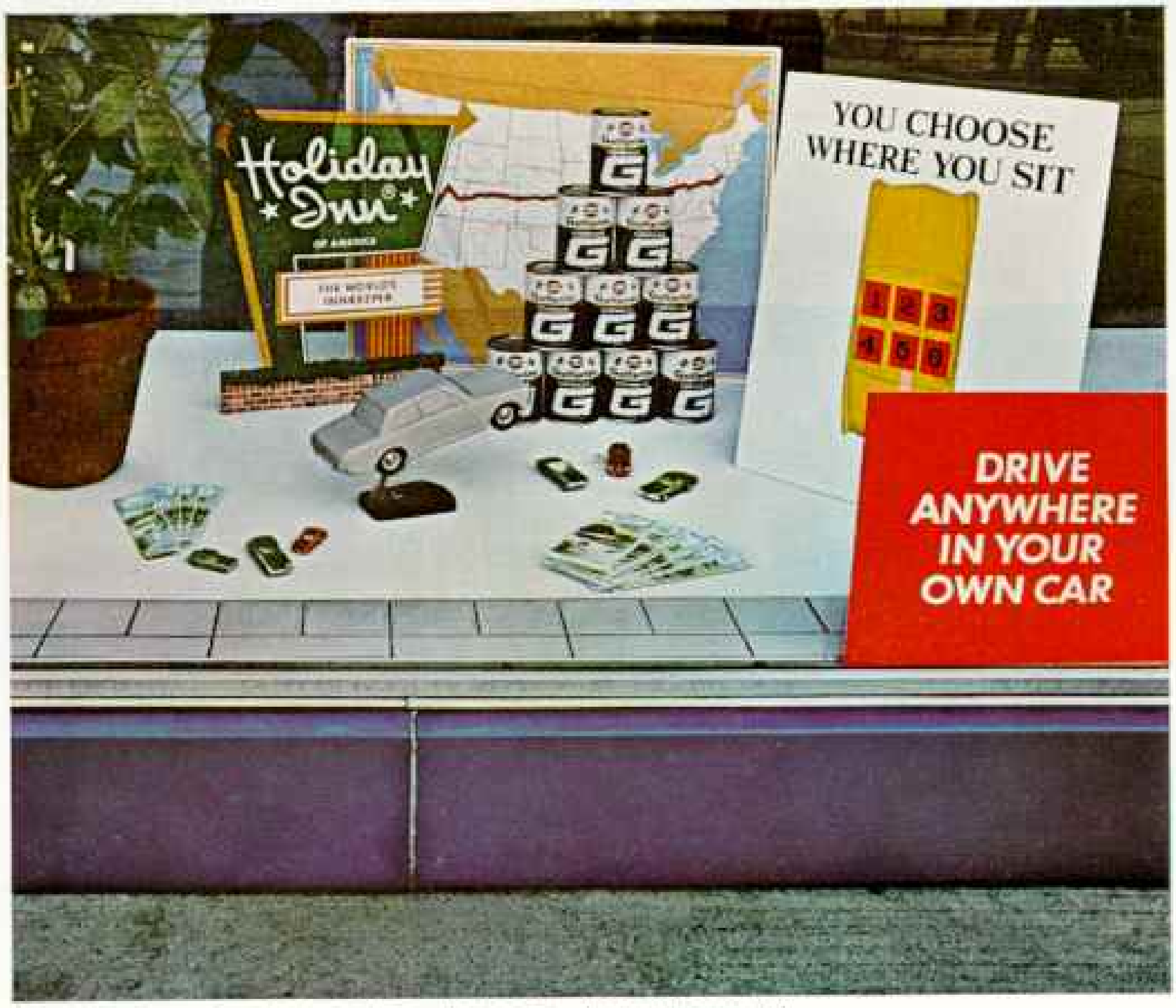
We're extremely pleased that the world's finest hotels, clubs and restaurants agree that serving the best means serving Prime and Choice Colorado Beef. Behind this honor lies years of research and experimentation by Colorado cattlemen in raising and feeding a strain of beef which produces meat with more taste and tenderness than any you've ever eaten.

The big difference, however, goes even beyond this exclusive breed. It can be traced to what we proudly call "the magic ingredient"—Colorado's incomparable climate. Only here, in this high-altitude state, are cattle watered on pure, glacier-fed streams, nurtured to maturity on the rich grasses of lush mountain meadows, then fattened for market by the most scientific feeding methods known today.

The result is waiting for you now at your favorite dining spot in the form of delicious steaks and roasts. Why not call and make reservations for two?

COLORADO BEEF PROMOTION BOARD
Livestock Exchange Bldg., Denver, Colo. 80216

Now there's a travel agency that always books you by car. Your own car.



If you're planning a jet vacation, there are many fine travel agencies to help.

But what if you prefer a leisurely trip in the family car?

That's where we come in, your Travel Agency with Pumps. Travel by car is our specialty.

Mail us a Gulf Tourgide® Request Card, obtainable at any Gulf Dealer, and we'll send you route-marked maps free. Also tips on where to stay and what to see. Downpayments? Never. Our clients prefer to charge as they go with our Gulf Travel Card, good for gas, oil and other services.

Also for meals and lodging at more than 1,000 Holiday Inns (highly recommended by your agency).

When you leave town, we do more than say "Bon Voyage!" We follow your trip. Our 35,000 "branches" in the United States and Canada make sure things continue as smoothly as they started. And that small details are seen to. For instance, having clean restrooms waiting anytime you want to stop and freshen up.

See for yourself how your Travel Agency with Pumps can make any trip a pleasure. Even if it's just downtown.

Gulf

THE TRAVEL AGENCY WITH PUMPS
Gulf Oil Co.—U.S.

Baring a reef's secrets

PROBING new underwater horizons, Dr. Walter A. Starck and a colleague explore Cozumel reef, off Mexico's Yucatán Peninsula. Dr. Starck, a research associate of the University of Miami's Institute of Marine Sciences, designed a breathing apparatus which operates without discharging noisy bubbles, enabling him to approach wary creatures and photograph them with high-intensity lighting equipment, also of his design. Here his camera reveals a brilliant scene: A bluehead *(Thalassoma bifasciatum)* hovers above a purple vase sponge.

Dr. Starck's Geographic-sponsored journeys into a fabulous realm will be described in a future issue. Use the blank below to let your friends share in such scientific adventures.

Add it up. A Pre-Set Board lets you create an unlimited combination of voices and effects before you play. Then draw on them at will. (No other organ under $8,000 has it.)

Instant Pre-Set Cancel lets you shift from one combination of voices to another. Instantly. (It's as though you had a three-manual organ.)

Touch Vibrato is something no other organ has. At any price. It lets you produce vibrato exactly the way a violinist does. Simply by rocking your fingers on the keys.

The Natural Sound Speaker system is totally unique. It projects sound with a rippling motion, spreading tone evenly and equally.

Variable volume voice tabs. Two 61-key manuals. 25 pedals.

And you get it all for $2395.00.*

It's too much. It's just too much.

The Yamaha Electone E-3. It's too much organ for the money.

YAMAHA
International Corporation

*Manufacturer's suggested retail price. Other Electone models from $359.00

See more of Canada in 72 hours than most Canadians see in a lifetime.

In comfort.

Wine, dine, play, listen to music, make friends or just sit back and enjoy the scenery.

A variety of accommodation is available, including berths, roomettes, bedrooms, compartments and drawing rooms—all reserved including coach seats.

"The Canadian" is a streamlined crack transcontinental train. Designed with Scenic Domes to provide you with a wide-angle view of the most spectacular, breathtaking scenery. 3,000 miles in all.

Including the best of the Canadian Rockies, the rugged northern shore of Lake Superior, the vast prairies, and such favorites as Banff and Lake Louise.

Faresaver Plan includes meals in deluxe Dining Room cars, or budget-priced meals are available in the Dome Coffee Shop.

"The Canadian" leaves daily from Montreal, Toronto and Vancouver. All aboard!

Contact your travel agent or Canadian Pacific.

CP Rail

Only 1 insurance company (we think) deals with malevolent swans: The St. Paul

IF THE SWANS DON'T MATTER, THE ABSURDITY DOES.

You may never want our new Swan policy. But you could want the elastic attitude that made us write it. This elastic attitude of ours means that your special problems get special treatment. Also of course, it leads us into absurdity, and delivers onto our desks such things as this:

SWAN REPORT, FROM OUR DEPARTMENT OF UNUSUAL POLICIES

"Swans in question resided in a suburban pond, regarded affectionately by nearby homeowners. One swan, however, having fussy day, did push, poke, flap at or otherwise annoy one local taxpayer.

"Taxpayer, unhinged, demanded Village Council remove swans from pond. Community rift developed. Coffee parties divided. Car pools suffered.

"Swans continued residence in pond, apparently enjoying publicity and extra bread crumbs.

"Council met, pondered, decided in favor of swans, but sagely insisted on Swan Liability Coverage for village. Hard to get. Didn't exist. Two insurance companies laughed at request.

"The St. Paul did not laugh, wrote policy. Suburban peace restored, car pools and coffee parties back to normal."

Why wait until you need an elastic insurance company? Find our Agents or brokers in the yellow pages. Get our quiet, venerable, solvent sagacity, too.

THE ST. PAUL
INSURANCE COMPANIES

Serving you around the world ... around the clock

St. Paul, Minnesota 55102

Now we can get rid of mosquitoes

Mosquitoes are more than a pest. They are a menace. The diseases they carry kill more people than cancer.

The most effective way of killing these mini-monsters is to attack them where they breed. In water. And man has tried many weapons. Among them, diesel fuels and insecticides. But all have a serious snag. They can pollute the water or harm plants and wildlife.

Last year, Humble Oil & Refining Company (a Jersey affiliate) introduced a new weapon —FLIT® MLO. Mosquito control experts are getting more and more excited about it. And so are the conservationists. With good reasons on both sides.

A thimbleful of FLIT MLO can kill several million mosquito larvae. Yet, even when used in large quantities, FLIT MLO will not harm fish, birds or plants. Nor will it pollute the water.

FLIT MLO is a unique water-white liquid which spreads an imperceptibly thin film over the water's surface. It kills larvae by a non-poisonous process.

without hurting anything else.

When the larvae come up to breathe, they actually ingest the product deep into their bodies. So deep, they can't wash it out. They die from lack of air. It is difficult to build up resistance to that.

FLIT MLO can also give the adult female mosquito quite a shock. It reduces the surface tension of the water. When she swoops down to lay her eggs, her feet prick through the surface as she lands. She sinks and drowns.

And a similar thing happens in the unlikely event a new mosquito is born in a treated area. It clambers out of the pupa to dry its wings, puts its feet in the water and down it goes.

Mosquito control crews are now being trained to use FLIT MLO in ten different countries on three different continents. Mosquito legions beware. This may seem like a skirmish. But it could be the start of a global war.

Standard Oil Company (New Jersey)

Esso

Paint yourself into Fall.

This is the uncrowded time to touch your brush to nature's wildest palette, alpine Colorado. Aspengold, sumac scarlet, nights a timberline indigo. Silver a waterfall. Whiten a glacier. Touch a ghost town with the grey of yesterday. And live a little at fascinating resorts and cities. If nature paints our hills gold, surely you're free to paint our towns red.

The coupon brings a free color preview. And a big, exciting literature packet. Mail it today.

STATE OF COLORADO, DIVISION OF COMMERCE & DEVELOPMENT
553 State Capitol Building, Denver, Colorado 80203

PLEASE SEND FREE your big 52-page color vacation guide / statewide events list / full-color state highway map folder / hotel, motel, dude ranch, resort information, with prices.

Name_____
please print

Address_____

City_____ State_____ Zip_____
Zip Code essential. Thank you.

Colorado

Take on deep, north-facing powder bowls. Tree-lined trails. Mile-wide slopes. Take on gentle beginners' areas. Expert runs. All blanketed with fluffy, Colorado-dry snow. All groomed to perfection. All bathed in the warm sunshine that's Nature's special gift to this pristine valley.

Take on the world-famous Aspen Ski School. Or one of Aspen's elegant restaurants, hospitable lodges and swinging nightspots.

Just write to the Aspen Chamber and Visitors Bureau, Box 739, Aspen, Colorado 81611. Or call (303) 925-3122.

TAKE ON AN
Aspenglow
THIS YEAR. IT LASTS FOREVER.

this is Nova Scotia...
a season's colors slowly fading
crackle of logs by a fireside chair
burnished skies still Autumn seas
only moments away in time

NOVA SCOTIA

Canada's Ocean Playground

for **NOVA SCOTIA TRAVEL INFORMATION** write:

New York 30 West 54th St., New York, N.Y. 10019 Tel. 212-581-2420

Boston 607 Boylston St., Boston, Mass. 02116 Tel. 617-267-1431

Name _____

Address _____

City _____

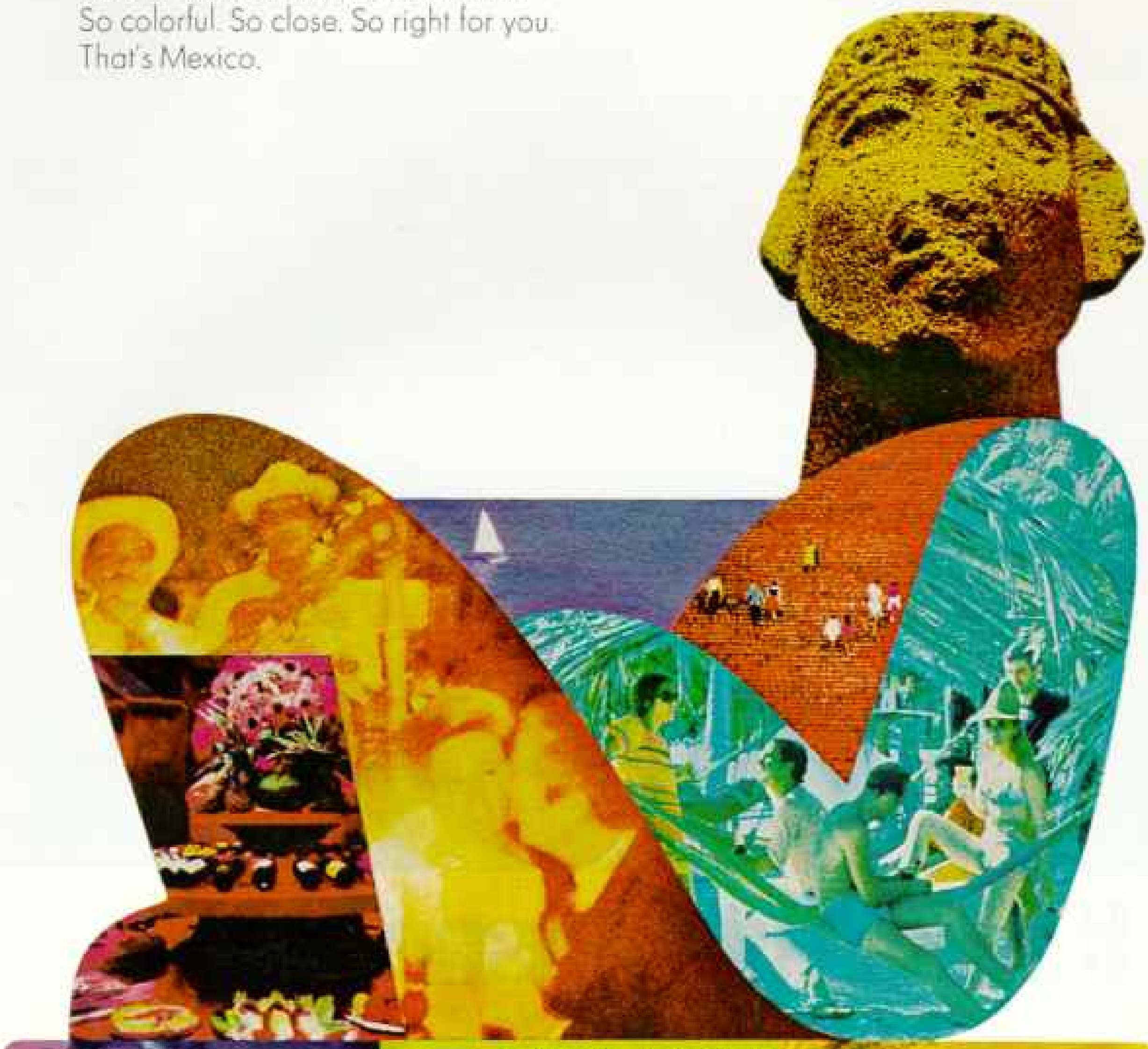
State _____ Zip Code _____

or **Nova Scotia Travel Bureau**
P. O. Box 130, Halifax, Nova Scotia, Canada.

The 1969 Canada Games
2700 athletes - gold medal competition - Halifax - Dartmouth - Aug. 16 to 25

Today. Tonight. To Mexico.

Beaches and waters are warm the year 'round.
And the fun doesn't stop after dark.
So colorful. So close. So right for you.
That's Mexico.



Mexican Information Office, Dept. S
Mexico House, 9465 Wilshire Blvd.
Beverly Hills, California 90212

Mexico sounds great any day or night. Please send facts.

Name _____

Address _____

City _____ State _____ Zip _____

méxico

When home is 'way ahead, you want a Merc behind you.

It's the fuel miser.

When we say Mercs get more miles per gallon, we know. We test 'em against the competition. The test engines are chosen at random. We make all comparison tests on the same day, same boat, same water and weather conditions. While the test driver maintains a constant rpm, time is measured to the split second with a stopwatch.

Results? Take the new 80-hp Mercury with Direct Charging and *Thunderbolt* ignition. Gets the same gas mileage, at equal boat speeds, as a competitive 55! Or consider the new 7½-hp fishing Merc. Top speed, within 1 mph of competitive 9½s; yet it gets 50% better mileage on a typical 16' boat. We're not just guessing when we say Mercs get better gas mileage. We've proved it on the water—where you need it.

KIEKHAEFER MERCURY

LEADERS IN MARINE PROPULSION FOR 30 YEARS 1939-1969

MERCURY

FOR NEAREST MERCURY DEALER, SEE THE YELLOW PAGES UNDER "OUTBOARD MOTORS."

Kiekhaefer Mercury, Fond du Lac, Wisconsin; Canada, Ltd.; Australia Pty. Ltd.

August 1969

NATIONAL GEOGRAPHIC

The Rockies' Pot of Gold

COLORADO

By EDWARD J. LINEHAN

Assistant Editor

Illustrations by National Geographic Photographer JAMES L. AMOS

THE GHOSTS OF COLORADO sleep fitfully, in very shallow graves. I recall a summer day when I tired of soaring steel and glass and concrete—even of friendly shirt-sleeved people—and turned my back on downtown Denver to seek some feeling of the past.

I poked my car west into a wooded canyon that wriggles up into the Front Range of the Rockies. In less than an hour I lost a century.

A weathered apparition brought me to a halt. He was hunkered down beside North Clear Creek, where it glints and burbles and dances down below Black Hawk and Central City, in the classic stance of a man panning gold. A ragged burro tethered to a nearby shack sang a nasal complaint, lending final credibility to the scene.

This, I thought, was how it was, and why it was—and almost exactly *where* it was, in 1859—that the State of Colorado was conceived.

Oh, Spanish and other explorers had come and gone by then, and a few traders, trappers, and buffalo hunters. And down on the rim of the prairie, miners' cabins already clustered in a gold camp called Denver City.

But it was the bonanza discovered in Gregory Gulch, just a shout or two upstream from where I watched the miner panning, that loosed a great stampede of men and wagons to the "Pikes Peak country" of western Kansas Territory. Fabulous lodes drew thousands in the '60's; with them came the certainty that a state would be carved from this rich, rough-hewn expanse of peaks and plains. And in 1876 it was.

The Centennial State (born a hundred years after the Nation itself) has evolved in less

COLORADO COLORAMA: ***Aspens in autumn gold gleam above a sun-silvered stream in Bogan Flats Campground, near 8,763-foot-high McClure Pass. September snows already dust granite peaks ringing the green vale.*** KODACHROME © N.G.S. 159

than a century into a complex giant that the most visionary pioneer could scarcely have imagined.

Along the eastern flank of the Rockies, where 80 percent of Colorado's two million people live, jet-age industry hums and space technology flourishes. Monumental waterworks—dams, tunnels, canals—move the generous snow melt of the Western Slope *under* the Continental Divide to a vast, thirsty agricultural empire on the eastern plains.

Skyscrapers now soar where cabins huddled on Cherry Creek; dignified Denver commands the commerce and finance of an eight-state mountain region (maps, pages 168-9).

Mining, the state's foundation stone, rings with metallic names unheard in gold-rush days: molybdenum, vanadium, cadmium, uranium. And every year, where solitary trappers and prospectors prowled a wilderness, more than seven million visitors now ski Colorado's slopes, climb its peaks, fish its streams, hunt its game, admire its vistas, or simply seek still-plentiful solitude.

I spent much of last summer, and part of last winter, as one of those millions, exploring Colorado by car and pickup camper truck. I roamed from flat farmlands near the Kansas line to sun-kilned canyons of the southwest. I drove over spectacular passes, floundered jubilantly in powder snow, and swam in hot springs. I fried trout over campfire coals, dined in elegant restaurants, and slept among the restless ghosts of crumbling mining camps.

Placer Claims Fade Away

They were lively and amiable ghosts—like the one before me in North Clear Creek Canyon (page 167). He seemed the picture-book prospector, with muddy boots and frayed checked shirt. He caught me staring.

"Don't get carried away," he said, and a wry smile creased his stubbled face. "Actually, I clean up pretty good!" Then Victor Couch waved off my apology for gawking and offered to show me around his placer claim.

Placer gold—the free dust, flakes, and nuggets weathered and washed down from the hills—is the easiest gold to extract. Once there were thousands of placer claims in Colorado; today fewer than a dozen are still being worked.

"This stream bed was cleaned out years ago," Vic said. "But I'm into virgin dirt over here—the roadbed of the railway that used to run up to Central City from Denver."

He climbed aboard a gasping old power shovel and scraped up a load of mud, gravel, and cobbles. The pay dirt clattered into an equally ancient dump truck, in which he hauled it some 50 yards to a rusty, inclined tumbler. As the perforated drum revolved, stream water sluiced the fine gold-bearing mud and sand into a series of wooden riffles.

Buckshot Ended One Miner's Dream

"You'd be surprised what you find from the old days," Vic said. "I've dug out picks, broken shovels, boots, bullets—even part of a corpse. Somebody'd filled him with buckshot."

He scooped out the fine muck trapped in the sluice box and with practiced wrist action slushed pebbles and lighter residue over the edge of his broad pan until heavy black sand remained. Now I could see the tiny dull-yellow flakes—disappointingly few to my eye—and a twisted quarter-inch bit of gold.

"That'll go a couple dollars easy," Vic crowed, and his smile was something to see. "Now I ask you—could a man ever get bored doing something like this?"

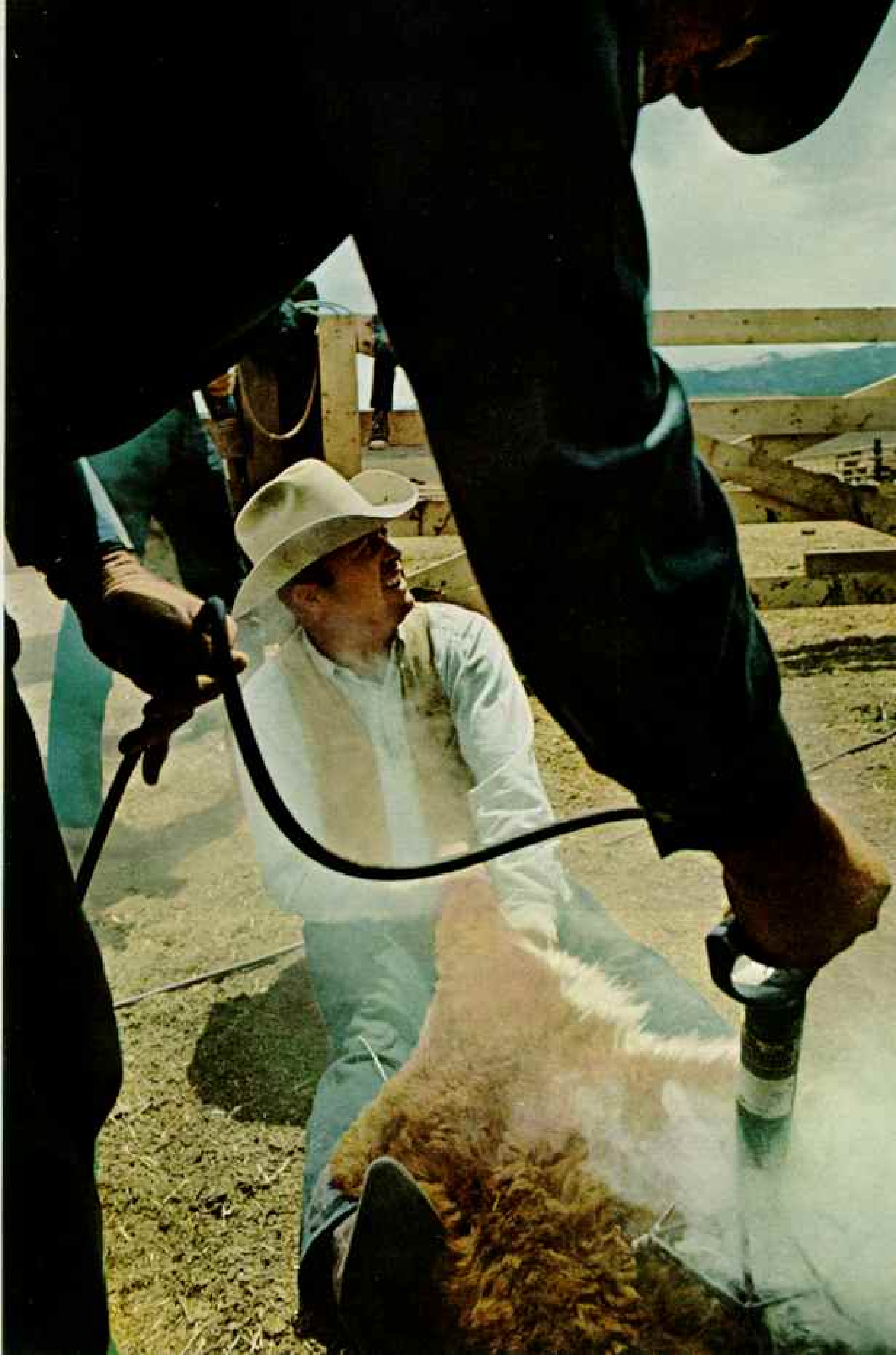
"Could a man make a living at it?" I asked.

His smile dropped. "Not at $35 an ounce," he said. "During the summer, with a couple of helpers, I can wash out about an ounce a day, maybe two. But I make out. I let tourists pan their own gold at a dollar a head."

Before I left Vic he thrust a rusty pan into my hands, pointed me at a pile of gravel, and invited me to strike it rich.

My prospecting fever cooled rapidly; sluicing six or eight pounds of gravel and water can do remarkably painful things to unaccustomed wrists. In 10 minutes my knees were kinked into what I feared would be a permanent crouch. Finally only black ferrous sand

Branding his Hereford calves, Michael Strang holds an animal as an electric iron sears it with the mark of his Mill Iron Lazy W Ranch: an axle support of an early gristmill and the letter "W" on its side. Strang runs a breeding herd of 600 head on his land by the Roaring Fork River near Carbondale. Cattle raising and feeding put $1,000,000 a day into Colorado's economy, but stockmen face an uncertain future because of soaring costs and hard-to-get help. "In this business you have to be combination cowboy, farmer, mechanic, truck driver, and fence builder," one rancher told the author.



Sunset comes early to Denver, walled on the west by the Front Range. Neon-bright Colfax Avenue spears toward the mountains.

Business and cultural center of the "Rocky Mountain Empire," the city had its birth in camps of tents and cabins that sprang up in 1858 when miners found traces of gold near Cherry Creek.

Cowgirl cheerleader enlivens an American Football League game between the Denver Broncos and the Boston Patriots in new Bears Stadium.

remained in the pan, with a few flecks of gold.

"Not bad—about a dime's worth," said Vic, and saw the expression on my face. "Maybe a little more," he added charitably.

I drove back to Denver. I knew where I could find more gold than that.

Mrs. Marian N. Rossmiller, an attractive Denver-born grandmother who directed the U. S. Mint there, had just finished her annual settlement—a monumental feat of bookkeeping and stocktaking that involved, among other things, some $2,400,000,000 worth of gold in the downstairs vaults. She had also to account for the metals used up in coining 307,314,000 half dollars, 1,335,148,200 dimes, and 218,017,748 quarters the previous year.

To see money in the making, 200,000 visitors a year tour the United States Mint in Denver. Here a counter tallies some of the day's penny production—18 million—part of the three billion coins stamped out by the mint each year. In its vaults lie about 2.4 billion dollars in bullion, nearly a quarter of the Nation's monetary gold reserves.

ASSEMBLING AND SYNCHRONIZING (LOWER LEFT) BY JAMES L. AMOS © N.G.S.

"It's quite a responsibility," Mrs. Rossmiller admitted. "When I took the job, my husband said, 'Don't expect me to make up any shortages.'"

The Denver Mint, a massive granite blockhouse, employs some 400 people to turn out about three billion coins a year. Its low production costs, says Mrs. Rossmiller, make this the most efficient coin factory in the world.

With Assistant Superintendent Charles Miller we walked down a long corridor to a room filled with punch presses. Their staccato hammering blended into an almost tangible roar as they stamped cascades of shiny blank disks out of sheet copper (above).

"We're in an emergency on pennies," yelled

Charlie Miller. "That's all we're making now —18 million pennies a day."

The nationwide penny shortage, I gathered over the din, was a mystery. "We don't know where they're all going," Charlie shouted. "Some think it's piggy banks, or vending machines. Maybe just collectors."

"Love to hear those presses pound!" Mrs. Rossmiller shouted happily as we moved on to a frenzy of other machines that, in turn, annealed, cleaned, and stamped heads and tails on the coins with 120 tons of pressure. Another device sorted out mis-struck pennies.

Charlie picked one of these from a bin and handed it to me. Abraham Lincoln's profile had been stamped off-center, neatly amputating his nose. "I wonder what a collector would give for this," I mused, returning it to him.

"Plenty," he said, and dropped the coin back into the bin with elaborate care.

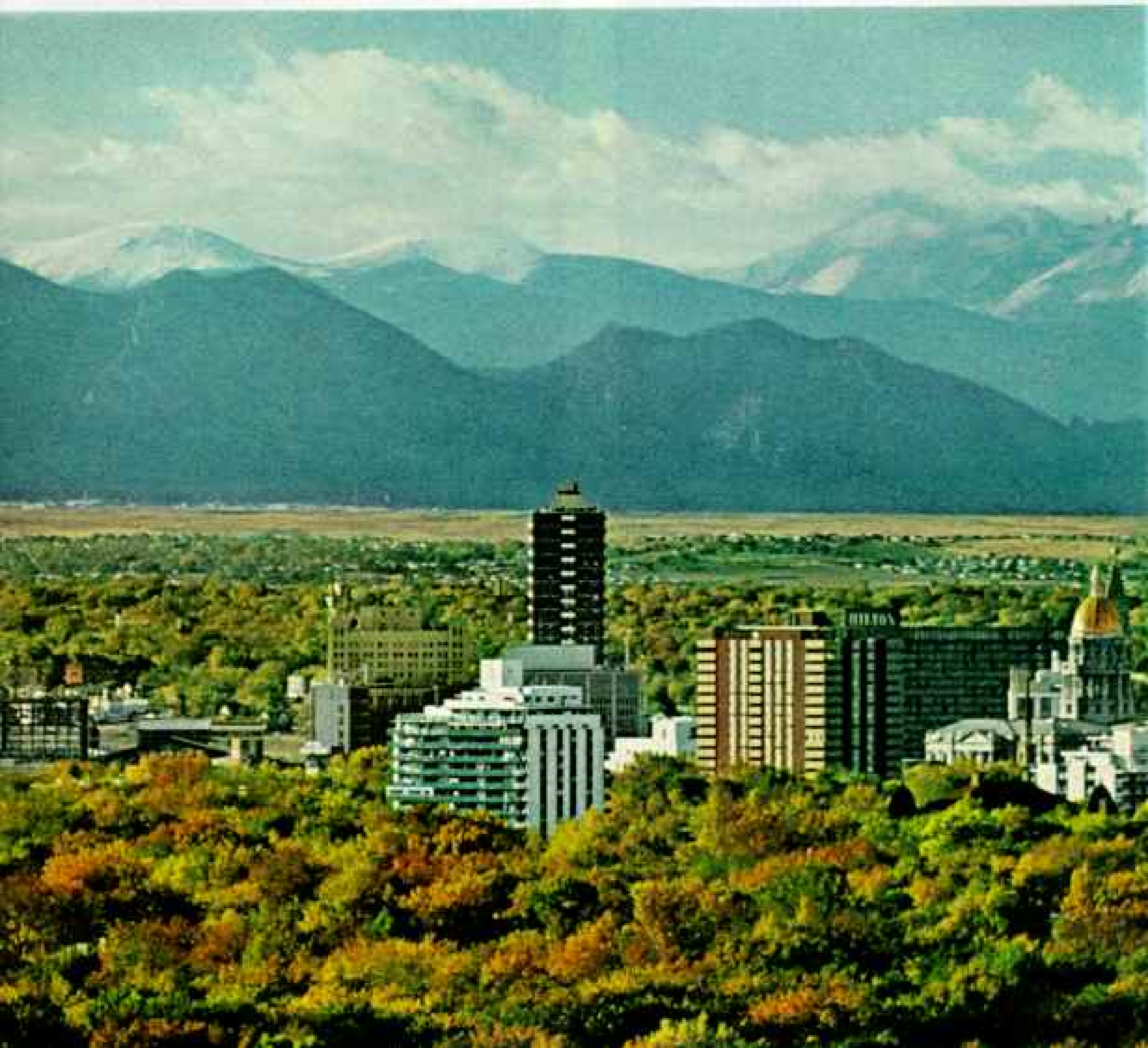
Mrs. Rossmiller reminded me that I had asked to see some gold—lots of it. "Will a million dollars do?" she asked.

There it was, in an alcove behind plate glass—several dozen yellow bars the size of building bricks, gleaming softly in subdued lighting. A million dollars, I decided, looks absolutely beautiful.

"We keep it on display for visitors," Mrs. Rossmiller said. "The mint gets nearly 200,000 sightseers a year—more than any other attraction in Denver."

Denver, in turn, is one of Colorado's major

In mile-high Denver, "Queen City of the Plains," the sun shines an average 300 days a year, and winters prove surprisingly mild for the altitude. Lured by climate and scenic beauty, newcomers since 1960 have swelled the population at more than twice the U. S. growth rate.



attractions. The mile-high capital is part of a clean and handsome metropolitan area that laps over five counties and houses 1.2 million people—more than half the state's populace.

Denver: Picture Window on the Rockies

Yet despite freeway, factory, and stockyard—even an incipient smog problem—Denver maintains an air of space and greenness, thanks to a patchwork of more than 100 municipal parks and the ubiquitous sprinkler hose.

Even its inevitable Skid Row—old Larimer Street, named for Gen. William Larimer who founded Denver City here in 1858—appears more mellow than tawdry, with derelicts basking hazily in old brick doorways. One stretch of the street has been beautifully restored into Larimer Square—a gaslit quarter of fine restaurants, courtyards, and shops.

Many Denver streets command striking views. Beyond the department stores and theaters of 16th Street looms Longs Peak, 50 miles away in Rocky Mountain National Park (below). Look west along Colfax Avenue (pages 162-3) and you can see Mount Evans, the 14,264-foot peak, so remote looking, is easily climbed by the Nation's highest paved road, which dead-ends just short of the summit.

Against the spectacular backdrop of the Rockies, Denver has something else that has helped to double its population in two decades. As one cab driver expressed it to me, "Sometimes I almost get sick of sunshine." The climate isn't quite that benign, but

Telephoto view, looking northwest, sweeps across the city's leafy canopy to the golden-domed State Capitol, set amid gleaming new skyscrapers, and the towering Front Range. Longs Peak, rising 14,256 feet at center, stands 50 miles away in Rocky Mountain National Park.

Denverites boast that most years you can play golf in the sun 300 days out of 365.

"The weather here is one of the greatest things we've got going for us," said Julius Pickoff, a stocky transplanted Texan. He heads a vigorous Chamber of Commerce program with a name that sounds like a cavalry charge: Forward Metro Denver.

FMD has played a major role in bringing scores of new industrial firms to Denver and neighboring counties in four years. This influx, centered on Space Age industry and research and development organizations, has provided the most dramatic stimulus to Colorado's economy since the Cripple Creek gold strike in 1890.

Julius Pickoff sat me down in a plush armchair in FMD's unique briefing center, a circular mini-auditorium equipped with charts, microphones, projectors, and screens. For half an hour he plied me with facts and figures.

"Notice the kind—and the caliber—of organizations and industries that Colorado is attracting," Julius said. "The National Bureau of Standards. The National Center for Atmospheric Research. Companies like IBM, Beech Aircraft, Ampex, Sundstrand, Western Electric, Martin Marietta. That means computers, aircraft instruments, electronics, aerospace products, rockets. I can name dozens of others, all settled here along the Front Range in the past eight years."

In a single decade, he pointed out, manufacturing across the U. S. grew some 75 percent. In Metro Denver it mushroomed by 170 percent.

Colorado's Governor John A. Love, in his office in the capitol, explained this phenomenal growth to me in simple terms.

"Colorado is just such a delightful place

Riches from the earth

A CENTURY AGO Colorado swarmed with prospectors who scoured the terrain for precious gold. Today the state records fewer than a dozen placer miners. One is Victor Couch (right). At his claim along North Clear Creek, he pans for gold and finds a fair-size nugget (below), valued at about $25. Tourists, however, provide him with a large part of his income. In summer as many as 100 a day pay $1 each to pan for gold.

Though Colorado has mined some 40 million ounces of gold since 1858, another metal is much more valuable to the state today: molybdenum, a heavy silver-gray element with a very high melting point. It toughens steel and is used in lubricants, inks, and paint, and as an oil-refining catalyst.

At the Climax Molybdenum Mine (left), largest underground mine in North America, visitors watch the gyratory crusher reduce five-foot-wide chunks of ore to grapefruit size. More than 2,000 pounds of ore must be ground and milled to extract four pounds of molybdenum.

to live," he said. "Take IBM, for example. They'll tell you that it's easier here to hire the kind of technical and professional employees they need. These people want to live in an attractive area. They want a college or university nearby. And they want the recreational and cultural facilities we have."

Planners Aim for Cluster Cities

The state's rangy chief executive uncoiled from his chair and strode across the spacious paneled office to a map.

"Eastman Kodak recently announced that they're going to build a large installation—not in one of our bigger cities, but here, outside the little town of Windsor, near Fort Collins. To me that's a most hopeful thing.

"You see, the danger is," he went on, "that left to its own devices, this eastern side of the Rockies—all the way from Fort Collins and Greeley on down through Colorado Springs, perhaps even Pueblo—could eventually become an urban sprawl. We're trying to devise a plan to prevent that. We want cluster cities, groups well separated, with correct treatment of transportation and all the other problems of rapid growth, and—above all—plenty of open spaces."

Open space is a personal concern to Governor Love, an ardent outdoorsman. "I've seen every part of Colorado almost every way possible," he said. "By plane, by helicopter, on horseback, by car. I believe it's the greatest piece of real estate on the face of the globe."

He touched at random on the beauty of the San Juan Mountains in the southwest, the wide-open sagebrush country of the northwest, glimpses of lonely miners' cabins or sheepherders' camps.

"There's a view as you come over Rabbit

FLUNG LIKE A SADDLE BLANKET over the backbone of the Rockies, Colorado is the loftiest of the 50 United States, averaging 6,800 feet above sea level. Fifty-five of its peaks top 14,000 feet. To the east, high grassy plains slope up to meet foothills of the mountains. West of the Continental Divide stand sawtooth ranges and high plateaus and mesas cut by plunging canyons. Rivers rising among the Colorado Rockies supply water to 19 other states. Gold and silver built Colorado Territory into a boomtown state; today mining runs behind industry, agriculture, and winter and summer visitors as an income earner.

AREA: 104,247 square miles, ranks 8th. **POPULATION:** 2,072,000, ranks 30th. **ECONOMY:** Manufacturing and food-processing industries along the eastern flank of the Rockies; livestock, grains, alfalfa, sugar beets on eastern plains; tourism, timber, and mining (molybdenum, vanadium, uranium, zinc, lead) in the rugged west. **MAJOR CITIES:** Denver, pop. 521,000 (metropolitan region 1,167,000); capital, Colorado Springs, 128,500, Air Force Academy, light industry. Pueblo, 105,600, manufacturing, trade center. **ADMISSION:** 1876 as 38th state.

Ears Pass and look down the Yampa Valley. You see the water shimmering. . . ."

I believe I might have talked the Governor of Colorado into going with me, right then and there, to Rabbit Ears Pass.

I drove out of Denver in a rented camper, headed for the mountains. The fact of Colorado's altitude impressed itself on me the first night out, in a U.S. Forest Service campground. I carelessly ripped the paper seal from a jar of instant coffee, packed near sea level, and a puff of brown powder exploded all over my shirt front. I was parked at 9,000 feet.

More than a thousand of Colorado's peaks soar higher than 10,000 feet, and 55 of them top 14,000. They are high because they are young, as mountains go.

For half a billion years this land was repeatedly warped and broken by cataclysmic forces, rasped by erosion, and flooded by intruding seas. But only some 80 million years ago (roughly last weekend to geologists) did a period of upheaval called the Laramide Revolution begin shaping today's Rockies.

Abode of the vanished Anasazi, or "Old Ones," cliff dwellings in Mesa Verde National Park once bustled with life, but fell silent two centuries before Columbus, when the inhabitants abandoned the area. This visitor inspects a courtyard in Spruce Tree House, the park's third largest complex, with 114 rooms. Ladder leads to a kiva, an underground ritual chamber.

In addition to Mesa Verde National Park and Rocky Mountain National Park, Colorado holds six national monuments—including Dinosaur and Great Sand Dunes—and two national recreation areas.

Gradually it uplifted the crust of Colorado into a gigantic arch, later to be worn away and sharpened into ragged teeth by water, wind, and ice. Volcanoes belched and molten rock seeped up into crevices. When the heavy fluid fire cooled, some of it crystallized into mineral veins and lodes that would give men compelling reason to come to Colorado.

Today the mountains are reason enough. In Rocky Mountain National Park, which straddles the Continental Divide, Superintendent Fred J. Novak told me, "We're expecting two million visitors this year—a record."

For several days I accompanied park rangers patrolling this 410-square-mile preserve of breathtaking peaks, flower-strewn meadows, alpine tundra, and gemlike lakes.* The park is a paradise for campers, trout fishermen, hikers, and climbers, and for those who find rare reward in a glimpse of grazing elk or bighorn. I spent one entire evening seated by a lake, watching a beaver colony carve silver furrows in the moonlit water.

But a disturbing note has crept into paradise. While examining the rescue equipment Seasonal Park Ranger Dick Shillinglaw carried in his patrol car, I noticed a slim black canister at his belt. "Chemical Mace," he explained uncomfortably.

Park rangers prefer to talk about other things, but admit that motorcycle gangs have harassed motorists and that occasional "car clouters" have broken into unoccupied autos and trailers.

"We don't want to be policemen," several of the rangers told me. But they have quietly undergone riot training in case more serious disturbances intrude into this lofty sanctuary.

Western Water Slakes Eastern Thirst

And lofty it is. Trail Ridge Road, the highest continuous paved highway in the country, tops 12,000 feet as it snakes across the Continental Divide from Estes Park on the east to Grand Lake on the west (pages 176-7).

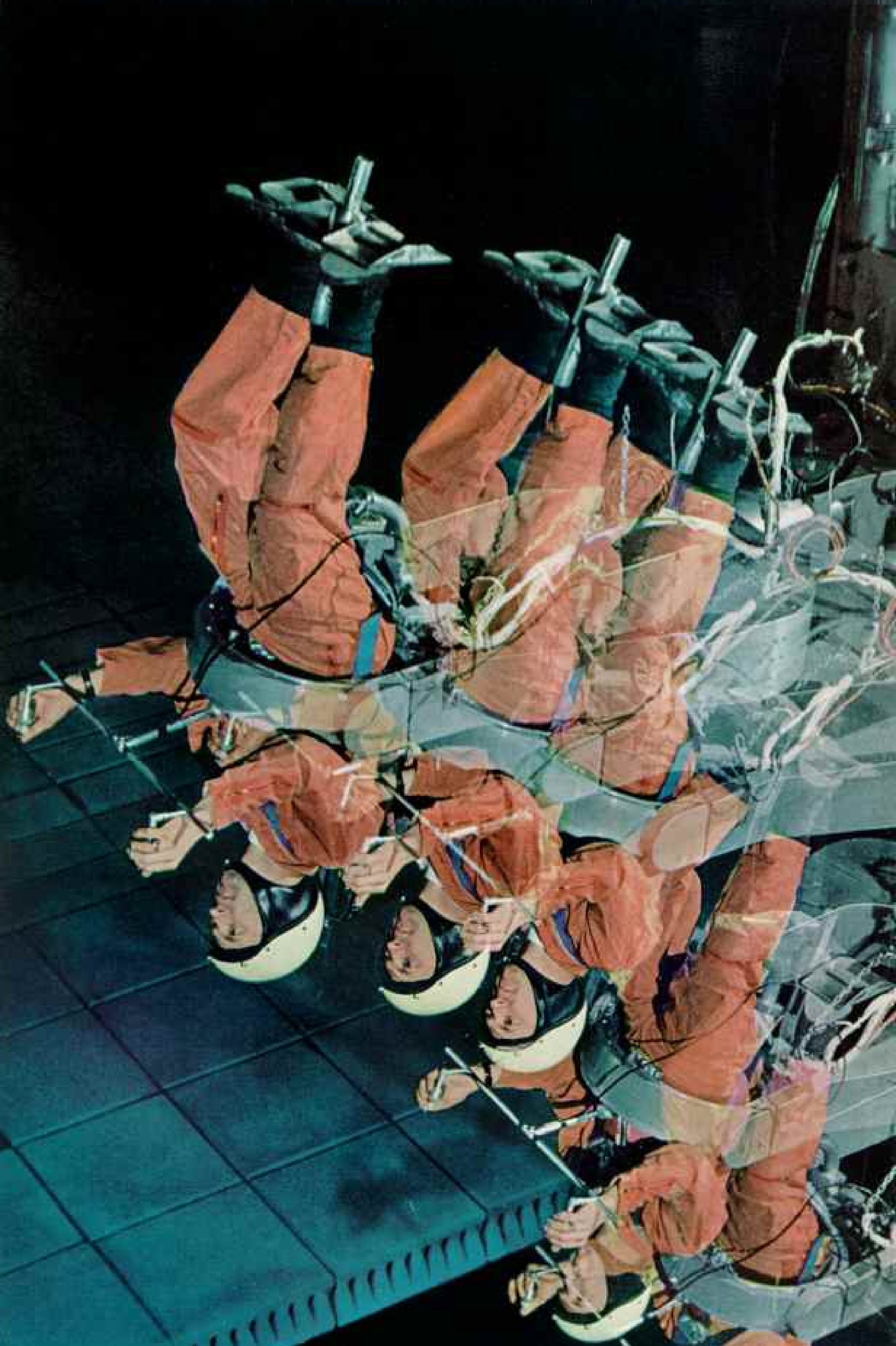
East of the divide it was overcast but dry as I headed my camper toward Grand Lake; on the Western Slope I encountered a gusty, drumming rain. The difference demonstrated Colorado's principal economic problem and has spurred the state's most remarkable engineering achievements.

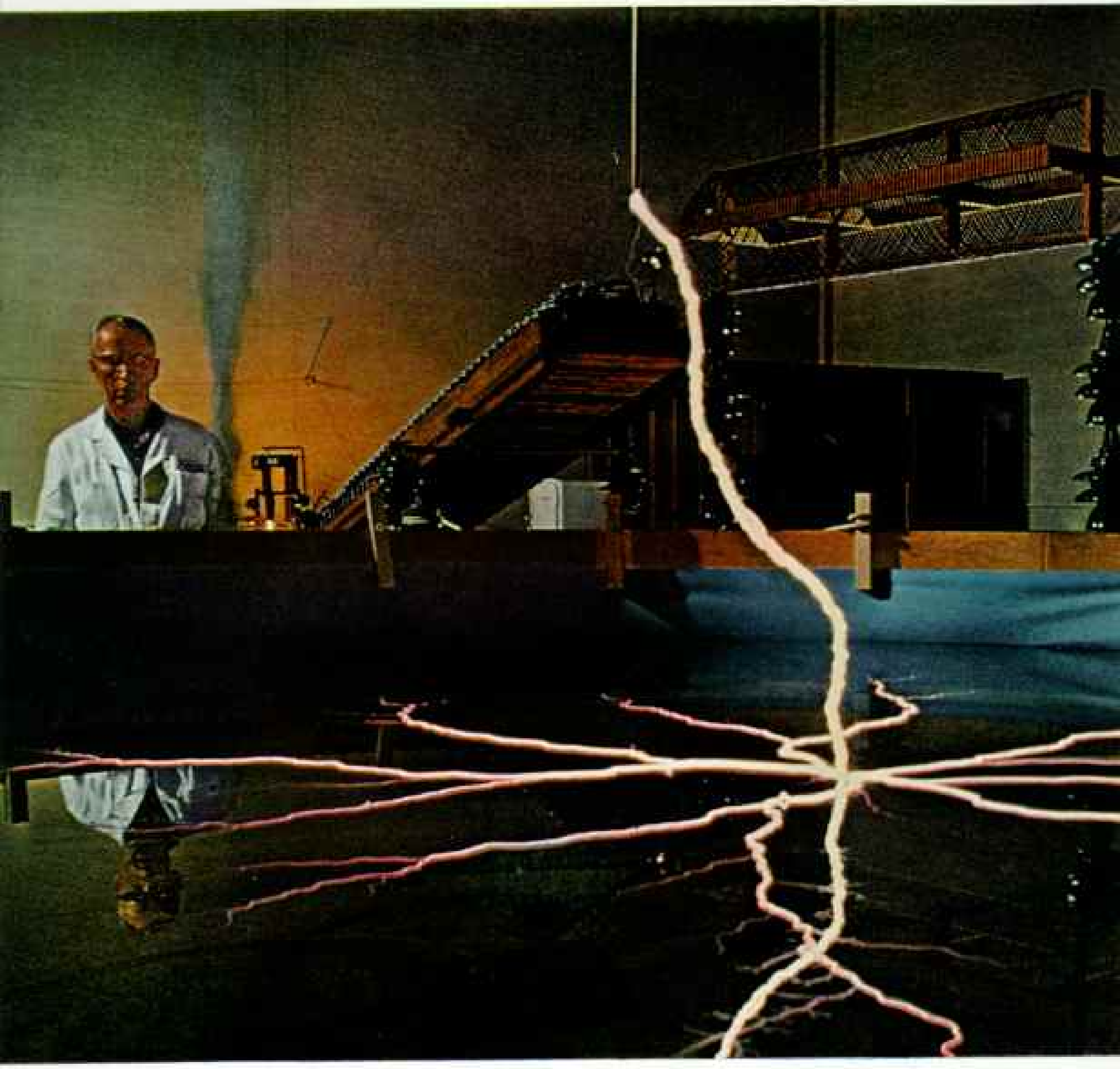
Eastward-scudding clouds colliding with the Rockies drop two-thirds of their moisture on the Western Slope, leaving too little for the broad, fertile farmlands east of the divide. One solution was the ingenious Colorado-Big Thompson Project, finished in 1959 after 21 years of work by the U. S. Bureau of Reclamation.

A vast man-made reservoir, Lake Granby, intercepts the Colorado River early on its long journey to the Gulf of California. Granby's huge pumps lift water nearly 200 feet to nearby Shadow Mountain Lake and Grand Lake. Gravity does the rest. Through the sloping 13.1-mile Adams Tunnel, water flows beneath Rocky Mountain National Park, emerging on the Eastern Slope to feed a network of reservoirs and power plants. Cables

*See in NATIONAL GEOGRAPHIC: "Colorado by Car and Campfire," by Kathleen Revis Judge, August 1954, and "Colorado's Friendly Topland," by Robert M. Ormes, August 1951.

How man may walk in space: Multiple exposures follow the movements of Arlen A. Schlaht as he rides a device that simulates weightlessness at the Martin Marietta space center near Denver. Seated in the yokelike apparatus, the engineer grasps knobs wired to a computer that maneuvers him in any direction he wishes—up, down, sideways, forward, or backward. Here Schlaht descends from upper left. NASA's Apollo Applications Program envisions a workshop inserted into orbit in the early 1970's, from which astronauts will venture out with self-propelling backpacks and move through space much in this manner. To make this dramatic picture, photographer Guisinger opened the shutter of his camera in the darkened chamber and fired strobe lights every other second.





carry power back through the tunnel to drive the pumps at Lake Granby (map, page 187).

Each year Colorado-Big Thompson moves an average of 85 billion gallons of water to help irrigate 720,000 acres of eastern Colorado farmland and meet the cities' soaring demand for water and power.

To the south, other tunnels perform similar feats—with fringe benefits. The Bureau of Reclamation's Fryingpan-Arkansas Project, about one-third completed, will ease the chronic water shortage of southeastern Colorado. It will also generate power and guard the Pueblo area against floods from the Arkansas River.

Huge Dillon Reservoir, 60 miles west of Denver, slakes that city's growing thirst via the 23.3-mile Roberts Tunnel (diagrams, pages 186-7). The lake, which consigned the rickety old town of Dillon to a watery grave several years ago, has already spawned a handsome new resort community.

From Firstview to Last Chance

A fleet of sailboats bobbed at their moorings as I drove up the Blue River, which feeds the new lake. Twisting ridges of washed stones and gravel, resembling the castings of some monstrous earthworm, followed the stream bed all the way to Breckenridge. These were the waste heaps of gold dredges that worked as late as 1942.

On the other side of 11,541-foot Hoosier Pass, I found that dredges had also chewed

Man-made lightning from a million-volt generator stabs an experimental pool of fresh water in an engineering laboratory at the University of Colorado in Boulder. Fingers of fire flare out on the surface and dissipate energy over a wide area. Researchers, seeking to learn through such tests whether lightning endangers marine life or submerged craft, have discovered that the region affected by the bolts is smaller in salt water than in fresh water; hence sea water is less dangerous.

PHOTOGRAPHED BY JAMES L. AMOS © N.G.S.

their way up the head of the high, sprawling basin called South Park, past a town with the intriguing name of Fairplay.

In 1859 miners of the nearby gold camp of Tarryall jealously excluded a group of newcomers. Dubbing the place "Graball," the latecomers pushed on to strike pay dirt on the South Platte River, where they built their own town. Today Tarryall is silent, gone. Fairplay survives, in righteous rebuke.

Early Coloradans knew how to name their towns. Of course, Denverites christened theirs for a governor of Kansas Territory to curry political favor—not knowing that he had already left office. And some places bear no-nonsense names that only a miner could love, like Bedrock, Basalt, Granite, or Silt.

But glorious dreams linger in wizened mountain towns named Eureka and Bonanza; others speak of harvests—Orchard City, Fruita, and Sugar City. You can't mistake the brimming anticipation that inspired the name Firstview (where the westward-bound with their oxcarts and wagons first glimpsed the distant Rockies), or the vague despair of Last Chance, named as late as 1926 because it was still so far from *anything*.

On the plains I passed crossroads hamlets named Punkin Center and Toonerville. And in the high country I smiled with the whimsical ghosts who called their towns Tincup, Lulu City, and Buckskin Joe.

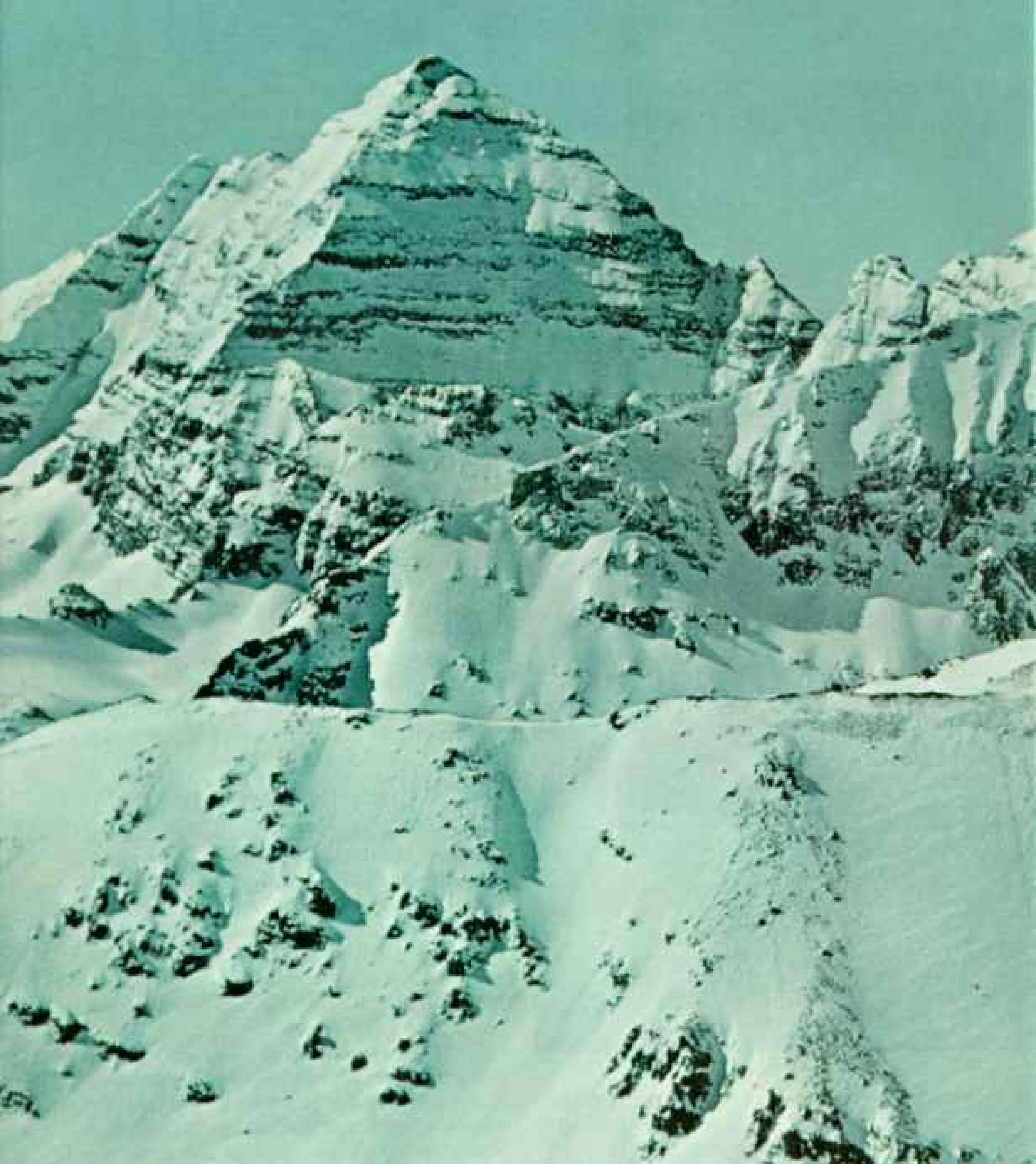
"Hang On to the Matchless"

Across the rugged Mosquito Range from Fairplay stands Leadville, once Colorado's second largest city, with 24,000 people. Dwelling nearly two miles above sea level, today's 6,000 residents claim their year has only three months—"July, August, and Winter." Their principal industry now is the world's largest molybdenum mine at Climax, 13 miles to the north (pages 166-7).

In 1874, when most of Colorado's placer workings had already petered out, someone discovered that the heavy dark sand that had hampered earlier gold miners in this area was almost pure carbonate of lead and silver.

Among the fortunes made here was that of H. A. W. Tabor, a storekeeper who grubstaked a pair of miners to $17 worth of groceries. They promptly struck silver. "Haw" Tabor sold his share for a million dollars and parlayed that into more than nine million from other diggings, including the famous Matchless Mine.

Tabor the millionaire turned to politics, rising to serve briefly as a U. S. Senator. Along the way his eye fell upon the beautiful Elizabeth McCourt (Baby) Doe, and in a scandal still warm in Leadville's memory, he divorced his wife Augusta to marry her.



FLOATING SOUNDLESSLY *amid a world swathed in white, a sailplane glides over the Maroon Creek country south of Aspen. Pyramid Peak, 14,018 feet, looms at left. Slope soaring, as performed by the pilot of this Schweizer 1-26, proves far more exhilarating than dangerous—as long as the wind holds.*

On the cloud-drifted roof of the Rockies, visitors stroll Forest Canyon Overlook near Trail

Safe in the sanctuary of the park, a bighorn lamb gambols in spring grass beside the Fall River.

Colorado's state flower, the columbine, and 750 other wild-flower species beautify the preserve.

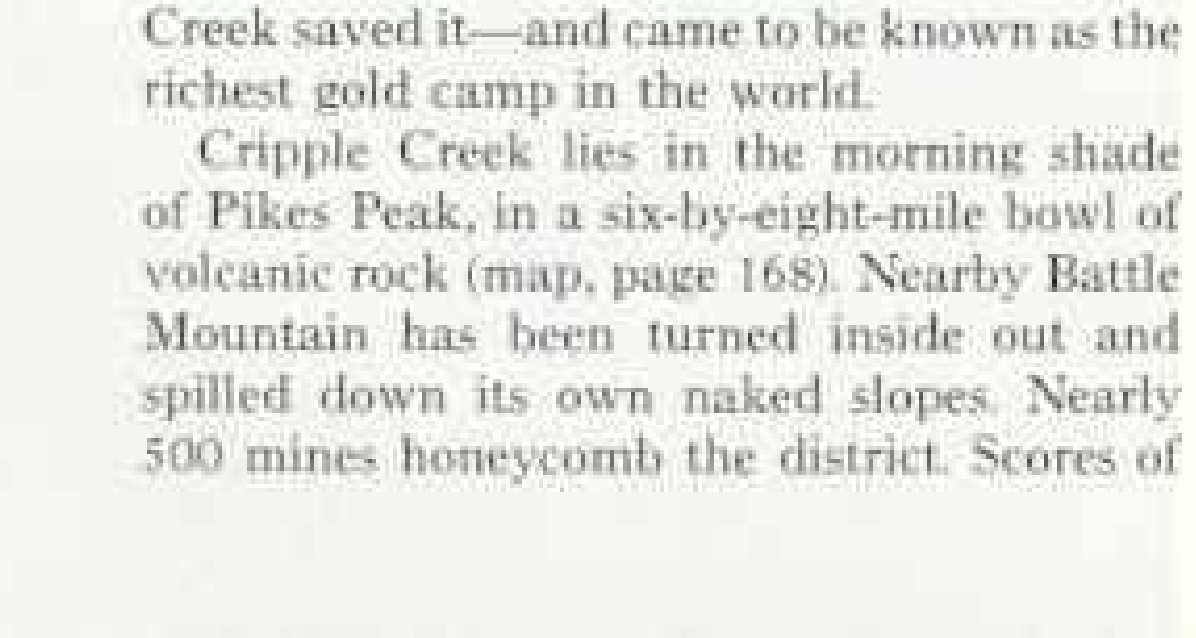
But the saga of Horace Tabor and Baby Doe ended like a Victorian melodrama. With the repeal of the Sherman Silver Purchase Act, silver prices collapsed and all Colorado staggered under the Panic of 1893. Tabor's financial and political fortunes plummeted. When he died in 1899, he was postmaster of Denver. His last counsel to Baby Doe was, "Hang on to the Matchless—it will make millions again."

I visited the shack beside the now-flooded Matchless Mine where Baby Doe lived for years, waiting for silver to become king again. The single room held an old iron bedstead, a table, and a chair. Cardboard and yellowed newspapers covered cracks in the walls.

Here Baby Doe Tabor, whose glittering wedding President Chester A. Arthur had attended, was found dead one day in 1935, penniless and frozen, at the age of 80.

Ridge Road in Rocky Mountain National Park.

Peaceful rodent who sleeps most of his life away, a marmot peers from his grass-lined apartment.



When Colorado floundered in the silver crises of the '90's, a pasture called Cripple Creek saved it—and came to be known as the richest gold camp in the world.

Cripple Creek lies in the morning shade of Pikes Peak, in a six-by-eight-mile bowl of volcanic rock (map, page 168). Nearby Battle Mountain has been turned inside out and spilled down its own naked slopes. Nearly 500 mines honeycomb the district. Scores of gaunt headframes and empty mine buildings have donned the somber hue of rust.

I strolled up hilly Bennett Avenue behind a pair of visitors from Nebraska, and found it difficult to believe that in 1900 some 30,000 people occupied Cripple Creek, neighboring Victor, and a dozen now-dead smaller towns nearby. At least 28 of those people became millionaires. Before rising costs finally swallowed the profit in gold fixed by law at $35 an ounce, closing most of the mines, Cripple Creek had disgorged more than $400,000,000 worth of ore.

Rich Ore Remains in Cripple Creek

A gray-haired waitress in the Home Cafe told me that about 550 people still live in Cripple Creek, and perhaps 300 more in Victor. "For some reason the two towns never did get along, though," she said. "Even now, with summer tourists coming in, they're having trouble cooperating."

The growing swell of tourists brings many to hiss the villains of the melodramas staged in the refurbished Imperial Hotel. And real estate prices are escalating again as many of Cripple Creek's old frame houses are being converted to vacation homes.

I drove the six miles over to Victor and wandered past blocks of empty storefronts. Grass poked through cracks in the sidewalks in front of the dusty Palace Barber Shop. Even the New Hotel Victor had long stood locked and empty. I tried to visualize a city of 17,000 some 60 years ago when Lowell Thomas went to high school here, when bloody labor warfare wracked the entire district, and when William Harrison Dempsey shoveled ore as a mucker in the Portland Mine. (Under the name "Jack," he later earned international renown with his fists.)

Between Victor and Cripple Creek I prowled old mine dumps and walked over untold wealth. "There's plenty of gold left around here," asserted the hoist engineer at the El Paso Mine. "Maybe more than was ever taken out. But you can't pay a miner $3 a day any more, and a case of dynamite'll cost you $40. Now, if the price of gold ever goes up to $100 an ounce. . . ."

The El Paso shaft is one of two in Cripple Creek still working—but they mine only enough ore for tourists to take home as souvenirs. I picked up a chunk from its depths for my collection and headed for the heights—the commanding bulk of Pikes Peak.

In 1806 Capt. Zebulon M. Pike, first American officially to explore Colorado, attempted

to scale this "Grand Peak," as he called it. His band of ill-clad men encountered waist-deep snow and temperatures below zero, and retreated. "I believe no human being could have ascended to its pinical," he wrote.

Last year, nearly 350,000 did. (Some even hiked up on New Year's Eve to set off a fireworks display.) Although 32 other Colorado peaks top its 14,110-foot summit, Pikes Peak is nonetheless spectacular, looming abruptly from the plains at Colorado Springs.

Tall Stories on Pikes Peak

A cog railway creeps up one broad shoulder, and a dusty ruffle of road climbs its throat. I took a bus up the mountain, and the driver pointed out a particularly steep grade.

"Couple of weeks ago a big tour bus from Denver gave out right here," he said. "They had to hook two patrol cars in front to pull it to the top.

"When they got up there," he lied solemnly, "the car in the middle was two feet longer."

At Summit House I joined other flatlanders slumped over cups of hot coffee, a few fed coins into a dispenser for a maskful of oxygen. Outside, wind keened around jumbled red rock. Far below, the neat green grid of Colorado Springs was warming up to a 90° day. Here I shivered near the freezing mark.

Then, with several hundred other spectators on the summit, I heard what we had come for: a faint snarl that swelled into an agonized roar. A sharklike racing car fishtailed across the finish line, pursued by a relentless plume of dust. Every three minutes another racer roared onto the mountaintop in the 46th annual Pikes Peak Auto Hill Climb.

Nick Sanborn, Jr., winner of the second division of the race (stock cars), offered me a lift back down. He had driven the tortuous 12½-mile course in just over 14 minutes, to win a $3,000 purse. I climbed into his Oldsmobile Toronado and sat on the dusty steel floor, stripped of all but the driver's seat.

I clutched the metal safety bar overhead as the car growled swiftly around a corner above Bottomless Pit. "To win this race you've got

Ranger on a busman's holiday, naturalist John L. Colyn roams Rocky Mountain National Park in off-hours. Beside a snow-fed brook on the Chasm Lake Trail, he crouches for a drink of the clear, cold water.

In this lofty land of perpetually snow-tipped peaks straddling the Continental Divide, the Arapahoe name for one range meant the Never Summer Mountains.

America's school of the air, counterpart of West Point and Annapolis, the United States Air Force Academy north of Colorado Springs now instructs 3,200 future officers, giving them a foundation in both the humanities and sciences. Here, by an F-105 fighter

to know the road," Nick said cheerily. "I've lived all my life right down there at Cascade." Pointing out over a 2,000-foot drop, he took another curve with scarcely a glance.

Wending skillfully through the "W's"—a series of switchbacks clinging to the mountainside around 13,000 feet—Nick chatted animatedly, gestured, peered at me through his sunglasses, and stuffed his pipe. Halfway down, to my silent gratitude, we caught up with a clot of homeward-bound spectator traffic. Patrolmen were feeling automobile hubcaps, checking for overheated brakes.

Nick dropped me off at the bottom. "That's quite a mountain you've got," I said, looking back up at Pikes Peak.

"She's a good old mountain," he replied—"a real good old mountain."

Eyrie of the Air Force

The Pikes Peak-Colorado Springs region abounds in attractions for the summer tourists, like the fantastic sandstone formations in the Garden of the Gods (pages 184-5), the Cave of the Winds, and Pikes Peak Ghost Town and Manitou Cliff Dwellings. But more than a million visitors last year flocked to the nearby United States Air Force Academy,

PHOTOCHROME BY GARY SUGHROE © N.G.S.

plane that commemorates academy graduates killed in Viet Nam, blue-clad cadets drill for June Week parades. In the background, 17 tetrahedral spires soar 150 feet above the all-faith chapel, shadowed on the west by the rugged and aptly named Rampart Range.

making it the single most popular attraction in Colorado.*

I arrived there on a Saturday afternoon, and Capt. Michael P. McRaney, community-relations officer, graciously left unfinished a trout fly he was tying and showed me around.

Only 15 years old, the academy is scaled to fit the Space Age. In the shadow of the beautiful Rampart Range, it occupies part of an 18,000-acre tract threaded by 100 miles of road, and cost $200,000,000 to build. A single dormitory, Vandenberg Hall, has 1,328 rooms. The famous Cadet Chapel, with its striking aluminum-and-steel spires, soars 150 feet into the Colorado sky (above).

The academy teaches some 3,200 cadets subjects ranging from astronautics to vertebrate embryology, preparing them to become career officers in the Air Force.

I discovered that it also raises chickens. The poultry constitutes the diet of eight feathered mascots, six of them prairie falcons.

"These two are arctic gyrfalcons," said the base veterinarian, Col. James McIntyre, pointing out a pair of snowy, fierce-eyed birds. "There are only a few of them in captivity in

*See "Where Falcons Wear Air Force Blue," by Nathaniel T. Kenney, NATIONAL GEOGRAPHIC, June 1959.

the U. S. Too bad you can't see them at their best—they're moulting now."

Mike McRaney picked up a stray white hackle from the floor. "What a trout fly this'll make," he said.

Before I left, Mike handed me several "McRaney Specials"—gray fox fur wound on tiny hooks to simulate freshwater shrimp. As I took a final look at the academy's spectacular geometry of glass and steel, Mike pointed out an F-105 fighter parked near the chapel as a memorial to academy graduates killed in Viet Nam (page 180).

"When they dedicated that plane about a month ago, another one flying overhead as part of the ceremony came in just a little too fast." The captain stared thoughtfully at the sky. "The sonic boom broke 300 windows."

I doubt that the concussion bothered airmen deep inside Cheyenne Mountain, south of Colorado Springs. The 900-man U. S. and Canadian staff of NORAD—the North American Air Defense Command—works under a roof of granite a quarter-mile thick, in 11 windowless steel buildings mounted on heavy springs, behind 30-ton blast doors.

NORAD's computers instantly evaluate contacts picked

Iceberg lettuce from the sun-drenched San Luis Valley heads for salad bowls across the Nation. Pickers cut, select, and pack the heads on the 2,500-acre farm of the Mizokami Brothers, the region's largest vegetable growers and shippers.

Remarkably level, the lofty San Luis Valley in south central Colorado is an ancient lake bed 125 miles long and averaging 50 miles wide. Access to it from the rest of the state can be gained only by way of five mountain passes, three of them above 10,000 feet.

Leaning tower of cartons arrives in a field south of Blanca. Farmhands will pack each case with two dozen heads of lettuce.

PHOTOGRAPHED BY JAMES L. AMOS © NATIONAL GEOGRAPHIC SOCIETY

up by a far-flung network of radar and other devices and show any aerospace threat to the continent. Through this nerve center our civilian populace would be warned, and our own missiles and bombers launched.

Not far from NORAD's Combat Operations Center, at the foot of Cheyenne Mountain, stands another of Colorado's most distinguished institutions. After having spent several days there, summer and winter, I cannot bring myself to call the Broadmoor simply a hotel.

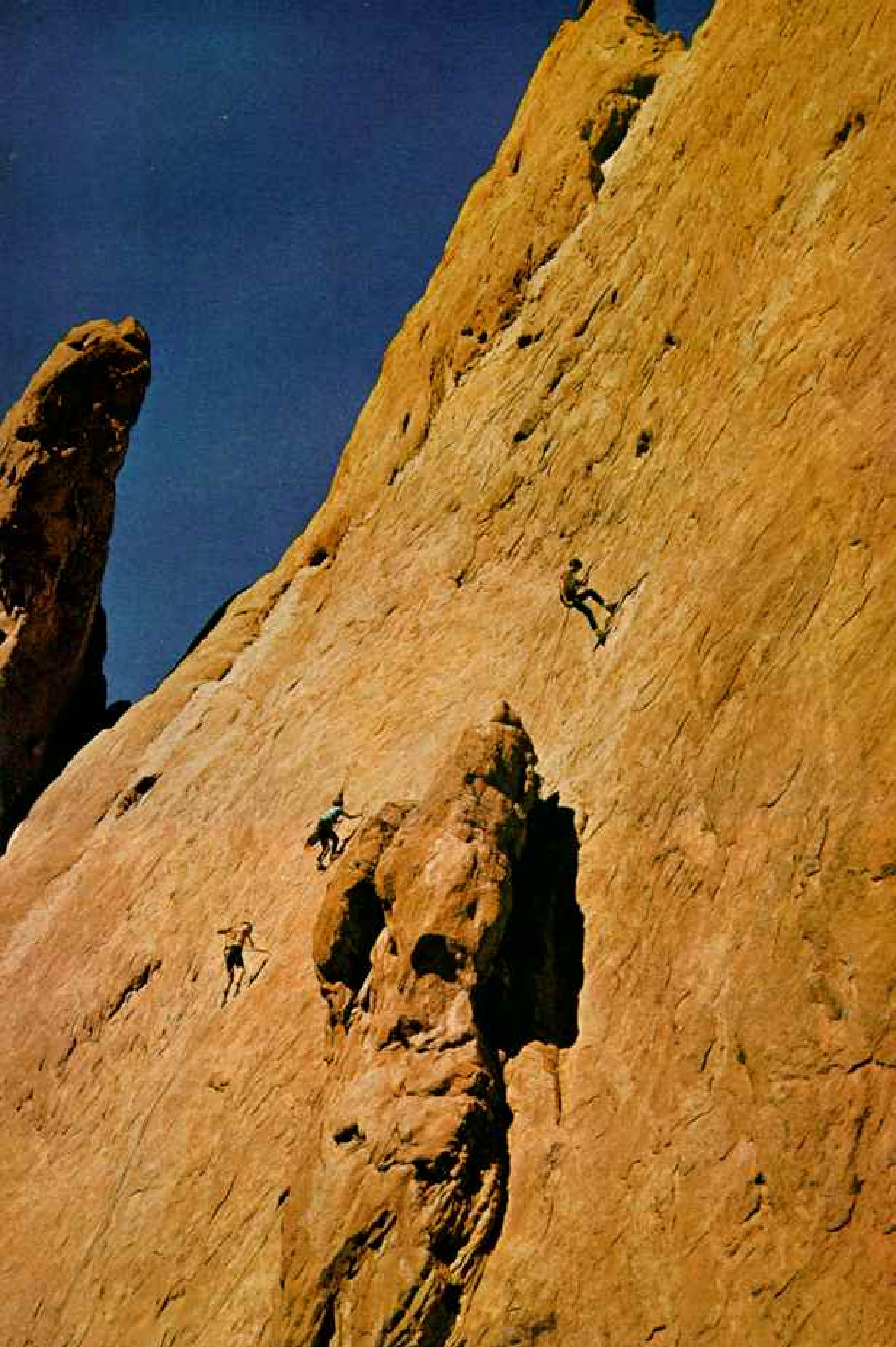
Since it opened in 1918, the Broadmoor has grown into a resort and sports mecca sprawled over 5,000 acres, including two championship golf courses, swimming pools, tennis courts, stables, skeet and trap ranges, ski slopes, and a little cog railway leading up to the Cheyenne Mountain Zoological Park—for its modest size, one of the Nation's finest zoos.

To me the Broadmoor's charm lies in an improbable mixture of Edwardian elegance and Western informality—*haute cuisine* in the plush Penrose Room, hot dogs at a rodeo in Penrose Stadium behind the pinkish stucco hotel. Kings and presidents have felt at ease here—as do 50,000 lesser guests a year.

The Broadmoor is the child of the late Spencer Penrose, who, with his partner Charles L. Tutt, made millions in real estate and mining. Penrose was a wealthy world traveler with a fondness for good hotels, good horses, and an occasional touch of showmanship.

He once acquired a circus elephant for the hotel grounds. He changed her name from Tessie to Empress of India, fostering a rumor he had started himself that she was a personal gift from the "Maharaja of Nagapur."

On my visit in late February, I watched the 1969 World Figure Skating Championships on the shining ice of the Broadmoor World Arena. Among skaters from 15 countries, a



petite East German blonde, Gabriele Seyfert, won the women's title; a Detroit youth, Tim Wood, the men's.

Outside, far into the night, skiers schussed down the floodlit swath of Ski Broadmoor on machine-made snow. As usual, the Western Slope was getting most of the moisture. Next morning I headed my car for Aspen—the heart of Colorado's ski country.

Plaster Casts Abound in Aspen

Nowhere in the United States can you find more ski lifts (30), more miles of slope and trail (200), or more plaster casts than in the mountains around Aspen.

Dr. Robert L. Swearingen, young orthopedic surgeon whose office is conveniently located at the foot of Aspen Mountain, gave me the previous season's casualty figures: 1,757 skiing patients treated at Aspen Valley Hospital; 545 casts applied—473 of them to fractures of the tibia or fibula, the long bones between knee and foot. "This year will be even bigger," he said cheerily.

I wondered why skiers I'd seen limping around Aspen seemed to take it so lightly.

"I think there's a certain camaraderie involved," the doctor replied. "Then, too, in addition to some of the finest orthopedic facilities in the country, our hospital has some of the prettiest nurses. We get 15 applicants for every nursing vacancy, and we choose them carefully."

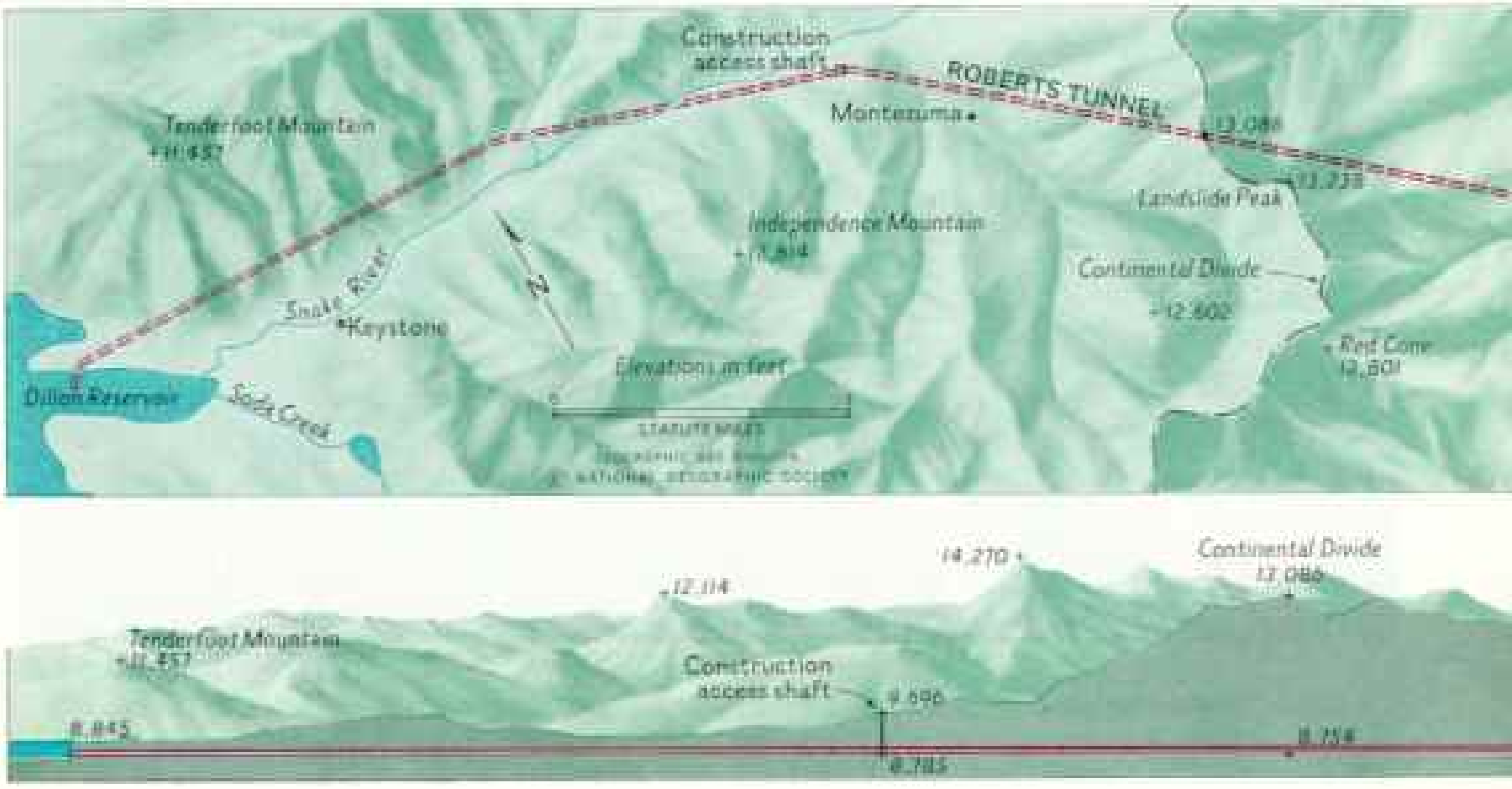
He went on to a more serious point. "I suppose I could be practicing in a plush paneled office somewhere. But here in Aspen there's an air of . . . of freedom that I enjoy. Many other people do, too."

Perhaps that air survives from the rip-roaring 1890's, when a mine at Aspen yielded a silver nugget weighing more than a ton. While you can still find the architecture of that period, much of it now houses fine restaurants, ski shops, and boutiques, flanked by modern apartments and lodges.

Similar modernity pervades the area's newest, sleekest resort, nearby Snowmass-at-Aspen. This self-contained village, with 50 miles of ski trails and lifts capable of serving 8,500 skiers per hour, opened in late 1967. Its planners envision it a dozen years from now as the Nation's largest ski resort, with five

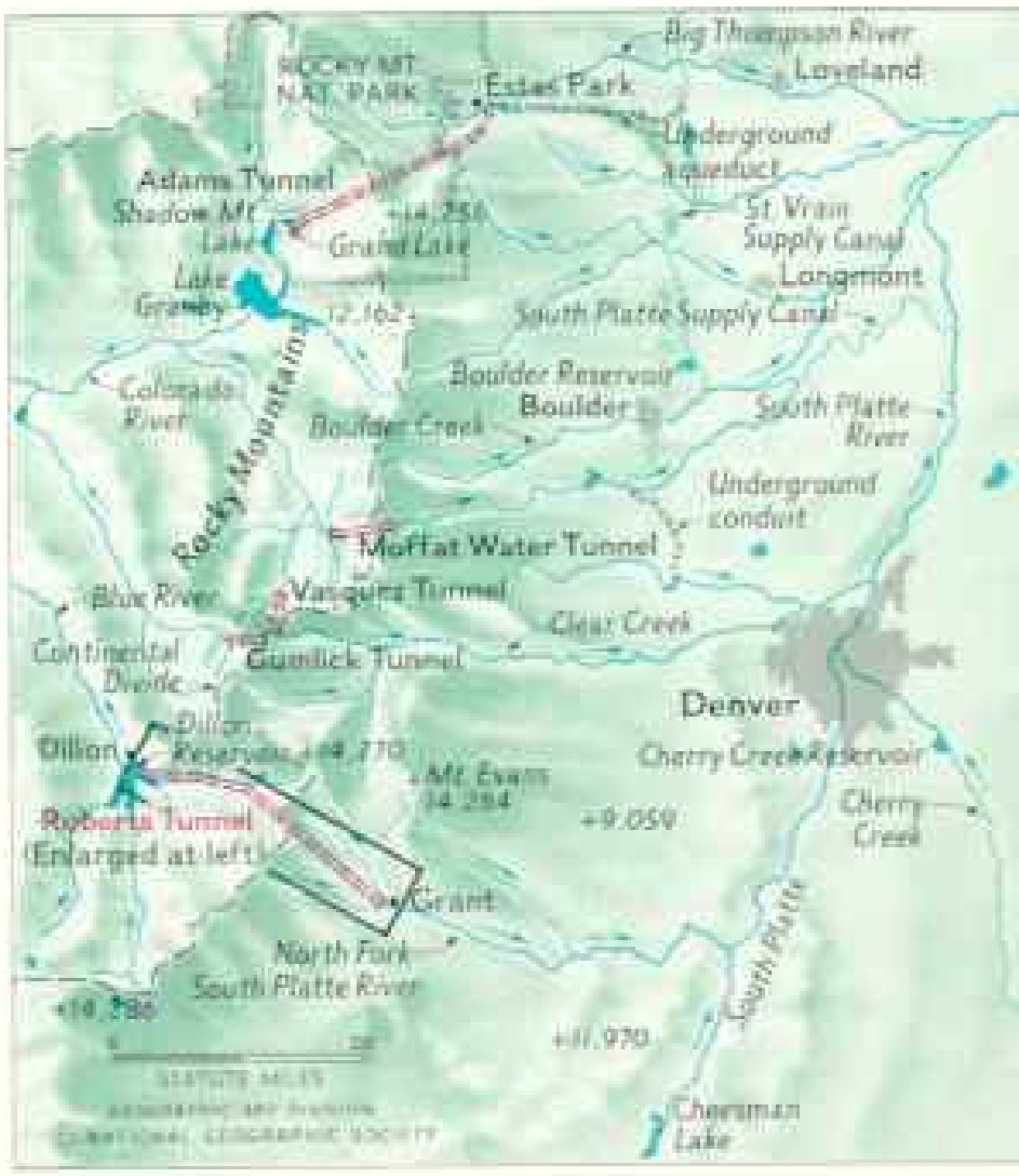
Ramparts of red sandstone thrust heavenward in the Garden of the Gods, a 949-acre city park west of Colorado Springs. "The weirdest of places . . . rocks of every conceivable and inconceivable shape and size," wrote Colorado author Helen Hunt Jackson in 1878, ". . . all motionless and silent, with a strange look of having been just stopped and held back in the very climax of some supernatural catastrophe." Climbers on the Garden's Gateway Rocks (left) scale a sheer face.

Racing sloops beat to windward shortly after the start of the summer regatta on Grand Lake (map, opposite). Winner of the annual August competition takes home the Lipton Cup, donated by the famed British yachtsman and tea magnate after a visit here in 1912. The glacial lake, Colorado's



Roberts Tunnel, 23.3 miles long, bores through the Rockies to feed fresh water from Dillon Reservoir to Denver. Vertical view traces the path of the big pipe—10¾ feet in diameter—which gradually descends 178 feet in its transmountain run. The dogleg enabled builders to bypass a treacherous

largest natural body of water, is only 1½ miles long and less than a mile wide. At 8,367 feet, it claims the Nation's highest yacht anchorage. Six species of trout in its depths attract hordes of fishermen. In summer the population of Grand Lake Village grows from about 200 to several thousand.



fault in the rocky depths. Map (right) shows other vital tubes that pierce the Continental Divide, carrying water to the eastern side.

Vail Village, designed by skiers for skiers, nestles in a valley of the Gore Range, 70 miles west of Denver. Though only seven years old, the hamlet of alpine chalets and inns has become an internationally acclaimed year-round resort. Nearly 11,000 skiers an hour can ride Vail's many lifts to swoop down its 10 square miles of ski slopes. Trailing powdery roostertails, eight experts weave through timberline spruce (right).

EXTACHROME (BELOW) AND KODACHROME BY DEAN CONGER © N.G.S.

villages and 250 miles of trails—at a total cost approaching a hundred million dollars.

The staff of some 50 ski instructors at Snowmass is headed by Stein Eriksen, a Norwegian former Olympic champion who is widely regarded as the most graceful human on skis. I intercepted this blond and busy Viking between a long-distance phone call and a helicopter waiting to fly him to a nearby peak to make a film.

"What's so special about Colorado snow?" I asked.

"Two things," he replied. "The snow that crystallizes in the cold air high over the Rockies has a lot of air in it. It's light and dry, and stays that way. And here you don't get the . . ." he groped unsuccessfully for a word in English, ". . . the *foehn*—the warm wind that turns a slope to ice. You can ski in your shirt sleeves on a warm day; still the snow stays dry—perfect for skiing."

Spring and Culture Bloom Together

Clomping ski boots retreat before advancing April, and the silver-green leaves that give the town its name flutter full-blown into June. Aspen shifts smoothly into summer gear.

When I drove through in July, a sprinkling of barefoot, bearded youths and lank-haired lasses lounged in Aspen's doorways, absorbing its air of freedom. The same atmosphere also attracts talented writers, musicians, and artists by the score, to a summer music festival and cultural potpourri (pages 192-3).

Each summer, too, business executives and educators meet at the Aspen Institute for Humanistic Studies in two-week seminars ranging from Plato to Thoreau. In the institute's hexagonal seminar room I listened to 15 sport-shirted participants thoughtfully chewing over Arthur Miller's classic *Death of a Salesman*. Was Willy Loman, the tragic central figure, in any way successful? What *is* success, anyway? For two hours they pondered and propounded.

An insurance executive came up with an answer that met approval around the table. "Success is two weeks in Aspen," he declared, and they adjourned to play volleyball, or to fish for rainbows in the Roaring Fork River.

I followed that river to its juncture with the Colorado at Glenwood Springs, and turned westward to the town of Rifle—for decades the world's center of shale oil inactivity.

In this northwestern segment of Colorado —and in neighboring Utah and Wyoming— lie the world's most extensive deposits of oil shale. Beds of this soft grayish rock, as much as several thousand feet thick, cover 17,000 square miles.

"Oil shale" is actually a misnomer. The rock is a marlstone, containing a waxy hydrocarbon called kerogen. When crushed shale is heated to 900° F., the kerogen breaks down into a thick refinable liquid—as much as 80 gallons per ton of rock. Estimates of the oil locked in the vast Green River formation range up to two trillion barrels—far exceeding all other known petroleum reserves.

In 1968 the U. S. Department of the Interior, which controls the richest shale land, offered test leases to oil companies, but their bids, disappointingly small, were rejected.

"Just to get started might cost a company 100, maybe 150 million dollars," said Malcolm D. Smith, who heads a U. S. Bureau of Mines maintenance team at the bureau's pilot plant near Rifle. "Then there's the problem of waste disposal. After you extract the oil from a cubic yard of rock, you've still got roughly a cubic yard of spent shale on your hands."

The bureau's now-idle pilot plant, a maze of silvery pipes, retorts, and refining units, has long since proved that oil can be wrung from shale almost as cheaply as petroleum can be pumped from the earth.

All Colorado awaits the erasure of that word "almost." It could happen with Project Bronco—a 50-kiloton underground nuclear blast planned in Rio Blanco County by the Atomic Energy Commission, the Interior Department, and a group of private companies. If the rock shatters properly, attempts will be made to heat it—perhaps by burning part of the fragmented shale itself—thus releasing the oil, to be pumped to the surface.

Whether or not Project Bronco succeeds, Mr. Smith remains basically optimistic. "Whenever this country needs the oil badly enough, we'll have it. The money will come. Everything will fall into place."

Some Coloradans envision a million-barrel-a-day oil industry on these raw mesas by 1975. A city of 350,000—second in size only to Denver—has already been designed for the Colorado River Valley, near Rifle.

High World of Hungry Trout

I drove down the valley southwestward to Grand Mesa, a spectacular plateau 30 miles long and nearly two miles above sea level, separating the Gunnison and Colorado Rivers.

More than 200 mirror-like lakes punctuate the mesa's flower-strewn meadows and thick forest of Engelmann spruce. In mid-July snowbanks linger under sheltering boughs; their trickle of icy water keeps the lakes chilled— and the trout lively—throughout the summer.

I camped on Grand Mesa for several days, to fish half a dozen of its trout-filled lakes. Morning and evening I cast wet flies, dry flies, spinners, and worms—and caught and released rainbows until the sport palled. Once, when I had fished without result for an hour, I remembered the tiny lintlike creations Mike McRaney had given me at the Air Force Academy. I tied one on, and caught a fish on each of three casts.

I ate crisp, fried trout for breakfast, lunch, and dinner. It was time to vary the menu—so I headed for Grand Junction and a thick sirloin of tender Colorado beef.

Fireworks explode as Aspen celebrates its January Winterskol festival in Fourth of July fashion. Bursting bombs light Little Nell, one of 47 ski runs rising above the town. In the late 1800's miners clawed some $122,000,000 in silver from these mountains, and Aspen became a six-newspaper boom city of 15,000. But when silver prices plummeted and mines closed, the population shrank to 500. Since World War II, Aspen has discovered a second bonanza —skiing—and its citizenry swells from a permanent 3,000 to 15,000 in the snow season.

Aspen's summer side: Sunday concertgoers in a 1,500-seat tent amphitheater enjoy Bartok's *The Wooden Prince* ballet suite, performed by students attending the annual music festival.

And its wintry face: Sun-bronzed skier revels in Aspen's light, dry snow and challenging runs.

In the 1950's Grand Junction, the Western Slope's biggest city, was the hub of a great uranium rush. Today a quieter but even bigger boom is in progress.

"If you're looking for a prospector with a burro and Geiger counter, you're about 15 years too late," said Neilsen B. O'Rear, an Atomic Energy Commission official. "It's big-time, sophisticated exploration now—deep drilling and aerial reconnaissance."

By 1958 defense needs had been met, but no commercial market had yet emerged for U_3O_8—uranium oxide, or "yellowcake." Within a decade, however, 13 nuclear power plants were in operation, and 87 more were being built or planned. To fuel these reactors, a new uranium rush is underway.

Near the Union Carbide mill town of Uravan (URAnium + VANadium), a truck driver hauling a 30-ton load of uranium ore offered me a lump of crumbly gray rock, streaked with yellow, for my collection. "We used to work 10 days on and 2 days off," he told me. "Now we're working no days off."

EXTACHROME (ABOVE) BY C. DAVID HISER; KODACHROME BY DICK DURRANCE II; © N.G.S.

I pushed southeast toward the crumpled mass of the San Juan Mountains—another of Colorado's mineral storehouses that disgorged fortunes, went through boom-and-bust cycles, and now beckon tourists in bouncing jeeps to their ghost towns and spectacular vistas (pages 198-9).

Towns like Telluride and Ouray, with fewer than a thousand permanent residents each, perch at the heads of high canyons. False-fronted stores line their main streets, and clapboard houses wear the wooden gingerbread of another time.

Near the clear, cold headwaters of the Rio Grande, a local newspaper editor in 1891 described his town thus:

Here meek and mild-eyed burros
On mineral mountains feed.
It's day all day in the daytime,
And there is no night in Creede.

During those raucous nightless days, Creede saloonkeeper Bob Ford, who had shot Jesse James, met his own abrupt end by a bullet.

I expected to find Creede drowsing beside the spoil banks of a silver feast that finished with the Panic of '93. Instead the town was buzzing over a new strike. Mineral County Tax Assessor W. G. Schultz told me that a decade ago scarcely half a dozen claims were filed all year. "Last year we recorded more than 600 of them," Bill said.

The excitement centers on a grassy slope where Homestake Mining Company has built a new mill beside a fresh tunnel into the hillside. "They say there's a vein of silver in there 54 feet wide!" a Creede storekeeper told me.

Homestake's youthful mine superintendent, Bud Ames, neither confirmed nor denied it. But he showed me ore samples, gray-black and glistening with silver and lead. And he handed me a recent news clipping predicting an output of a million ounces of silver a year. "We think that's a low estimate," he said.

The days grow longer again in Creede.

Each year more and more vacationists discover this southwestern corner of Colorado, and few drive through it without visiting two

man-made wonders wrought more than six centuries apart: the Durango-to-Silverton narrow-gauge railway, and the brooding cliff dwellings of Mesa Verde National Park.

For three decades after the first locomotive arrived in Denver in 1870, daring railroad builders pushed narrow-gauge tracks into Colorado's canyons, across tumbling rivers and over high passes—wherever miners needed supplies and had ore to ship out.

One lively specter remains of this colorful past—the Denver & Rio Grande Western's "Silverton," which last summer carried 90,724 passengers up the wild Animas River (pages 200-201). The 45-mile cliff-hanging ride delights children and aging railroad buffs alike. The stubby little steam locomotive chuffs and tootles up the grade, spewing coal smoke thick as wool, and wheel flanges sing around tight canyon curves.

I sat in an open wooden coach beside a retired depot agent from Wisconsin, who drew out a fat gold watch as we approached the old mining town of Silverton. "Right on time," he said with a smile. And as the hooting whistle and the hiss of steam proclaimed our arrival, he touched a knuckle to a glistening eye—irritated, I suppose, by a cinder.

"Man," he said softly, "That's music!"

Some 40 miles west of Durango a new miniature railway may be built through the stunted forests atop Wetherill Mesa, one of the high, flattened fingers that poke among the canyons of Mesa Verde National Park.

The idea of a mini-train is being considered by Park Service officials to protect Mesa Verde's fragile environment from human erosion. Nearly 450,000 visitors a year pour onto Chapin Mesa to troop through famous Cliff Palace and other spectacular dwellings (page 169). The Park Service hopes to relieve this pressure by opening similar sites on nearby Wetherill Mesa sometime in 1971.

Aided by National Geographic Society research grants of more than $300,000, archeologists spent five years, beginning in 1958,

Fence-riding cowboys, awaiting their turn to perform, cheer a buddy as he bulldogs a steer amid a cloud of dust at the Ouray County Fair and Rodeo in Ridgway. Members of the Rodeo Cowboys Association, they travel from coast to coast to compete for prizes in bareback bronc riding, saddle-bronc bucking, calf roping, steer wrestling, and Brahman bull riding. Last year's top winner earned nearly $50,000. Dangerous though their sport appears, the cowboys suffer few injuries.

excavating Wetherill Mesa ruins like Long House, Mug House, and Step House.*

The project, one of the most thorough ever undertaken in the U. S., shed new light on the Anasazi—the "Old Ones"—who occupied this region for more than a millennium, then vanished about A.D. 1300. The research supports the theory that prolonged drought, much like our own Dust Bowl days, drove the Indians from the mesas.

A new problem now threatens their dwellings, clustered under overhanging cliffs.

"Almost every afternoon the windows in this office rattle, and pictures start dancing on the walls," Park Superintendent Meredith M. Guillet told me. A landslide in February 1968 had cascaded across the entrance road near Point Lookout. Sonic boom—the same phenomenon that had struck the Air Force Academy—was the suspect.

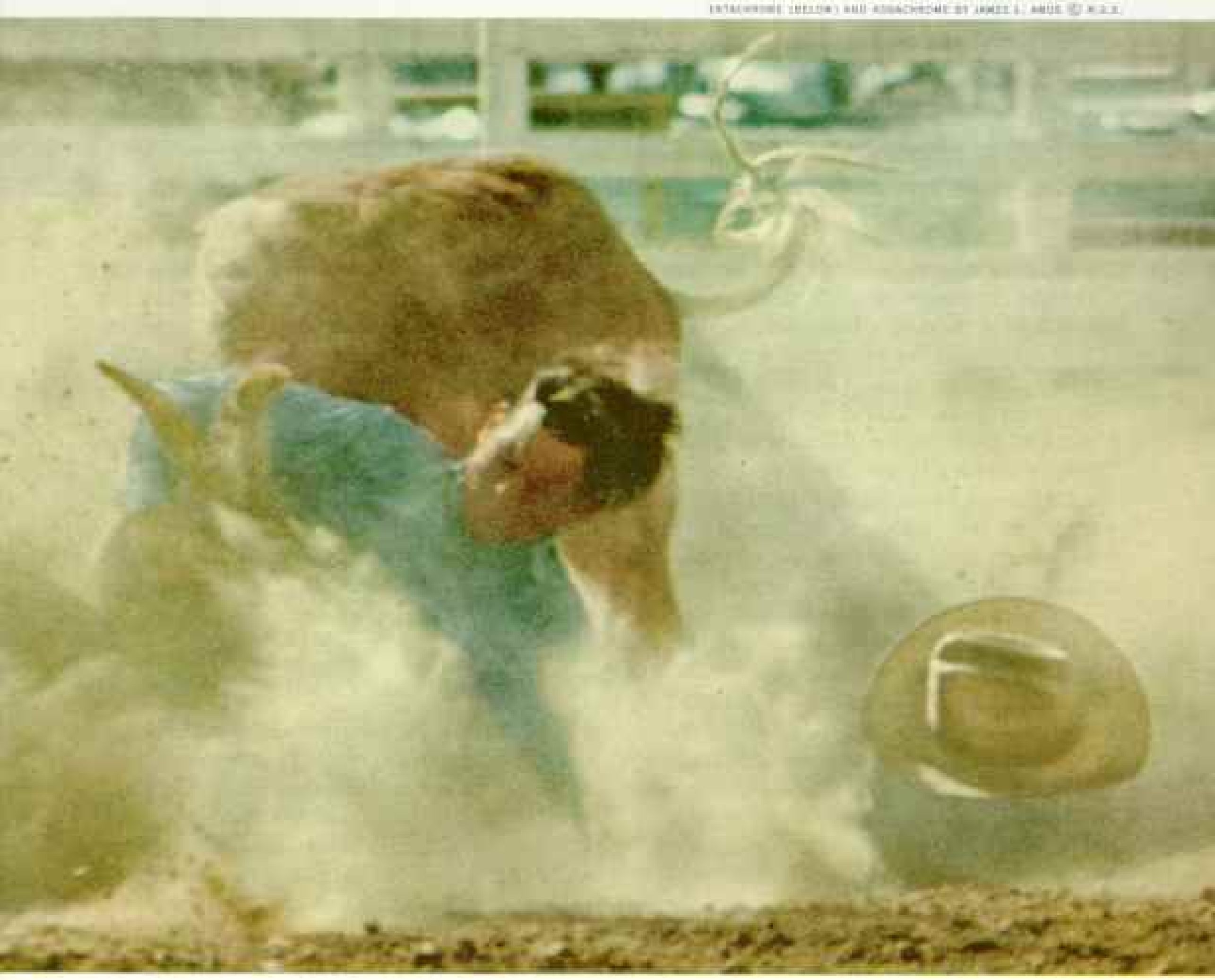
The Park Service and the Federal Aviation Agency have installed a recorder at Spruce Tree House to determine the intensity and frequency of the shocks. With this information, the offending air traffic may be rerouted away from the park.

*See "Solving the Riddles of Wetherill Mesa," by Douglas Osborne, GEOGRAPHIC, February 1964.

Eastern Plains Grow Crops and Cattle

Blue-gray rain clouds cloaked the crests of the Sangre de Cristo Mountains ahead when I reached the rich San Luis Valley in southern Colorado. I passed miles of neatly ditched fields of potatoes and sun-burnished barley and windrows of drying hay. I drove on east to the High Plains, where the land lay parched as usual. Except for irrigated fields along the South Platte and Arkansas Rivers, this eastern third of the state is dry-farming country, where wheat is coaxed from thirsty soil and ranchers' windmills ceaselessly seek vagrant breezes to keep the stock tanks filled.

Some 2½ million cattle graze Colorado's plains and high mountain valleys and national forests, accounting for 60 percent of the



state's agricultural income. The herds earn Colorado ranchers and feed-lot operators more than a third of a billion dollars a year.

"And most of the producers are operating in the red, going about 2 percent deeper into debt every year," David G. Rice, Jr., of the Colorado Cattlemen's Association told me. "What's keeping them alive is optimism, and the increasing value of their land."

Most of the cattle finish their growth in feed lots, which fatten them to butchering weight—usually 900 to 1,200 pounds.

Just outside Greeley, amid fields of sugar beets, alfalfa, and corn, I stopped at the Monfort Feed Lots, the state's biggest. It is so big, in fact, that its cattle are fed scientifically prescribed rations of chopped ensilage, hot corn flakes, and other nourishing ingredients dispensed by a pretty girl at a console, with the aid of a computer.

Dr. Duane Flack, Monfort's chief veterinarian, showed me around. Dodging an endless shuttle of feed trucks hustling between silos and cattle pens, we climbed an observation tower overlooking a sea of sirloin on the hoof. Each truck poured its load into the troughs without stopping and circled back for more. The girl at the control panel inserted punch cards into an electronic card-reader, which directed automated silos to reload the trucks with the proper formula and weight of feed for each pen of cattle. Every week the cards are run through a computer to analyze costs, consumption, weight gain, and other factors vital to profit margin.

"You're looking at 90,000 cattle," Dr. Flack said. "We keep them here for an average of 150 days, and they each gain about 2¾ pounds a day."

Meeker Massacre Sparked by Plow

Tucked among the impressive statistics, I found an interesting example of symbiosis—a mutually fruitful relationship. Each year Weld County farmers raise 10,000 acres of corn and 2,500 acres of alfalfa to fatten Monfort cattle. In turn the feed lot furnishes for their fields some 200,000 tons of manure.

The exchange no doubt helps keep this agricultural county one of the Nation's 10

PHOTOGRAPHED BY ANDY GOLDSMITH (ABOVE) AND JAMES L. AMOS © N.G.S.

most productive. Its seat, Greeley, a sedate city of 35,000, was founded by a group of colonists headed by Nathan Meeker, agricultural editor of Horace Greeley's *New York Tribune*. They reasoned, prophetically, that riches from the plains would one day overshadow mining.

Nathan Meeker knew the soil, but he didn't know Indians. He moved west to become Indian agent at the White River Agency (now Meeker, Colorado), and tried to make farmers of the Utes, hunters by tradition. In 1879, after he ordered their cherished race track plowed, they rebelled. After the smoke of the uprising had cleared, Nathan Meeker, 9 of his employees, and 12 cavalrymen sent to their rescue lay dead.

Today some 1,800 Utes dwell peaceably on two reservations in southwestern Colorado and neighboring New Mexico. Fittingly, their great chief, Ouray, sleeps among

Liquid pinwheels on a quarter-mile-long arm irrigate corn near Holyoke. The huge sprinkler, supported by towers that roll on motor-driven wheels, makes a complete circle every three to four days. Fields thus watered resemble great green lily pads from the air (below). Parched eastern Colorado, long irrigated by streams that often ran dry, today gets additional water via tunnels from the Western Slope (map, page 187).

"WE DRIVE . . . YOU LOOK" *is the sensible slogan of a jeep tour that takes passengers up harrowing switchback roads in the San Juan Mountains to mines that once produced more than $300,000,000 in gold and silver. At the ruins of Black Bear Mine, visitors gaze down on the town of Telluride, dubbed "To Hell You Ride" by early prospectors. Actually, its name derived from the tellurous ore found here.*


476
Rio Grande

them near the sun-splashed little town of Ignacio. Ouray read the handwriting on the wall and repeatedly stepped aside as white men, dazzled by Colorado's riches, struck bonanzas, broke treaties, and built boomtowns.

Eerie Lights Await Explanation

I recall quite vividly the last such town I visited before leaving Colorado—a place called Silver Cliff in the Wet Mountain Valley west of Pueblo. Today it counts about 110 year-round residents, where once 5,000 lived.

"Be sure to get there after dark," a fellow camper from Kansas had told me, "and drive out to the old cemetery. You'll see something mighty strange."

We had bounced about a mile out of Silver Cliff across pitch-black prairie when Bill Kleine, who runs the local campground, told me to pull up and switch my headlights off.

"Do you believe it?" I asked him. "About the lights in the graveyard?"

"I've seen them plenty of times. This is a good night for them—overcast, no moon."

We climbed out beside the old burying ground, and for long minutes I strained to see something, anything. Slowly, vague outlines of grave markers emerged, in ragged rows.

"There." Bill's voice was quiet, almost a whisper. "And over there!"

I saw them too. Dim, round spots of blue-white light glowed ethereally among the graves. I found another, and stepped forward for a better look. They vanished.

For 15 minutes we walked about the place, pursuing one will-o'-the-wisp, then another. I aimed my flashlight at one eerie glow and switched it on. It revealed only a tombstone.

"Some people think it's phosphorescence," said Bill. "You know, from decaying wood in the crosses or something. Others say it's just reflections from the lights of Silver Cliff, or Westcliffe down there."

I looked back at the two towns. Those small clusters of lights seemed far too faint to reflect way out here. Still, it was possible.

"Only trouble is," said Bill, "my wife and I have both seen these lights when the fog was so thick you couldn't see the towns at all."

No doubt someone, someday, will prove there's nothing at all supernatural in the luminous manifestations of Silver Cliff's cemetery. And I will feel a tinge of disappointment.

I prefer to believe they are the restless stirrings of the ghosts of Colorado, eager to get their Centennial State on with its pressing business: seeking out and working the bonanzas of a second glorious century. THE END

KODACHROMES BY JAMES L. AMOS © N.G.S.

"The Little Engine That Could." Like the doughty locomotive in the children's classic, the narrow-gauge Durango-to-Silverton train chugs up the Animas River Valley, letting no crag or canyon stay its way. Making a 45-mile, 3½-hour journey to the yesteryear of lusty frontier days, this line of the Denver & Rio Grande Western Railroad runs through the heart of the two-million-acre San Juan National Forest, Colorado's largest. Laid down in 1882, the three-foot-wide track carried out millions in metals mined near Silverton, today so little changed that film companies often use it as a set.

Keyboard wizardry of ragtime piano player Max Morath keeps guests tapping their toes at the Strater Hotel in Durango, where the flavor of the Old West still lingers.

Locusts: "Teeth of the Wind"

By ROBERT A. M. CONLEY

National Geographic Staff

Photographs by GIANNI TORTOLI

THE FIRST STIRRING was a mile away from Khalil's patch of bulrush millet when he noticed it. *"Sirb!"* he called to me in Arabic. "A swarm . . . among the dunes!"

Through the glassy waves of heat rising off the Sudanese desert, I could see what he meant. A hint of grayness slid along the sand, vague as a touch of smoke. Then, as we watched, it gathered into a wisp and began to spill over the dune slopes. Once it reached the stubble of scrub growth below, the wisp quickened and spread in the wind until it became a cloud of locusts three miles wide that swept straight toward us.

"Yalla!" Khalil shouted. "Let's go!"

We sprinted across to his dried-mud house, picked up fistfuls of reeds from a sheaf of roof thatching, and ducked back into the millet plants.

"My father knew these invaders before me," he said. "He called them the 'teeth of the wind.'" And with that, the cloud swirled into us. Flying locusts the size of index fingers bounced off my face, tangled in my hair, and grabbed at my shirt with twitchy legs. Wherever I turned, the swarm glinted in the sun in crystalline flecks that shifted and slid from brown to gold to pink like tumbling bits of mica.

"Bandits! Beggars!" I heard Khalil cry in the fluttering confusion. I yelled too, but my voice was lost in the rush of wings.

We fought for an hour to save his crop—a dozen or so wobbly furrows scratched in the bush—about 10 miles west of Khartoum, Sudan's capital. We slashed at the intruders with the reeds; we found two castaway cans and banged sticks against them; we ran up and down the rows throwing stones; and in the end, in the 110° heat, we knew we had lost.

COURTESY SKIRA ART BOOKS, GENEVA

Age-old adversary of man, the locust came as a scourge upon the land before recorded time. One of the earliest depictions shows the insect perched on a papyrus blossom in the tomb of Haremhab, Pharaoh of Egypt in the 15th century B.C.

. . . and when it was morning, the east wind brought the locusts.

EXODUS 10:13

Like the plague visited upon Egypt, desert locusts sweep across Keren, Ethiopia (pages 218-19). Children, unmindful of disaster, chase the insects.

A living tumbleweed, the swarm rolls onward. The forward edge alights to feed, then as others pass overhead, those left behind rise up and rejoin the host.

Soaking rains beginning in 1967 gave birth to a new plague of *Schistocerca gregaria*, the fifth in the past 60 years. During 1968 in northern Africa and southwestern Asia, hordes of eggs hatched in the moist sands, raising once again a threat to nearly 11 million square miles (map, page 212). Isolated desert scouts and dedicated scientists banded together to fight the enemy.

All around us locusts struggled for room on the plants; they pushed, kicked, and shoved each other, semaphoring furiously with excited antennae. They ravaged the ears on top. They tugged at the leaves. They gnawed at the stems with such frenzy that we could hear the faint sound of thousands of tiny jaws grinding and chewing, as if someone were scraping a carrot.

"Come, my friend," Khalil finally said. "We can do no more. These *jarad*, these locusts, they laugh at us."

I had met Khalil one morning last September while out scouting for locust swarms with an agricultural officer, who had gone on farther north. Now Khalil's patch was debris—shredded stalks, nibbled seed heads, tattered leaves. Yet, as we stared at the ruin, a sequence of events had started that would bring an international detection system to bear on the creatures we had tried to fight.

Alert Room Keeps Track of Swarms

A locust scout already had located the swarm, tracked its direction, and radioed the data to the Ministry of Agriculture in Khartoum. There technicians would log the course on an "active" sheet and send a spray plane

2 1/2 TIMES LIFE-SIZE

Close-up of the culprit: With serrated jaws rasping from side to side, adults daily eat the equivalent of their weight, .04 to .09 of an ounce. Yet they are capable of living four days without feeding, surviving on stored fat. Typical of the countless billions that impoverish African and Asian farmers, this voracious eater feasts on a privet leaf in a London laboratory for locust research.

Battle is lost but the loser fights on. Naseradia Jemi, an Ethiopian farmer, swats at locusts devouring his millet crop. Only a few kernels remain on the seed heads; stalks and leaves go next. In 1958 Ethiopia alone lost 167,000 tons of grain, enough to feed more than a million of her people for a year.

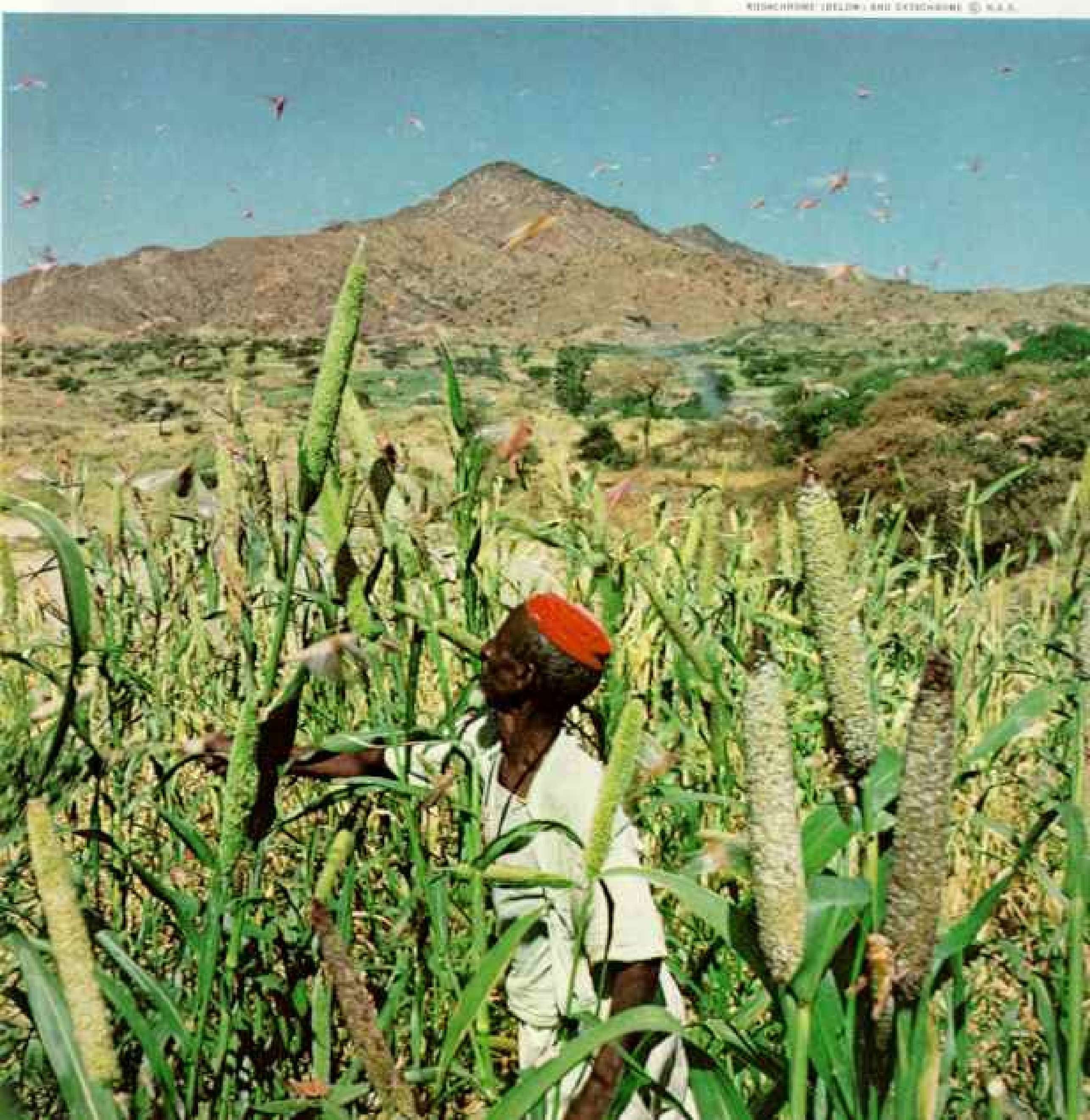
to the area. But more, they would relay word of the sighting to a British Government unit, the Anti-Locust Research Centre, which operates a plague "alert room" in London for the threatened countries.

In that alert room the week before, I had watched scientists piece together a portrait of an emerging plague. Their maps showed hundreds of such sightings from outbreak points between the Atlantic and the Himalayas (map, page 212).

It was a portrait, in fact, of an insect world gone mad. The central figure, the desert locust *(Schistocerca gregaria)*—probably the creature that caused the Biblical plagues—is capable of awesome multiplication. It can invade nearly 11 million square miles, an area that includes roughly 20 percent of the world's land surface, all or parts of 65 countries, and one out of every 10 persons alive today.*

"We have locust swarms from Mauritania to India, and that's a full-blown plague in any language," one scientist told me. "Good soaking rains in Africa and the Arabian Peninsula in 1967 set the stage for the outbreak. By 1968, with still more rains, moist soil for the

*See "Report From the Locust Wars," by Tony and Dickey Chapelle, NATIONAL GEOGRAPHIC, April 1953.



eggs, and fresh bush vegetation for the offspring, the locust population exploded."

The confirmation was spread before us on maps that reached from ceiling to floor. Clusters of red, green, and black tabs in different shapes marked every known locust sighting —triangles for swarms, squares for smaller groups, and circles for marching infants.

Starting at the Red Sea, some clusters ran inland along the southern edge of the Sahara to Africa's west coast; others stretched across the Arabian Peninsula and the Persian Gulf into Iran, Pakistan, and India.

By plotting those swarm sightings at every point they occur, the London scientists develop a pattern of locust movement that no single country in the threatened area can see. From that pattern, they draw up forecasts of probable flight directions and dispatch invasion alerts if necessary.

"We watch wind directions particularly," Dr. Peter Haskell, the British center's director, explained. "Locusts have no maps, no homing instinct, nor much control over where they go. About all they can do is hitch a ride on the passing winds and hope for the best.

"That's why it is difficult to tell how much damage they may do. The wind can carry

Secret of the locusts

WHERE DO THEY ALL come from? The centuries-old question posed by a locust swarm was answered in 1921 by Sir Boris Uvarov (right). He discovered that one of the familiar green grasshoppers of the African and Asian bush is really the ravenous locust in another guise. When repeated rains dampen the desert sands, thousands of eggs hatch. The hoppers constantly touch one another, triggering a change of behavior and color; they seek each other's company and turn yellow, black, and red.

In the Anti-Locust Research Centre in London, founded by Sir Boris, an experiment offers proof. A fan keeps tiny threads swirling inside a jar (left). As the threads brush a grasshopper, simulating the touch of its kin, it slowly changes color.

A laboratory encounter (below) between examples of the two guises shows the differences in coloring. Sir Boris, knighted in 1961 for his research, is completing volume two of his monumental *Grasshoppers and Locusts*.

PAINTINGS BY JOHN GIELGUD © N.G.S.

them into crops, it can whip them off in another direction at the last moment, or it can push them out to sea."

Should the pattern seem especially menacing, the center notifies the United Nations Food and Agriculture Organization, the agency most concerned with protecting and improving farm production in the world's developing countries.

"Thanks to the alerts," an FAO official told me later, "a country is rarely invaded by locusts nowadays without being warned in advance."

The FAO, from its Rome headquarters, acts as the strategic command for locust control, ready to send teams of specialists to whatever countries need them. It also helps sponsor the plague-warning service.

From the alert room Dr. Haskell led me down a corridor to the center's laboratory, where researchers have created a desert in miniature in the middle of London, with constant-temperature rooms, glass cages, sand, and heat lamps.

"We breed close to 500,000 locusts a year here to study their life cycle, their behavior, and their characteristics," said Dr. Peggy Ellis, a senior scientist.

London Researchers Develop Allergies

Intent figures moved about us in white smocks, rubber gloves, surgical masks, and face respirators. They handle so many locusts that they become allergic to them. In the main breeding room Dr. Ellis showed me the different stages of a locust's life displayed in a series of cages.

"Locusts normally live for four months,"

she said. "But they can slow their body processes and extend that life span to a year if the vegetation dries up or they're stranded in cold, mountainous areas."

We paused to watch a female prod the sandy bottom of one cage with her extendible abdomen to deposit her rice-size eggs (page 216). She eventually would produce about 200 in three layings. Farther on I saw wingless juveniles, known as "hoppers," shedding an outer layer of rigid, skeletal skin before growing into the newer layers underneath—a molt that they go through five times to reach adult size (page 217).

Desert locusts also are capable of a more profound change. They have two forms, and the ability to switch from one to the other in a way that suggests Dr. Jekyll and Mr. Hyde.

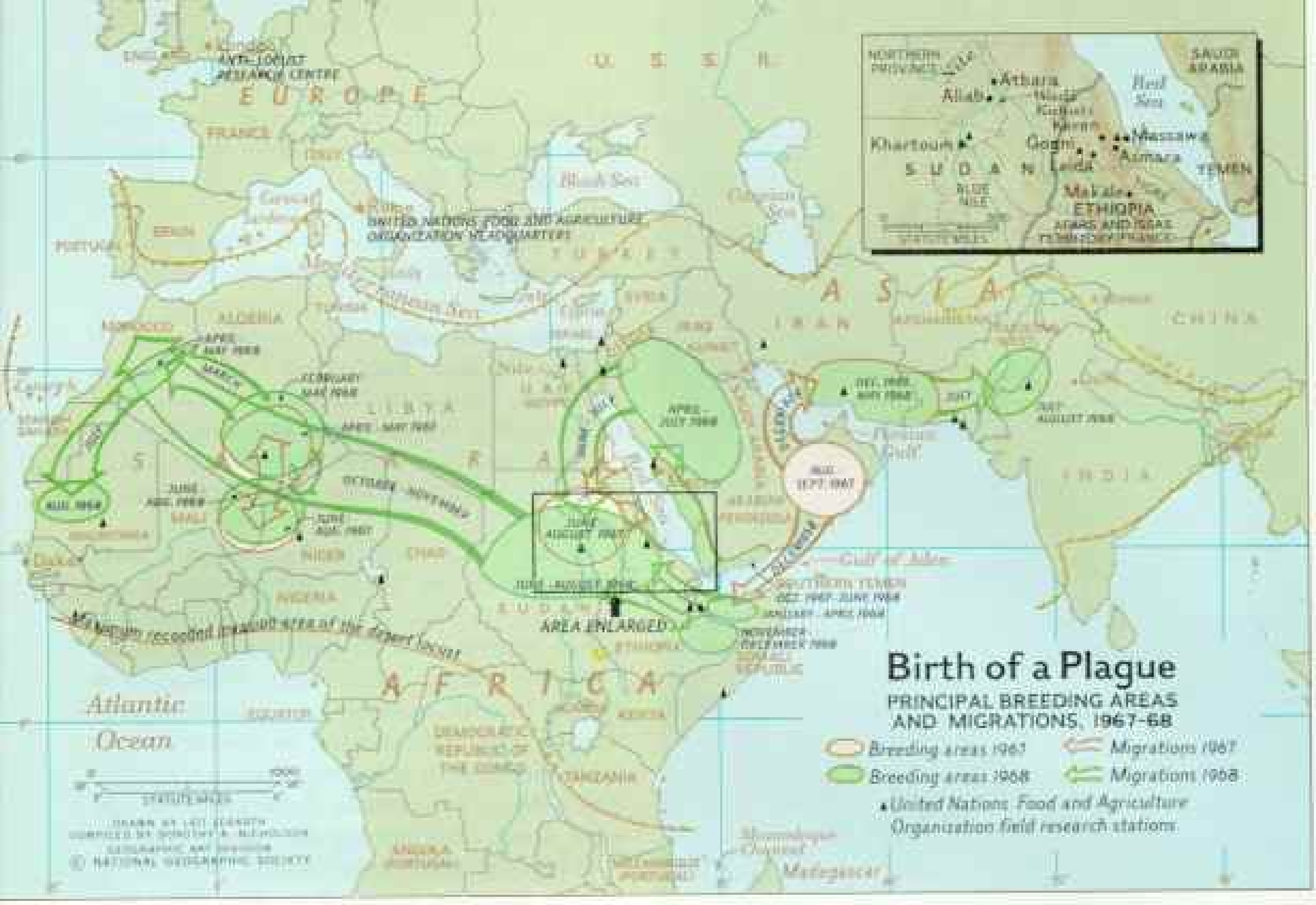
In dry years, when bush vegetation is sparse, locusts resemble green grasshoppers. They like to poke around by themselves for food and tend to stay away from each other. Their desire for solitude disperses them over wide areas, thus helping the species survive.

When the rains came in 1967 and the explosive breeding began, a curious thing happened to the locusts' manner and appearance. Crowded together, they became gregarious. Their color changed from green to black, yellow, and red. They turned into the voracious creatures that made up the threatening swarms of 1968.

That ability to change form was detected in 1921 by the founder of the center, Sir Boris Uvarov (page 209), and it answered one of the oldest questions about locusts: How did they vanish in some years and reappear in others?

Low-level raid attacks a swarm in an Ethiopian valley. Rotary atomizers on the wings disperse the insecticide. Oil mixed with the poison prevents evaporation in the hot sun or dilution by rain. It also aids penetration of the waxlike covering on the locusts' skin.

Tactical briefing: Author Conley and Abbebe Wordofa, chief pilot of the Desert Locust Control Organization for Eastern Africa, study a map before leaving Keren, Ethiopia, on a spraying mission. Locusts clogging the plane's oil cooler forced frequent returns to base.



"They didn't vanish, of course," Sir Boris told me. "They simply had a diabolical way of escaping attention. They changed back to the form resembling ordinary grasshoppers."

Whatever their appearance, locusts possess a remarkably effective sense of smell. John Moorhouse, one of the center's researchers, showed me how sharp it is by using a single blade of grass.

We stood at a sand-covered table about five feet long with a slight breeze from a fan blowing along it. A crush of 140 wingless juveniles basked at the far end.

"They tend to move downwind, even in the field, since that's the best location for picking up stray scents of food," John said.

He placed the blade of grass in front of the fan, and the hoppers reacted in an eyelash flick. One head perked up, and another. Then with a rush, they all turned, jumped, and scampered toward the grass.

The sight of those marching locusts, when I multiplied it in my imagination into the millions found in a plague, was unnerving. I thought of an Arabic verse that expressed the same fearsome potential. In it the locusts warn the Prophet Mohammed:

We are the Army of Allah,
We produce 99 eggs;
If the hundredth were complete,
We would consume the whole world
and all that is in it.

If those numbers are fateful, so is the locust's migration range. In a room next to John's, I watched another researcher, Michael Lambert, measure their flying ability in a transparent plexiglass wind tunnel.

He suspended an adult from a balance in the tunnel's air stream. When the adult felt the slight breeze, it opened its double set of wings—five inches across (pages 220-21). As it started to fly, a pointer moved along a scale to show the speed: 10 miles an hour.

"Locusts can stay aloft 12 hours at a stretch and with good winds range 3,000 miles in their lifetime," Michael said. "And that's only one generation. They breed as they migrate, so the eventual amount of ground covered by a swarm and its progeny is enormous."

I later saw graphic evidence of that geographic sweep in a diagram of the 1968 plague that the center drew up. It traced known or suspected swarm movements with arrows and circles. The farthest-ranging swarms came from the Arabian Peninsula (map, above).

One group rose out of the sandy wastes near the Gulf of Aden in the south. In successive generations the swarms pressed northward through Yemen and Saudi Arabia, where they curved around the northern end of the

Tan and green clouds on two continents locate the major breeding grounds of the plague. As eggs began to hatch in 1967, reports poured in to the Anti-Locust Research Centre in London. Scientists plotted swarm movements, shown on the map at left.

Politics forgotten: Delegates from seven threatened countries meet in Asmara, Ethiopia, to combat the 1968 plague. Ethiopia, Kenya, the Somali Republic, Sudan, Tanzania, Uganda, and the French Territory of the Afars and the Issas (formerly French Somaliland) allow locust-control planes to cross their borders, though they may dispute the location of those boundaries. The portrait on the wall is of Merid Azmatch Asfa-Wossen Haile Selassie, only living son of Emperor Haile Selassie I.

BATHURST © NATIONAL GEOGRAPHIC SOCIETY

Red Sea and swept south into Africa to invade the United Arab Republic and Sudan, a distance of approximately 2,000 miles in eight months.

Most of the locust's natural enemies (chiefly beetles, flies, and wasps) are neither numerous enough on the ground nor mobile enough in the air to challenge such swarms. Birds regularly attack locusts, but their effect is only marginal, as I was to see a week later in Khartoum.

A swarm had wafted in over the city from the *qoz*, the great crumple of scrub dunes in western Sudan. It was just starting to cross the Nile at the point where the river ambles past the capital when the birds struck.

Birds Grounded by Gorging

African kites dropped from the sky. They barrel-rolled through the swarm, grabbing locusts with snaps of their beaks, then climbed high to peel off again. Over the river, Abdim's storks flashed white against the chocolate brown water as they banked in and out of the locusts; after them came weaver birds and wagtails, picking up the leftovers.

The attackers gorged themselves until they could no longer fly. Some settled on banyan trees. Some fell to the ground. I watched one cattle egret, with sagging stomach, stagger in the dust trying to take off. It managed a few limp flaps of its wings, then toppled on its side, while the rest of the locusts continued past, molested no more.

I followed the swarm along the Nile to the Ministry of Agriculture, where I met Sayed Lloyd George, Sudan's chief locust officer.

"This year is terrible," he said. "At one stage we had locusts in six of our nine provinces—and Sudan, remember, is the largest country in Africa.

"Not only that, we had just been enjoying one of the longest plague recessions of the century. From 1963 to 1967 there were no swarms to speak of throughout the desert locust area."

Does that mean that locusts come in cycles?

"If they did, our work would be a lot easier

because we could be ready each time," he said. "No. There are no five-year locusts or seven-year locusts, but America has a 17-year 'locust,' the cicada." *

Much of Sudan's locust-control work is done by hand in the bush, using field teams to cast poisoned bait to stop bands of marching hoppers. The next day I flew in a scout plane to Atbara in the Northern Province to see one of the teams in action.

The plane skirted the Nile as the great river lazed through the sand flats with the dull sheen of a rubber band, passed over the cuneiform patterns of mud-walled villages, then crossed into the parched reaches of the desert, where black basalt outcrops seemed caught in a fossilized surf of sand.

Sixty-three Swarms Threaten Sudan

Locust officer Mustafa Ghorashi was waiting at Atbara with a Land-Rover to take me to the baiting area.

As we drove off, he described the bait: "It's an insecticide, usually benzene hexachloride, mixed with an edible base of crushed maize cobs, ground peanut shells, or wheat husks.

"Bait is bulky, but it has one advantage over the more sophisticated techniques when the hoppers are in out-of-the-way places. You don't need complicated equipment such as planes or motorized sprayers."

We bumped and clanked 25 miles south to Aliab, then cut east to Wadi Kahati. Sand, fine as a low-lying mist, drifted across our path. We lost the track, lurched over a boulder, and ground down into the wadi, a dry river bed, in low gear.

Two locust scouts were scattering fistfuls of bait in a wide swath across the wadi. Farther on I saw a dark mass of hoppers, bouncy as black popcorn snapping on a skillet, marching toward us in springy leaps.

"We don't go to the hoppers," Mustafa said. "We lay the bait as a barrier and let them move into it to eat. In an hour or so,

Army on the move devours lush vegetation near Leida, Ethiopia. Young adults such as these do the most damage. At this stage they begin to fly afar and eat more than at any other time.

Counting the toll after aerial spraying along a wadi outside Keren, Ethiopia, locust scout Mohammed Kalifa Ahmed will report the results to the Desert Locust Control Organization. Scouts travel from village to village, picking up information on swarms.

*See "Rip Van Winkle of the Underground," by Kenneth F. Weaver, NATIONAL GEOGRAPHIC, July 1953.

Extending her abdomen to about twice its normal length, a female locust deposits a pod of some 70 rice-size eggs four inches deep in moist sand. Sensors at the end of her tail test moisture, salinity, temperature, and softness of the ground to ensure that conditions are right for laying. A glass case permits this view of the orange eggs and the white foam that hardens into a plug to seal the pod against moisture loss.

To hatch, the eggs must absorb their weight in water, ideally in the first five days. During the last weeks of her four-month life, the gregarious female lays three times, usually a total of about 200 eggs.

the insecticide will get them, whether they keep on eating or move off, and —*khalas!* finished!"

Sudan, while I was there, had heavy locust breeding in the north, and it was invaded by swarms from four directions—Chad in the west, the United Arab Republic to the north, Ethiopia on the east, and Saudi Arabia across the Red Sea.

"Altogether we've had 63 swarms this year," one locust-control man told me.

Because no single country can cope with such mobility, the United Nations Food and Agriculture Organization coordinates the international efforts in locust control.

When the 1968 plague swept out of the deserts, FAO allocated $395,000 to send search teams and pesticide squads to the threatened areas. Technicians from Jordan, Pakistan, Sudan, and Kuwait flew to Saudi Arabia, an Egyptian unit went to Yemen, and an Indian group to Southern Yemen.

"Our whole approach in plague control has shifted," Gurdas Singh, an Indian entomologist and the FAO's locust specialist, told me in Rome. "Instead of trying to hold the line defensively at the danger points, we're now going deeper into the bush to attack the plague before it can do much damage."

Plague Strikes Africa

To support that offense, the FAO spent 3.8 million dollars to build or enlarge 19 field research stations and to supply 221 radio transmitters and receivers to 22 countries for a network of observation posts. It also sent two ecologists on a 69,500-mile trip through 15 countries to chart every known breeding area.

"Here are some targets for you," Mr. Singh said, and passed me a cable he had received from one of the field stations in Africa:

"Major infestation Sudan, Ethiopia, and Red Sea coast. Situation serious."

I left the next morning, spent a week in Sudan, where I fought the swarm with Khalil in his millet patch, then went on to Asmara in the

misty highlands of Ethiopia.* Asmara is the headquarters of the Desert Locust Control Organization for Eastern Africa—a regional body run by seven countries in the area. I found the Ethiopian director, Adefris Bellehu, in a flurry of activity, assigning the organization's six planes to forward sectors, routing truckloads of insecticide to different airstrips, and checking with the pilots by radio.

"This is the first time we've had enough spray planes to hit the swarms repeatedly during a plague," he said. "In 1958 we had only one aircraft; now we're a fighter command flying daily sorties."

Combat Pilot Leads Attack

An hour later I joined that command at an airstrip at Keren, 50 miles northwest of Asmara. The chief pilot was Abbebe Wordofa, a former Ethiopian Air Force captain with combat experience in the Congo (page 211).

He waved me into his De Havilland Beaver, a chunky Canadian bush plane fitted with a 120-gallon spray tank in the cabin and a pair of rotary atomizers on the wings.

"Our scouts have sighted six swarms moving fast in rough country," Abbebe said. He pressed the starter, kicked the tail around in a whoosh of dust, and lifted off over an *amba*, a flat-topped butte, as brown as bread crust. On the far side we saw the telltale shimmer of a swarm blowing across the fractured scree at the base.

With a rush of power, Abbebe canted the Beaver up on a wing tip. We slipped through a cleft at 5,700 feet, sailed over two sentinel rocks, then nosed down toward the valley floor at 120 miles an hour.

He pulled out at 2,600 feet for the first run. As he eased open the spray control, I saw the atomizer blades begin to whirl in our slipstream, spinning a trail of deadly mist. In this case, the insecticide was dieldrin, a nerve poison mixed with a light oil to keep it from evaporating

*Nathaniel T. Kenney described this area in "Ethiopian Adventure," NATIONAL GEOGRAPHIC, April 1965.

Big-eyed hoppers hatch from the warm sands. The insects promptly shed their natal skin, turn dark after about two hours in the sun, and within a few days begin to move off in dense bands.

Changing coats, a hopper emerges as an adult. At each of five moltings the shell-like skin, or cuticle, splits down the back. Hanging upside down to let gravity aid in the shedding, the locust expands its abdomen and thorax to break out of the armor.

in the sun or washing away in the rain.

"The usual trick is to lay the insecticide over the swarm, so the spray drifts down on it, but this one's too big," Abbebe said, and turned directly into it for an extra dose.

Locusts whipped past the engine cowling, splattered on the wings, and slapped the windshield with loud *thwacks!* Abbebe glanced at the instruments.

"The oil cooler's clogged," he said. "Let's go back to the strip."

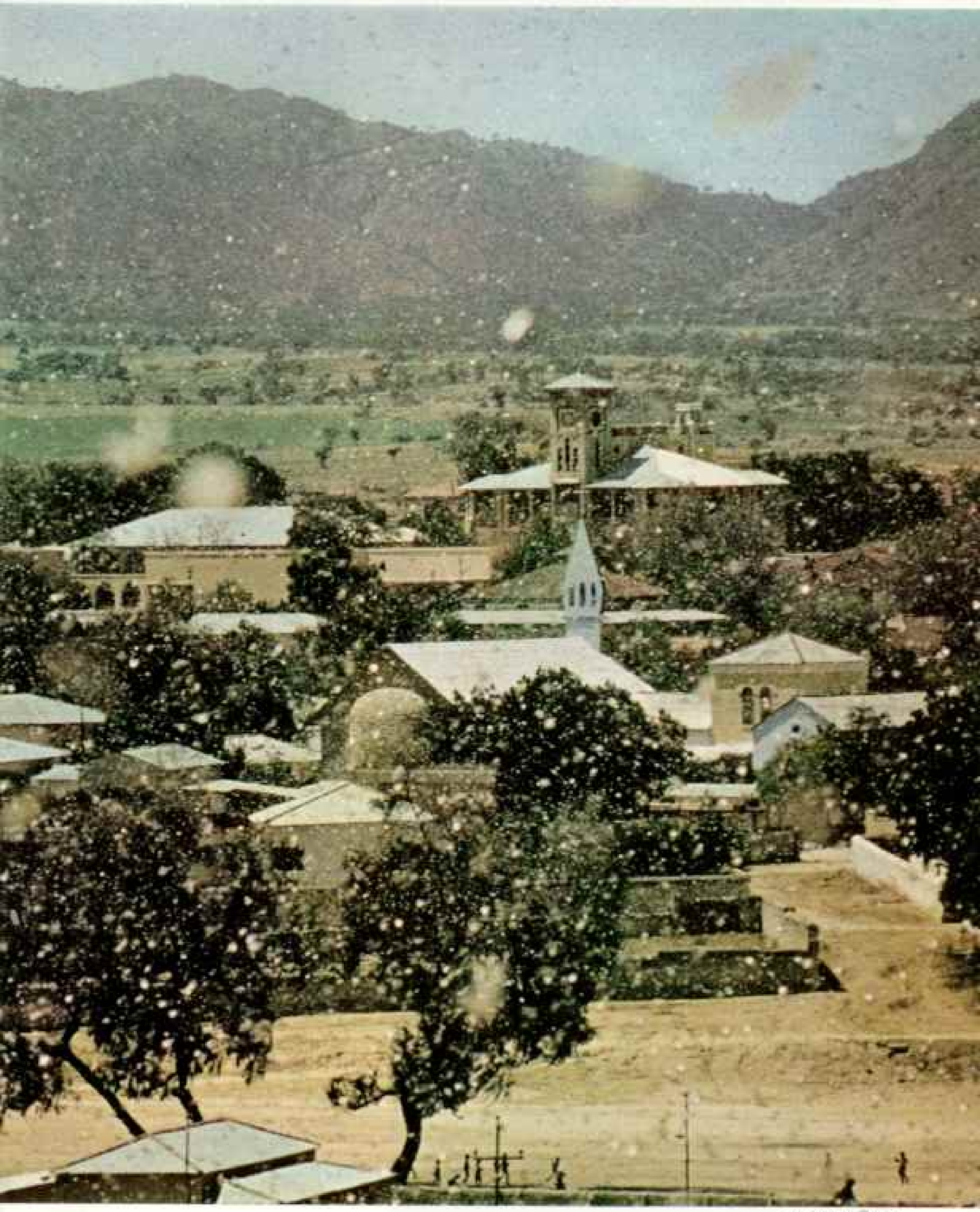
We flew like that for several days, from first light to last, chasing swarms around sheer rock cliffs and ducking in and out of the strip with 12-minute reloading stops, until no swarms were left.

The control organization's chief scientist, John Sayer, a British chemist, greeted us with some startling calculations when we returned to Asmara. "You two are going to start an earthquake around here, dropping all those locusts," he said. "By my count, you've killed three billion—that's 6,000 tons!"

The credit, however, was John's. He had helped develop the rotary atomizer, then had gone on to invent a ground sprayer that uses the exhaust gases of a Land-Rover for power.

"Twenty years ago, using farm sprayers

Belt of living locusts encircles a boy's waist. A thread tied around each one secures them. Sometimes a child will attach a string to a single locust and let it fly about his head like a toy airplane.



KODACHROME © N.G.S.

Snows of the desert, children call the locusts. Here a blizzard of insects passes over Keren, an old silver-marketing town turned agricultural center in northern Ethiopia. As the storm moves onward, it picks up all solitary locusts in its path. One 1958 swarm in Somalia measured 400 square miles and contained an estimated 40 billion locusts—a menace capable of eating 80,000 tons of food a day.

mounted on the backs of pickup trucks, we were lucky to destroy 10,000 locusts with a gallon of insecticide," he said. "These days, with aircraft and atomized mist, we can knock down three million or more with a gallon."

Ethiopia had no hitting power of that sort in 1958, when the last plague swept in, destroying 167,000 tons of crops. The result was a disaster, particularly in Tigre Province.

I drove to Tigre from Asmara the next day and watched farmers winnowing their wheat where there had been ruin a decade before. At Makale the provincial governor, Ras Mengesha Seyoum, recalled how bad it was.

"We had a terrible famine and 15,000 of our people died," he said. "The locusts destroyed everything—the trees, the leaves, the grass. In the end, we even tried a *tangquali*, a magic man. The farmers believe that he helped drive off the locusts. He still is here. I'll have an interpreter go with you, if we can find the man."

The search for the magic man took two days, but we finally tracked him down on the edge of a barley field, sitting cross-legged in the shade of some frankincense trees.

He spoke in Ge'ez, the ancient liturgical language of the Ethiopian Orthodox Church, with a halt after every few words to let the interpreter catch up. This was his story:

His name was Gerauwerk Durso, he was 37, and he had

In flight to nowhere, a locust beats its wings in a wind tunnel at London's Anti-Locust Research Centre. A small hook fastens the insect to the tunnel's suspension bar for a test of its flight characteristics. The double set of wings, five inches across, beats 1,100 to 1,200 times a minute.

Locusts fly with the wind, remaining airborne as long as 12 hours. The cool of night stiffens their muscles, and they like to bask in the sun before taking wing. They cannot fly until their bodies reach about 70° F.

Testing insecticides, a London Research Centre technician prepares to spray a locust dangling in the wind tunnel. Constant experimentation helps scientists determine the most effective poison.

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

learned the *medhanit*, the medicine, from religious hermits—the *bahtawi*, who live on leaves, roots, and grass. Now he was a *debtera*, a lay priest who took no vows, but could put amulets on sufferers and drive out evil.

Magic Man Orders Locusts to Leave

When the locusts come, he cleanses himself by withdrawing in solitude to fast, sipping only a mixture of milk, honey, and an herb that locusts will not eat. He catches seven locusts, puts them in the folds of his cloak, then casts three of them off with words from a time-worn book on his lap, so that all the locusts will follow (next page). If they do not, he takes the fastest horse he can find and leads all the locusts away from the crops. They follow because they know he still has the four others in his cloak.

"I was told you would come, and I am ready," he said.

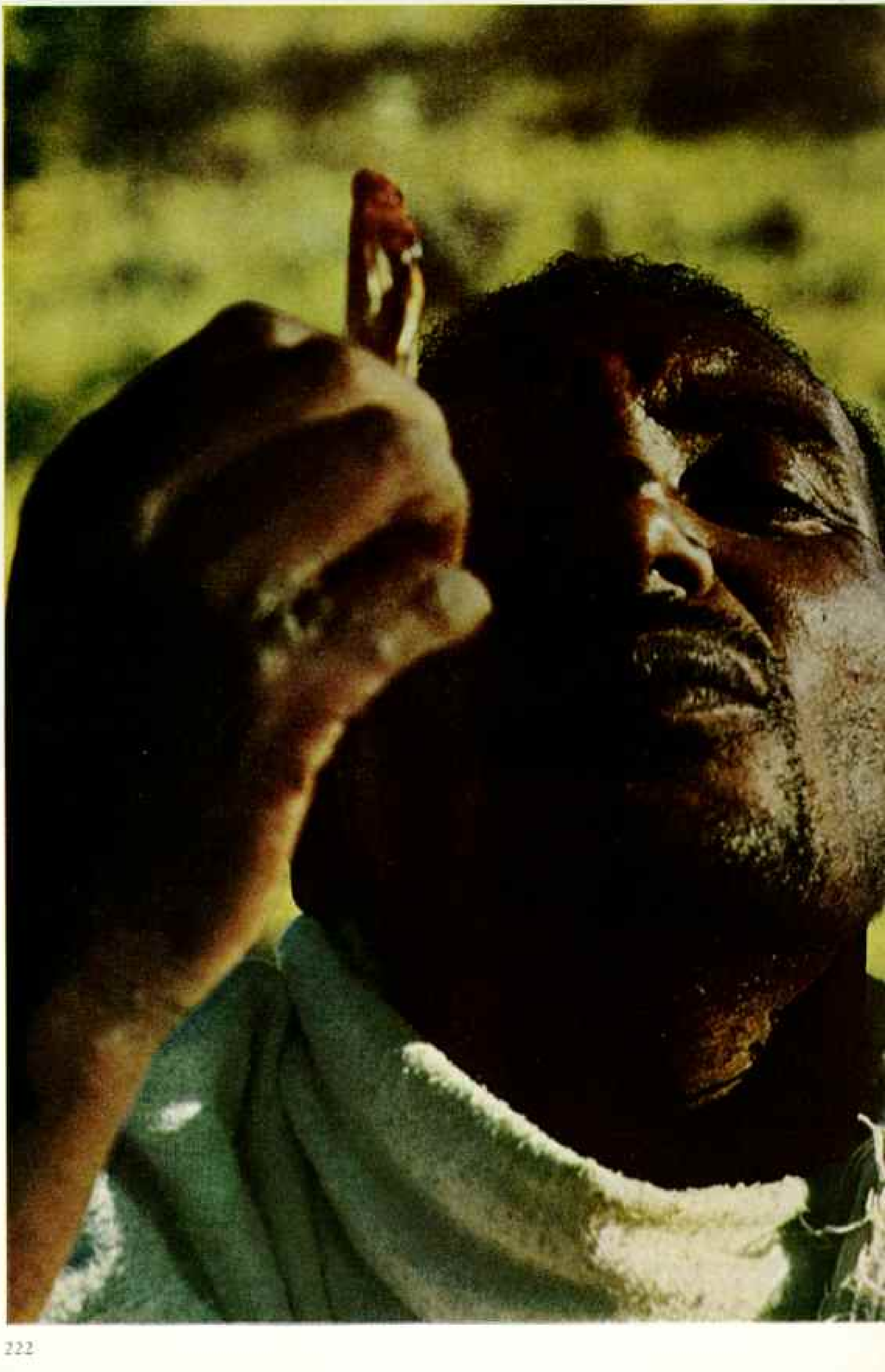
With eyes lifted toward the sky, he began a nodding incantation. "*Hadjburhak . . . iskahail . . . turbihak.*" I listened to the lilting obscurity drift through aged incense trees. The eyes came down to his book. The lips fell silent. From his cloak he drew the three locusts he would cast away, and began again.

"*Anbeta!* Locusts! During the period of our emperor, Haile Selassie, be thrown to the air, to the mountains, to the desert, and to the Red Sea."

He opened a clenched left hand to show a fragment of metal in the palm. "Locusts! May your mouths be as hard and dry as this piece of iron." With his right hand, he raised the three locusts to his lips, blew on each, and bestowed names on them. "*Jeril. Jerbahel. Mikael Archobia.*"

The interpreter leaned toward me to whisper that the last name meant: "The leader. The one with wings."

"Close your mouths, locusts," the voice commanded again. "Do not eat. It is the time



of Haile Selassie and Ras Mengesha, so fly through the air and go.

"*Khid. Khid. Khid!* Go. Go. Go!"

The locusts flew off after he intoned the same words in the 1958 plague. Did he cast a spell, or was it coincidence? Will it work for future plagues? In Tigre they wonder.

Satellite Shows Where Trouble Breeds

Leaving the magic man, I drove north again to study locusts from the edge of space. The means for doing that was the United States Weather Satellite Tracking Station at Asmara.

"The locust-control people get our weather pictures every day," said Capt. Peter Abt, an Air Force meteorologist in charge of the station. "Since locusts drift downwind, they eventually pile up in a zone of converging winds. The control people keep tabs on how the zones are moving, and the changing cloud patterns tell them the most likely places to look for swarms."

A pulse tone sounded from the monitor console as the satellite, ESSA 6, swung overhead. "We're receiving a picture," Captain Abt said.

I watched the facsimile recorder whir out a new length of sensitized paper for the scanner to start its faint tracings of the earth. The Caspian Sea took shape first, then the Mediterranean, the Nile, and the Horn of Africa before the image faded away below the Mozambique Channel near Madagascar.

Another United States satellite, in the new ITOS series, may show locust controllers even more. It will have infrared sensors and cameras capable of picking out vegetation in the deserts, where the appearance of any fresh growth means that rain has fallen and the soil is moist enough for locusts to breed.*

Ethiopia's first indication that breeding had begun again came in a more arduous way. A young locust scout named Hamdan Hamid discovered a swarm laying eggs on the Red Sea coast and walked 60 miles south to the port of Massawa to telephone the news to Asmara. A day after his call, I left for the coast in a caravan of three Land-Rovers with Jim Tunstall, a field officer on loan from

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

"*Khid. Khid. Khid!*" Gerauwerk Durso intones to the locusts. The magic man, a lay priest of the Ethiopian Orthodox Church, bids the insects flee. Neighboring farmers believe his incantations saved their crops in the 1958 plague.

the Anti-Locust Research Centre (below).

"We'll be going into Rashida country," Jim said. "They're a tribe that came across from Saudi Arabia donkey's years ago. They know every rock and pebble along the coast."

We stopped overnight at Massawa to pick up Hamdan, then turned north at first light to churn along a sandy track, trailing rooster tails of powdery dust.

Jouncing and rattling, we ground through scrub brush that lashed at the door sides, or listed and pitched over the sandy undulations of dunes, until our eyes blurred from staring at the liquid panels of heat.

Six hours later, Hamdan pointed us through a path in the salt grass to the goatskin tents of a Rashida camp. "The house of my father, Hamid," he announced.

"*Allah akbar!*" the father hailed us as he emerged from the lee of a shade flap. "God is great! He has brought you to us." His angular wind-carved face, bordered with a strip of beard along the jaw, might have come from an Assyrian bas-relief.

"Would that you had come yesterday," he said to me, "then God would have let us be friends longer."

He led us under the flap to sit on goat-hair mats dyed red with henna, while his wife served us Arabic coffee spiced with ginger from a flask with dried grass across the mouth to filter the grounds. I listened to the *whisk whisk* of her bare feet on the sand as she withdrew in silence.

"How are the locusts, Hamid?" Jim asked.

"*Mush kwayis*," the father answered. "Bad." Then he added an Arabic expression, "As bad as if Rashid had run off with Abdullah's wife!"

Straw-hatted houses shelter the villagers of Cogni, Ethiopia. In early morning, Land-Rovers prepare to leave a field station of the Desert Locust Control Organization. Scouts later discovered a locust swarm in the hills behind the village, near Sudan's border.

Old friends meet again by the sands of the Red Sea. Jim Tunstall, a locust field officer from Britain, greets Hamid, a Rashida tribesman and father of one of his scouts who reported new hatchings in the area. Mr. Tunstall's investigations in late 1967 brought one of the first warnings of the plague.

Silver threads adorn the drapery of a Rashida girl. Facial tattoos—one on her forehead, others hidden by her veil—identify the tribe. The Rashida came to Ethiopia from Saudi Arabia in 1846.

Frustration, utter frustration impels an Ethiopian youth to hurl a stone at a locust-laden acacia tree. To combat the pests, man has tried smoke screens, flame throwers, artillery, steam rollers, and, most successful of all, aerial spraying. Such methods can only contain plagues. Ironically, the final solution, one that stops the locusts from hatching in prolific numbers, is another catastrophe—drought.

Jim looked across at me to say, "And around here, my friend, that is very bad indeed." When we rose to leave, I noticed a double-edged sword, five feet long, hanging from a tent pole.

Hamdan guided us to a ridge 10 miles farther north. As we cleared the top, an incredible sight came into view—chrome yellow locusts, intense as saffron, covered every bush with a menacing bloom in their final color change for the breeding time. Jim hopped out, caught some random females, and examined their abdomens.

"Just as Hamdan told us," he said. "They've been laying eggs. We've been working flat out for a year, and now the whole sorry sequence is starting all over again. Let's go on to the camp site. I have enough to report."

Controls Bring Dramatic Results

We drove on in silence, lulled by the heat. At camp that night beside the Red Sea, Jim still sat quietly by the fire. Strain showed on his sun-creased face.

"Human intervention has never stopped a plague, and I wonder if it ever will," he said. "We can contain a plague by keeping the locusts away from the crops, but the only thing that can really end one is a whacking great drought."

The results of that containment—by the field teams on the ground and the spray planes in the air—were remarkable in 1968. The desert locusts had threatened more than 15 billion dollars' worth of crops; reported damage was practically nil.

Out over the water, I watched Orion rise on its side. Silhouetted on a dune beyond us, one of the Moslem scouts knelt and bowed in supplication toward Mecca, to the north.

When he had rejoined us, I asked him why there were locusts.

"To show us that life is not ours alone," he said. "It is written that when there are no more locusts, there will be no more world."

THE END

SAILING ICELAND'S RUGGED COASTS

OF THE FLEET OF FAT WHITE CLOUDS scudding across the sky, one seemed to have run aground and stopped. This could mean only one thing: I was looking at the glacier high atop the cape of Snaefellsnes on the west coast of Iceland.

"Pat!" I shouted down the hatchway. "Land!" My wife, the only other crewman on our 40-foot yawl *Delight*, came on deck.

"Don't get excited," she said. "Remember, this cruise has only begun."

And so it had, for our North Atlantic crossing from St. John's, Newfoundland, a 16-day battle with icy squalls and cold summer gales, had been just a prelude. Ahead lay a circumnavigation of Iceland, where winds may hit 75 knots, where the compass tells fibs, fierce currents race, and charts describe a rock-studded coast.

Why sail around Iceland? For one thing, we've spent years cruising the cold waters off New England, Nova Scotia, Newfoundland, and Greenland. We've come to love the lonely seas and the stark beauty of northern lands. Then, too, we knew that only a handful of small craft had accomplished the feat, and we wanted to join this select group.

Cruising Denmark Strait and the Norwegian Sea, we would see something rare in this day and age: a bit of unchanged past. Nearly everything hereabouts is as it was in Viking times—the sea, the rocks, the gales, even the language of a people hardily resistant, both by character and geographic isolation, to outside influences.

"Do you feel like a Viking?" Pat asked as Snaefellsnes loomed ever larger. I admitted I did. For in raising its 4,744-foot-high peak we had made the same landfall early Icelanders sought, returning home from Greenland and Vinland nearly 1,000 years ago.

Gulls, guillemots, arctic terns, eider ducks, and those clowns of the cliffs, puffins, appeared in increasing numbers around us. "Well, the birds were

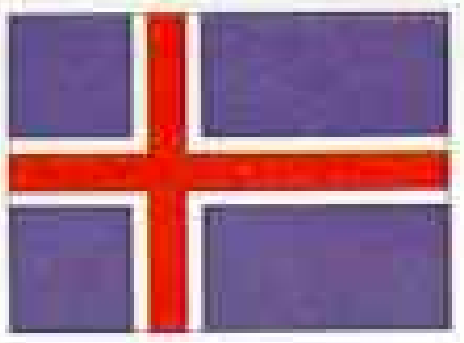
Crossing the wake of Viking ships, Wright Britton and his wife Pat sailed their 40-foot yawl *Delight* on a bold circuit of the hazard-studded coast of Iceland. Grim Seydhisfjördhur headland (left) dwarfs their craft as they skirt the eastern shore. Riding the wings of a fickle wind, the author (above) trims his foresail. Pat—the strain of cold and fatigue written on her face—tends the tiller.

By
WRIGHT
BRITTON

Photographs by
JAMES A. SUGAR

Iceland

FLAMES of freedom, first lit by the Vikings more than a millennium ago, burn intensely in this frosty land. Iceland, or Ísland in the native tongue, has no military forces of its own, but it is protected, under the North Atlantic Treaty Organization, by a contingent of U. S. troops known as the Iceland Defense Force. Colors of the national flag are symbolic of three Icelandic features: molten lava, glaciers, and the sea.



AREA: 39,768 sq. mi. **POP.:** 202,000. **GOVERNMENT:** Republic. **LANGUAGE:** Icelandic, only slightly changed from Viking times. **ECONOMY:** Based on fishing and trade. Some agriculture. No important minerals. **RELIGION:** Chiefly Evangelical Lutheran. **CURRENCY:** 100 aurar equal 1 króna; 87.9 krónur to one U. S. dollar. **MAJOR CITY:** Reykjavik (pop. 90,000), capital, port.

Kentucky-size steppingstone, Iceland nudges the Arctic Circle about midway along a well-traveled air route between northern Europe and North America. Despite its name, barely an eighth of the island remains ice-covered year-round. A branch of the warm Gulf Stream swirls much of the Arctic chill away, making Reykjavik's winters warmer than Chicago's. The Brittons set off on their voyage from Newfoundland, which may have been the Vinland of early Viking colonists.

right again," Pat commented. Friends of the mariner, these are among the species that feed from the sea but seldom venture far from land. So, seeing a gull some seven hours earlier, we had known land was near.

We had also come to recognize the true sea birds—fulmars, shearwaters, and various petrels—that spend most of their lives at sea, returning to land but briefly each year to breed. At the request of the American Museum of Natural History in New York City, we had been identifying and counting all birds encountered in our crossing. This fascinating pastime lightened many a long and lonely hour at the helm.

Reykjavik First Port of Call

On the advice of the Icelandic sagas, we held on for Snaefellsnes, although it is 70 miles north of Reykjavik, Iceland's capital and largest city. We knew that the closer point, Reykjanes, was guarded by the notorious Fuglasker, a chain of islets, rocks, and ledges which extends 40 miles in a southwesterly direction (map, opposite).

Once past this sailor's nightmare, we altered course to cross Faxa Bay. At 9 p.m. we passed the concrete moles protecting Reykjavik's harbor and looked for a berth.

Eyes round with astonishment at the sight of American colors, the skipper of a harbor tug suggested in English that we lay alongside a trawler, *Ingólfur Arnarson*, to save us the trouble of tending our lines as the tides rose and fell. We took his advice.

For the first time in many days, *Delight* was silent—no whistle of wind in rigging, no crash of waves against hull.

"Will I ever sleep tonight!" I said. "Let's turn in."

Crash! Somebody jumped the eight feet from the trawler's deck to ours. A uniformed Icelander appeared in the hatchway.

"Customs!" he said, beaming.

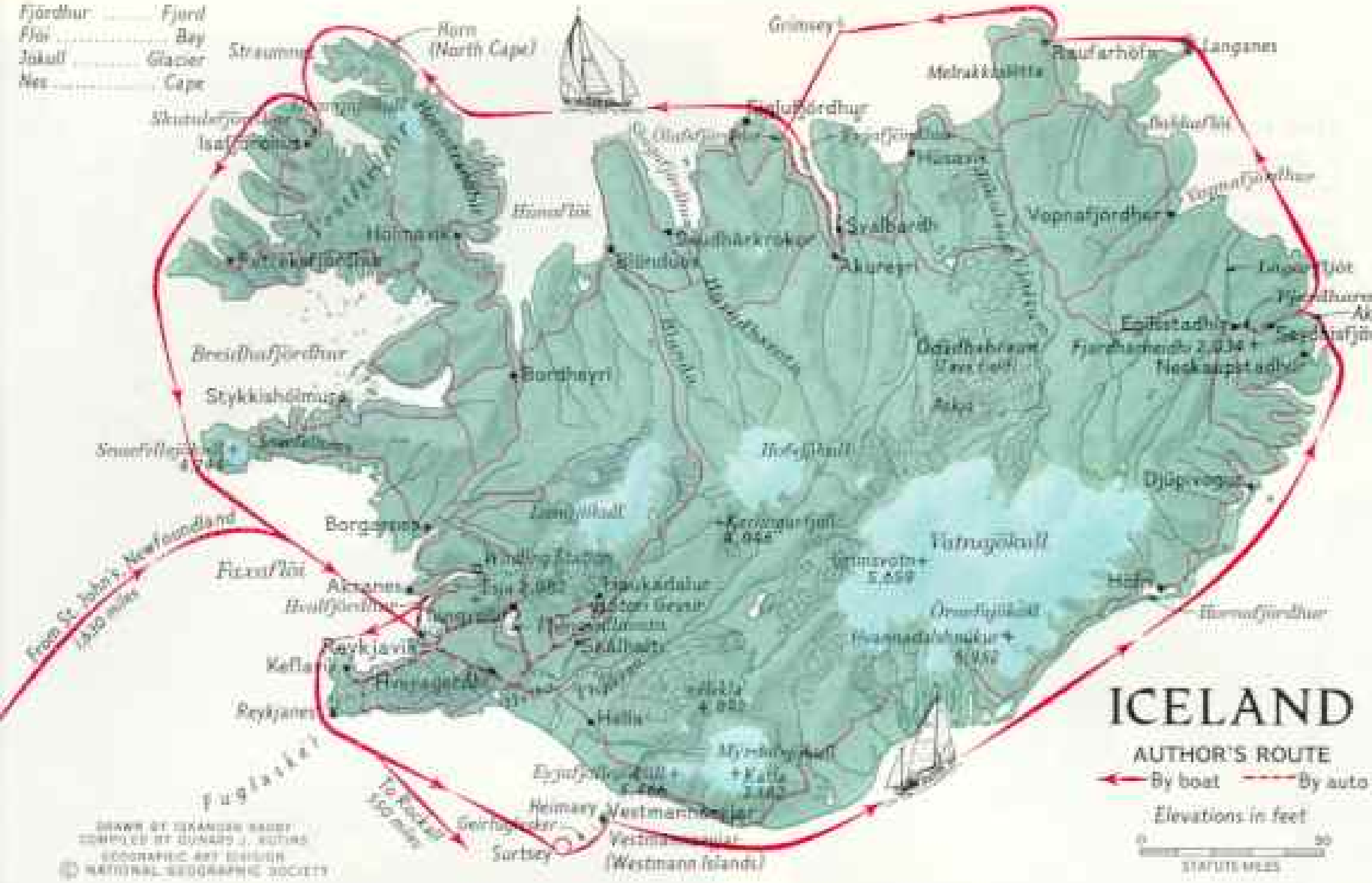
"It's 10 o'clock at night," I replied. "Don't you good people ever sleep?"

"We sleep the whole dark winter," he said. "In summer we have daylight the night through, and we pay no attention to the clock."

He produced the only entry form he had, one for a large ship. We answered such questions as "Do you have any dead bodies aboard?" and "Does your ship contain rats?" before receiving our cruise permit.

The trawler to which we were tied, the customs man told us, was named for the island's first permanent settler. In this land of 100 percent literacy he, like other Icelanders, knew a great deal about the country's history.

"Ingólfur Arnarson came to Iceland in A.D. 874 and later built a house where Reykjavik now stands," the customs officer said. "He and other Norsemen who followed him found the island virtually uninhabited. Everyone



seems to think we have Eskimos here. We've never had any. Practically all our 202,000 people are descended from those first settlers."

The official left. We fell into our bunks. We set no alarm clock.

A series of resounding thumps roused us at 6 a.m. Then, silence. I looked out the hatchway. To my horror, our lines lay in heaps on deck, and we were adrift. A huge tanker was headed for our berth alongside *Ingólfur Arnarson;* someone had casually turned us loose to make room for the newcomer.

We scrambled topside, and Pat tossed a line to the tanker. The crewman who caught it heaved in lustily.

"No, no!" I shouted. "We'll collide!"

"*Já, já,*" said the sailor, cheerfully continuing to haul. When the crash came, it took off a chunk of our mahogany railing.

Apologetic, the tanker crewmen helped make us fast in a new berth. An *Ingólfur Arnarson* sailor who spoke English brought us redfish fillets for breakfast, so delicious they almost made up for the damaged rail.

"How's the fishing this season?" I asked. More than 90 percent of modern Iceland's imports—and nearly everything on the island must be imported—are paid for by exports of fish and fish products (pages 246-7 and 249).

"Fishing's bad," the man said. "Foreign trawlers are making the cod scarce. As for herring, a recent change in the cold currents

Fjord-scalloped coast challenged the sailing skills of the Brittons, who began and ended their circumnavigation at Reykjavik, which Norsemen settled in the late ninth century. *Delight* flies the Icelandic flag from her main spreader, a traditional courtesy. The U. S. ensign waves from her mizzensail, the blue-and-white burgee of the Cruising Club of America from her masthead.

PAINTING BY JAMES A. SUGAR © N.G.S.

Atop Iceland's uneasy crust, glaciers slide to the very brim of boiling springs, steam vents, and geysers. Some sheets of ice flow over active volcanic fields. A pretty skier (below) slaloms in August at Kerlingarfjöll in the icy midlands, a realm virtually impenetrable in winter. Members of a skiing class (right) queue up between lessons to peer down the throat of a hot spring; one man warms his bare feet in hot mud. A rivulet of ice melt meanders at right.

has forced them away from Iceland toward Spitsbergen. That's too far for us to go."

The cod in *Ingólfur Arnarson*'s hold would be made into frozen fillets and fish sticks, many destined for the United States.

Reykjavik proved full of surprises. One was the discovery that Icelandic girls wore skirts about as short as those at home in New York City (page 237).

"I'll bet they change to ski pants in winter," I remarked during a courtesy call on Karl Rolvaag, United States Ambassador.

"Not necessarily," said Mr. Rolvaag, a former Governor of Minnesota and son of the late Ole Edvart Rölvaag, famous Norwegian-American author. "Iceland's coastal areas, where most people live, have milder winters than my home state."

A branch of the Gulf Stream keeps Reykjavik's average temperature in January, the coldest month, at 31° Fahrenheit. Winter days are depressingly dark and brief. July, the warmest month, averages 52°.

Although it was chartered as a city in 1786,

DETACHPOINT (ABOVE) AND BOTACHROMY © NATIONAL GEOGRAPHIC SOCIETY

Reykjavik has few old buildings (following pages). Early turf-and-timber houses have long since disappeared. To avoid importing high-cost construction materials and to provide protection against the weather, nearly all of today's houses are made of concrete. But a few corrugated iron buildings dating from the turn of the century still stand.*

Grateful for a chance to stretch our legs, we went sightseeing afoot. The broad avenue we took from harbor to city center confusingly changes its name every few blocks. Trying to get our bearings, we came across many picturesque parks and handsome pieces of statuary honoring some of Iceland's famous sons—poets, pioneers, and politicians. One of our favorites was a heroic likeness of Leif Ericson presented to the people of Iceland by the United States in 1930. We found bookstores everywhere—not surprising when we learned that the per capita publication of new books here is almost 20 times greater than in the U. S.

*See "Iceland Tapestry," by Deena Clark, NATIONAL GEOGRAPHIC, November 1951.

Sole metropolis in Iceland, and northernmost capital of any nation, Reykjavik has grown from a fishing village of some 6,000 in 1900 to a sprawling city of 90,000 today. By heating most homes and offices with water from thermal springs, it has avoided soot and smog and earned the sobriquet "Smokeless City." A Roman Catholic church, right foreground, stands on a greensward opposite the Catholic hospital.

With the Rolvaags we dined at the Naust, once a fishermen's shed, now a smart restaurant. The menu's boiled sheeps' heads, pickled blood loaf, and well-aged shark failed to tempt us. I had Norwegian lobster, delicious shellfish about the size of large Louisiana shrimp, and Pat settled for *hangikjöt*—smoked lamb —with white sauce.

Word that an American yacht lay in the harbor spread quickly. Scores of people of all

ages came to look *Delight* over, any time of day or night.

One evening a man stepped out of the crowd and introduced himself.

"I am Gunnar Árnason," he said. "I would like to pick you up on Sunday and take you on a motor trip out into the country." We eagerly accepted his kind invitation.

A wicked rain-bearing northeaster roared in on Sunday, but Mr. Árnason arrived as promised. "Much better you see the interior in the rain than not at all," he told us. We drove out of Reykjavik through suburbs with shopping centers and apartment buildings that could have been a bit of United States suburbia (pages 262-3).

The city ended abruptly. We left its paved streets to clatter over a road of crushed volcanic cinder. I do not believe our route had changed very much from the trails that

Like most Icelanders, this pretty teenager descends from the ancient Norse and Celtic settlers of the island.

the Vikings traveled long ago on their hardy ponies.

We moved through a landscape of lifeless, tormented rock, relieved occasionally by patches of swampy grassland. Volcanoes created Iceland so recently, geologically speaking, that erosion has not yet softened its harshness. On the rainswept slopes of Esja, a 2,982-foot tabular mountain that dominates Reykjavik, a few sheep searched for scarce moss and bits of grass.

"What do you think of my country, now that you've sampled its scenery?" Mr. Árnason inquired.

I mumbled something about the beauty of desolation. Our host laughed.

"This is the most fertile part of Iceland," he said. "Wait until we get farther north. Then you'll see real desolation."

Of Iceland's 40,000 square miles, 4,500 are barren lava and 5,000 ice. Not a soul lives on 80 percent of the island; it is a country for lovers of loneliness.

As we neared the shores of Iceland's largest lake, Thingvallavatn, the rain stopped, the sun shone, and campers emerged joyfully from little multicolored tents pitched

about the treeless plains. At the lake's northern end we visited Thingvellir, where, in the year 930, early inhabitants founded the Althing, which Icelanders claim to be the oldest legislative assembly in northern Europe.

They picked a magnificent site for their experiment in democracy. Legislators met on a broad grassy plain ringed by mountains; speakers stood at the foot of a sheer cliff that provides a powerful acoustical backdrop. Most Icelanders attended, and it was quite a social occasion.

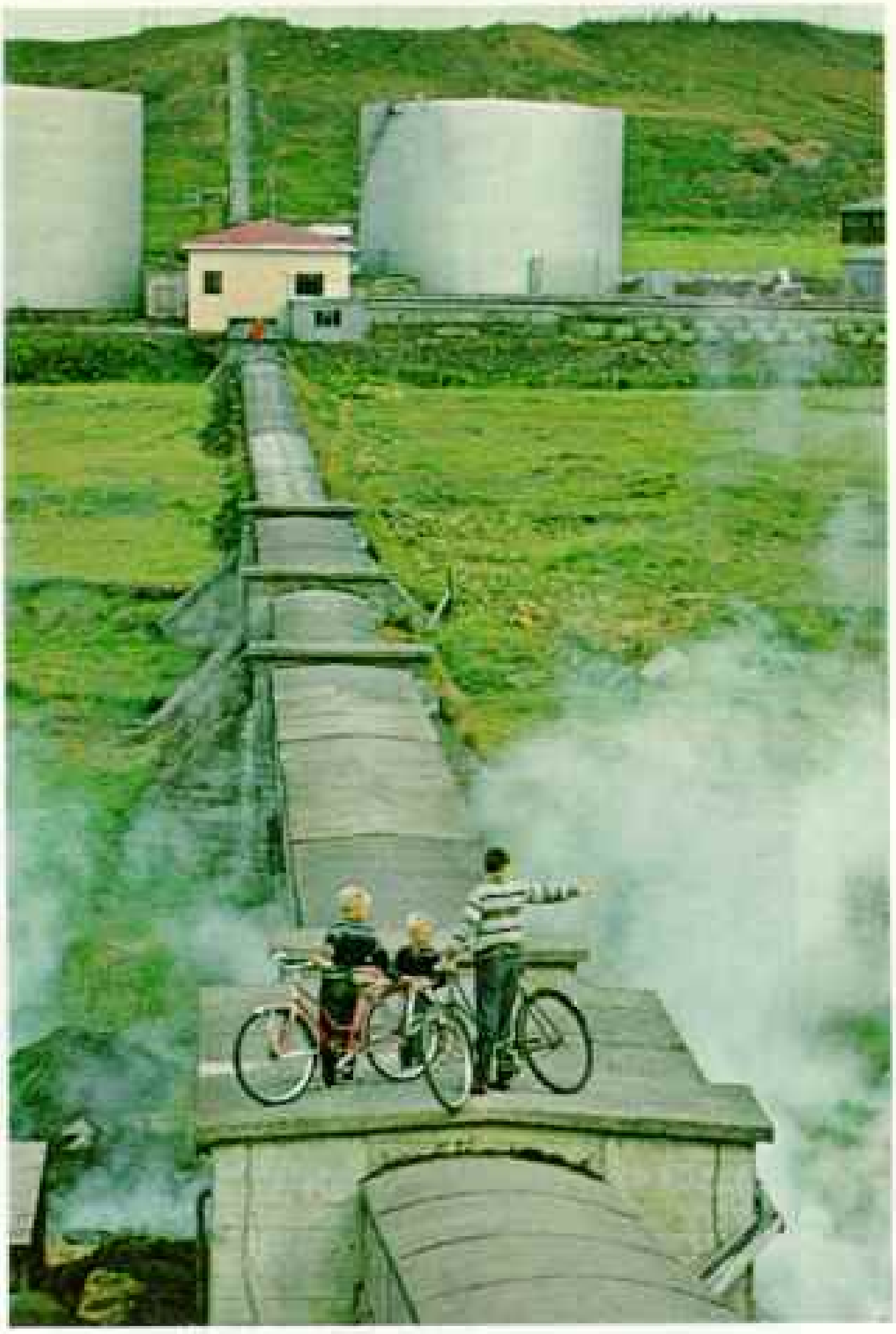
Today the Althing meets in Reykjavik. But Thingvellir has been made a national park and will remain forever unchanged, the perfect natural monument to democracy.

While lunching at a nearby hotel on succulent native salmon, I told Mr. Árnason that his country, the land of frost and fire, had shown us plenty of ice, but no fire.

"You'll soon see the fire," he replied as we headed for Haukadalur, 30 miles away. "And you'll see how it could heat our entire nation without costing us a penny for fuel."

Swinging Reykjavik, on the doorstep of the Arctic, pleases visitors with the warmth and vigor of its social life. On Austurstraeti, the main shopping thoroughfare (right), the sights are thoroughly modern.

Fine restaurants, such as the rooftop dining room of the Hotel Saga (above), tempt patrons with dishes ranging from seafood and home-grown lamb to local specialties like pickled blood loaf and *hákarl*—shark that has been buried in sand and aged to a high degree of pungency.



Harnessing earth's fire

GARDENS UNDER GLASS, heated by boiling subterranean springs, flourish at frigid Hveragerdhi. Here such unlikely produce as tomatoes and cucumbers are grown for market. Fruits, like bananas (left), are raised experimentally. Colorful bouquets of Transvaal daisies (right) will soon grace dinner tables in the capital.

Steaming conduits (above) carry water pumped from nearby hot springs to tanks on hills above Reykjavik. It flows by gravity to heat about 90 percent of the city's buildings.

Beneath Iceland's harsh landscape earth's inner fires still burn. Rainwater trickles down through cracks in the lava soil, is heated into steam and boiling water, and erupts in countless hot springs. The English word "geyser" comes from Iceland's Stori Geysir, or Great Geyser, at Haukadalur.

Until recently Stori Geysir shot 170 feet into the air, but we found it quiescent. However, over the surrounding area of at least five acres, craters large and small spit steam and hot mud, gurgling like frogs in a swamp.

In 1928 the first attempts were made to bring hot water into Reykjavik, and in 1942 a large-scale system was completed (preceding pages). Hot water is now piped from springs as far as 10 miles away to heat 90 percent of the city's homes, offices, institutional buildings, and factories. The cost, including hot tap water, averages about $7 a month for a 3-room apartment.

Today about half of all Icelanders live in buildings heated by thermal springs. As drilling continues to add supplies, more users are hooking into the system. Thus the country has greatly reduced its dependence on imported oil, the other major source of heat.

On the drive back to town we passed acres of greenhouses where farmers raise cucumbers, tomatoes, and flowers, and experiment with grapes and bananas—another benefit from the hot springs.

EXTACHROME BY JAMES A. SUGAR

To Sea With a Royal Send-off

Much as we enjoyed our nine-day stay in Reykjavik, it was time to go to sea again. Getting out of the narrow, concrete-guarded harbor was a bit tricky. Later we learned *Delight* had had a distinguished audience as she charged, rail down, safely to sea. Visiting Crown Prince Harald of Norway, a yachtsman himself, interrupted an official ceremony to watch us make good our offing.

We smelled our destination long before we saw it—a whaling station well up Hvalfjördhur, or "whale fjord." The smells of Iceland are of the sea, mostly from fish factories. They take some getting used to. Icelanders, however, have managed it.

"Aha!" they exclaim when the wind is right. "The wonderful smell of money!"

Christmas custom: In a Reykjavik cemetery a woman lights a flame before a family grave. By decorating with evergreens, colored bulbs, and flowers, families honor their dead during the holiday season. Small fir trees, set among the rows of crosses, glow with lights. Because it is illegal to cut Iceland's few trees, most Christmas greens must be imported.

Each year Hvalfjördhur handles 400 to 500 whales. Some are served to humans as whale steaks; most end up as pet food. Despite limitations on the catch, whales are rare today in waters where old Norse sailing directions noted their abundance.

Overfalls: Ocean on a Rampage

We were still anchored off Hvalfjördhur when a vicious 60-knot gale roared down from the surrounding heights and hit us full blast. It raged for a day and a half, covering *Delight*'s decks with gritty lava sand and saturating her cabin with the smell of the whaling station. Nothing would kill the stench. As Herman Melville so vividly describes it in his classic, *Moby Dick*: "It has an unspeakable, wild, Hindoo odour about it, such as may lurk in the vicinity of funereal pyres. It smells of the left wing of the day of judgement; it is an argument for the pit."

When the gale died and the sun shone and sails once more clothed the masts, we raced by Reykjavik and crossed the southern part of Faxa Bay without a care in the world. But then, as we came abeam of Reykjanes Light, we encountered our first stretch of overfalls, those turbulent, treacherous waters Icelanders call *röst*.

Overfalls are created when a fast current from the cold sea depths strikes an underwater ridge. In shallow water the current shoots to the surface and there makes vertical waves, sometimes four feet high, that follow no directional pattern but boil every which way, as in a maelstrom. They may be found off every one of the island's horns, or promontories.

Suddenly we found ourselves in the midst of Fuglasker's overfalls. At that moment the wind died completely, so that *Delight* leaped wildly about, going nowhere. Quickly I started the engine, and an hour under power freed us from the frightening turbulence.

The following day a southwester piped up to 15 knots, and *Delight* burbled along over a benign sea. Our plan was, briefly, as follows: We would circle Iceland counterclockwise, sailing east along the south coast, west along the north coast, around her great North Cape, and back to Reykjavik where we began. Then we would continue on to Great Britain. Our immediate goal was the Westmann Islands, which Icelanders call Vestmannaeyjar. They lie 85 miles from Fuglasker (map, page 231), and we raised them in early afternoon.

Until November 14, 1963, there were 14 islands in the group. That day fishermen working off Geirfuglasker watched in amazement as the sea exploded with a roar and a geyser of water thick with cinders shot into the air. They were witnessing the birth of Surtsey, the world's newest island.*

Surtsey has grown to a height of more than 560 feet above the sea (pages 244-5). Now one square mile in area, she at first had two smaller island neighbors, but these were formed from soft material, and the following winter's gales washed them away.

We passed near Surtsey, but not too near, for wisps of smoke and steam still rose from her central crater. We had the eerie feeling that she might at any moment salute us with a salvo of boiling lava and hot rocks. Our haven that night was the little fishing port on Heimaey, largest of the Westmann Islands and the only one inhabited (pages 248-9).

A young lady of Heimaey, Erna Jóhannesdóttir, was in Maine as an exchange student. We had read about her before we left the States, and decided to call on her family when we reached the Westmanns. It wasn't easy.

Custom Causes Name Confusion

Iceland alone retains a patronymic system once in use throughout most of Scandinavia. Here children's surnames are still formed from the Christian names of their fathers, with *son* or *dóttir* tacked on. Small wonder our search for a Mr. Jóhannesdóttir caused confusion. Finally someone understood the difficulty and led us to Mr. Jóhannes Tómasson, Erna's father. He introduced his wife as Mrs. Gudfinna Stefánsdóttir, for a woman keeps her own name after marriage.

"Naturally, when we travel outside Iceland," said Mr. Tómasson, "I sign hotel registers 'Mr. and Mrs. Tómasson.'"

Although Heimaey measures less than four-by-two miles, Mr. Tómasson, like many of his 4,000 neighbors, has a car; he very kindly took us for a tour. I asked how the island reacted to the emergence of Surtsey.

"Fear, then curiosity," he replied. "And some annoyance. You see, we depended entirely on rain for fresh water. Volcanic ash sifted into our collection tanks, ruined our supplies, and we had to import all we used. Now a pipeline brings it from the mainland."

Ahead lay an airport perched on the edge of a cliff. Flugfélag Islands—Icelandair—

*See "Surtsey, Island Born of Fire," by Sigurdur Thorarinsson, NATIONAL GEOGRAPHIC, May 1965.

provides scattered communities with plane service. Iceland's leap into the 20th century was so swift that the country skipped right over building railroads or express highways, even on the mainland. Icelanders practically climbed from their ponies into airplanes.

A young man walked along the clifftop carrying what looked like a lacrosse racket.

"He's after puffins," said Mr. Tómasson. "He sweeps them out of the air with the net."

Islanders catch more than 50,000 puffins a year for food. Once they ate fulmars, until an epidemic of a type of infectious ornithosis broke out among the birds. Some dressers caught the malady, and the fulmars have rarely been molested since.

We left Heimaey on a sunny day with a fair wind in the running sails, but we were a nervous crew. The United States Navy's Sailing Directions warned of dangers ahead.

"The south coast of Iceland has always been feared by seamen," it said, noting that for 230 miles there is only one harbor of refuge —Hornafjördhur—which we couldn't enter because an 8-knot tidal current, further powered by glacial streams, pours out of its mouth.

Glowing like molten lava, fireworks spill down the inner slope of an extinct crater in the Westmann Islands during an annual patriotic fete first held in 1874. That year, the 1,000th anniversary of Viking settlement, Denmark granted Iceland partial self-rule.

Replicas of Viking ships recall the golden age when Norse founding fathers established an Icelandic republic. A general assembly, the Althing, first convened in 930. During the early centuries after settlement, poets perpetuated traditions brought from Norway, and Icelandic genius created a brilliant prose—the sagas.

But then, after 1262, Iceland fell into the shadows. First Norway and then Denmark won control of the island. Smallpox, famine, and volcanic upheavals decimated the population. A rebirth of patriotism in the mid-1800's triggered a struggle for home rule; ties to Denmark were severed one by one. Complete independence and re-establishment of the republic came in 1944.

Against a mountainous backdrop ranging from 8 to 20 miles inland, the low coast can't be seen until you're actually in the breakers.

But after 100 miles—or halfway to the good port of Djúpivogur, our destination—we began to relax. The sun still shone on magnificent glaciers to the north, among them Öraefajökull, which sits atop 6,952-foot Hvannadalshnúkur, Iceland's highest volcano. This, we thought, was how the land of frost and fire should look, but so seldom does.

Night fell, and the aurora borealis flickered in the northern sky, then suddenly vanished. The wind turned clammy. The red compass light in the binnacle blurred. We knew the reason and dreaded it. Fog!

Between us and Djúpivogur lay a maze of terrifying rocks and shoals, all boiling with ferocious tidal currents. To complicate matters further, I could not trust the compass, for in these latitudes there are magnetic anomalies that can pull the needle off as much as 20 degrees.

Still I had no choice but to hold my course. With the fog came wind; we set working jib,

(Continued on page 248)

Cataclysm spawns an isle

SEETHING CLOUDS of steam and ash boil skyward in November 1963, signaling the birth of the volcanic isle of Surtsey off Iceland's southwest coast. Still active today beneath its cooling crust, the one-square-mile islet harbors a lonely research station (left) partially supported by the U. S. Office of Naval Research.

Shifting sands recently filled the sea-water lagoon at center. Seeds borne by birds, winds, and tides are beginning to take root, giving a glimpse into the way life may develop in barren and isolated areas. Icelandic biologist Dr. Sigurdur Jónsson (below) examines a sprouting plant called a sea rocket.

EKTACHROME BY GOLDBERG (UPPER); KODACHROME (LEFT) AND EKTACHROME BY JAMES A. SUGAR © N.G.S.

Slippery silver from the ocean's treasury, herring squirt from a huge net hoisted aboard the trawler *Gjafar* off the Westmann Islands. Sophisticated electronic fish-spotting apparatus helps make Iceland's fishing fleet among

EXPACHROME BY JAMES A. SUGAR © NATIONAL GEOGRAPHIC SOCIETY

the world's most efficient and profitable. Fish and fish products comprise the main exports of the resource-poor nation, enabling it to import such necessities as foodstuffs, lumber, gasoline, automobiles—and fishing nets.

main, and mizzen, and flew on over the water in our little gray world of perhaps twenty yards in circumference.

On through the next day we sailed blindly, ears straining for the sound of surf breaking on rocks. It was a harrowing experience. We decided not to stop at Djúpivogur, and picked Seydhisfjördhur, some 70 miles farther north, as our next port of call. When we judged ourselves opposite it, we put the helm down and headed directly for the coast.

Smoke Cloud Erases a Town

Luck was with us. Just where they should have been loomed the 3,005-foot-high cliffs of Akurfell, landfall for Seydhisfjördhur. A great whale surfaced in the wide mouth of the fjord and spouted a greeting. As we shortened sail, the sun came out (pages 250-51). There lay the harbor, with the usual welcoming committee waving us to a berth.

To vary our sea-level view of the countryside, we motored next morning to the top of Fjardharheidhi. The switchback road was scary—narrow and without guard rails—but the panorama from the 2,034-foot height was worth it. Westward lay an enormous fertile valley cut by the Lagarfljót, whose waters originate far to the south in Vatnajökull, largest glacier in Iceland. Sun sparkled on a plane inbound for the town of Egilsstadhir. But when our gaze turned seaward again, Seydhisfjördhur had completely disappeared, screened from sight by smoke from the local

One fish dinner coming up. In a rare moment of relaxation, Pat Britton reels in a small but delectable cod from *Delight*'s deck in the harbor at Seydhisfjördhur. The Brittons paused here after grueling hours of blind sailing through fog, fierce currents, and murderous shoals. Hardly had they hoisted anchor and left the harbor when a wild southeaster roared up and brought *Delight* dangerously close to capsizing.

PHOTOGRAPHED BY JAMES A. SUGAR (ABOVE) AND WILLIAM A. SMITH © N.G.S.

Snug anchorage at Heimaey, in the Westmann Islands, serves as home port for a far-flung fishing fleet. Boats enter at lower right, the harbor's gateway to the sea.

Speedy but spattered, a Seydhisfjördhur girl packs fresh herring in salt before final cleaning and pickling. Usually Iceland's second-ranking commercial fish, herring sometimes moves ahead of cod when heavy runs give the economy a substantial but short-lived boost.

Beating on sun-silvered wings, gulls veer past *Delight*'s stern pulpit in Seydhisfjördhur harbor. From time immemorial Iceland has been a major breeding ground for scores of feathered species, making the island an ideal bailiwick for bird-watchers. The author and his wife brightened many an

otherwise bleak hour of their voyage by identifying and counting birds in a study for the American Museum of Natural History. Ghostly hexagonal configurations, upper right, are caused by sunlight bouncing off the camera's six-sided lens aperture and reflecting on the glass elements.

fish-processing plant. The entire fjord, stretching for eight miles, looked like a milky pool.

On our descent, I joined local trout fishermen beside the Fjardhará river but failed, despite an hour of casting, to land so much as a minnow. We had fresh fish for dinner anyway—small cod Pat caught with little effort from *Delight*'s deck (page 249).

Norwegian Skipper Warns of Danger

That evening we were invited for coffee aboard *Norman*, a Norwegian naval vessel. I told the officer in charge, Capt. Johan Mydske, how lucky we felt to have hit Seydhisfjördhur on the nose in the fog after a 300-mile passage.

Captain Mydske raised an eyebrow.

"You may not be so lucky another time. Have you read the British Arctic Pilot about weather here?"

He handed me a copy, and I read, "The frequency and violence of frontal activity over much of the area is not exceeded elsewhere in the world."

"And," added the captain, "the dirtiest weather starts in about a week; that is, after September 1. If I were you, I would sail for Great Britain right now, as soon as you finish that coffee."

Later we would wish we had taken his advice.

Making the most of a land strewn with glaciers, lava fields, mountains, and deserts, Icelandic farmers wrest a living from less than 1 percent of the island's total area. Hay, raised for livestock, ranks as the main crop. Blessed by long hours of summer sunlight, the grass grows rapidly, sometimes permitting three cuttings a year.

In Hella (above) a lad rides a hay rake pulled by an Icelandic pony, a breed imported to the island more than a thousand years ago.

Haying outside Djúpivogur (above, right) becomes a harvest ballet.

Near Hella (right) a solemn youngster milks a family cow.

ILLUSTRATIONS AND DECORATIONS (BELOW) BY JAMES A. SUGAR © M.C.C.

We cleared Seydhisfjördhur early in the morning, ghosting out to sea on a light breeze blowing out of a cloudless sky. Our next destination, Langanes—a duck-shaped point of land—lay 80 miles to the northwest.

A mile from the harbor mouth a southeast gale charged up from astern and sent *Delight* surfing wildly before a sea gone crazy. This is dangerous. A small ship can run under or broach and take a knockdown from which she might not recover. I fought forward over a deck awash with icy water, and dropped the mainsail in a heap.

All day and night the little ship fled past the brooding, lonely land. The temperature dropped to 38 degrees.

At 1:30 in the morning we picked up the twin flashes of Langanes Light and, to seaward, 13 mystifying white lights that looked much like the lights of a town. We brought out the Sailing Directions.

"It says there are bad overfalls there, and no land," I said. "We'll hold on until dawn and see what it is."

With daylight, we did see. The overfalls proved no worse and no better than we had expected, and the lights turned out to be a fleet of 13 trawlers taking shelter behind a towering cliff. These full-powered ships had run for cover, but our little yawl had survived the gale and also made good our northing.

Arctic Adventure a Chilly Chapter

Now we were halfway through our circumnavigation and, thanks to the Norwegian officer, in a hurry. Rounding the tip of the Melrakkaslétta peninsula, northernmost part of Iceland, we laid a course due west, bound for the island of Grimsey. On this passage we would be just north of the Arctic Circle.

It was midnight and pitch dark when we entered the tiny harbor on the island's west side. Not one kindly light shone from the shore to guide us, but we found a berth open at the end of a jetty where a number of fishing boats were tied.

The sun rose next morning as a fiery ball.

"Red sun in the morning, sailor take warning," said Pat. "Let's find someone and ask."

That was easy. All 85 of Grimsey's inhabitants stood on the wharf inspecting their first American yacht.

"What do you make of the weather?" I called out.

"Double your lines," advised a fisherman. "We shall have a bad wind."

Grimsey's harbor is only a small cove with a concrete jetty protecting it from the southwest. It is wide open to any weather coming from due south. Not much later a full gale struck the rigging with a banshee shriek. A wild sea thundered at the jetty, occasionally surging angrily over it. Sheets of spray mixed with cold rain flew across the harbor. *Delight* pitched and rolled.

Storm Sinks a Ship but Spares *Delight*

During the day and following night we changed two fenders and four dock lines that had chafed to uselessness against the concrete pier. Islanders looked in on us from time to time, ready to help.

"We just heard that one of our large fishing boats foundered 50 miles to the north," an islander told us.

"Another vessel rescued all the crew. Practically every year we lose one or two boats right here in the harbor."

When the gale ended and the sun reappeared, we were glad to leave. Islanders let go our lines and waved.

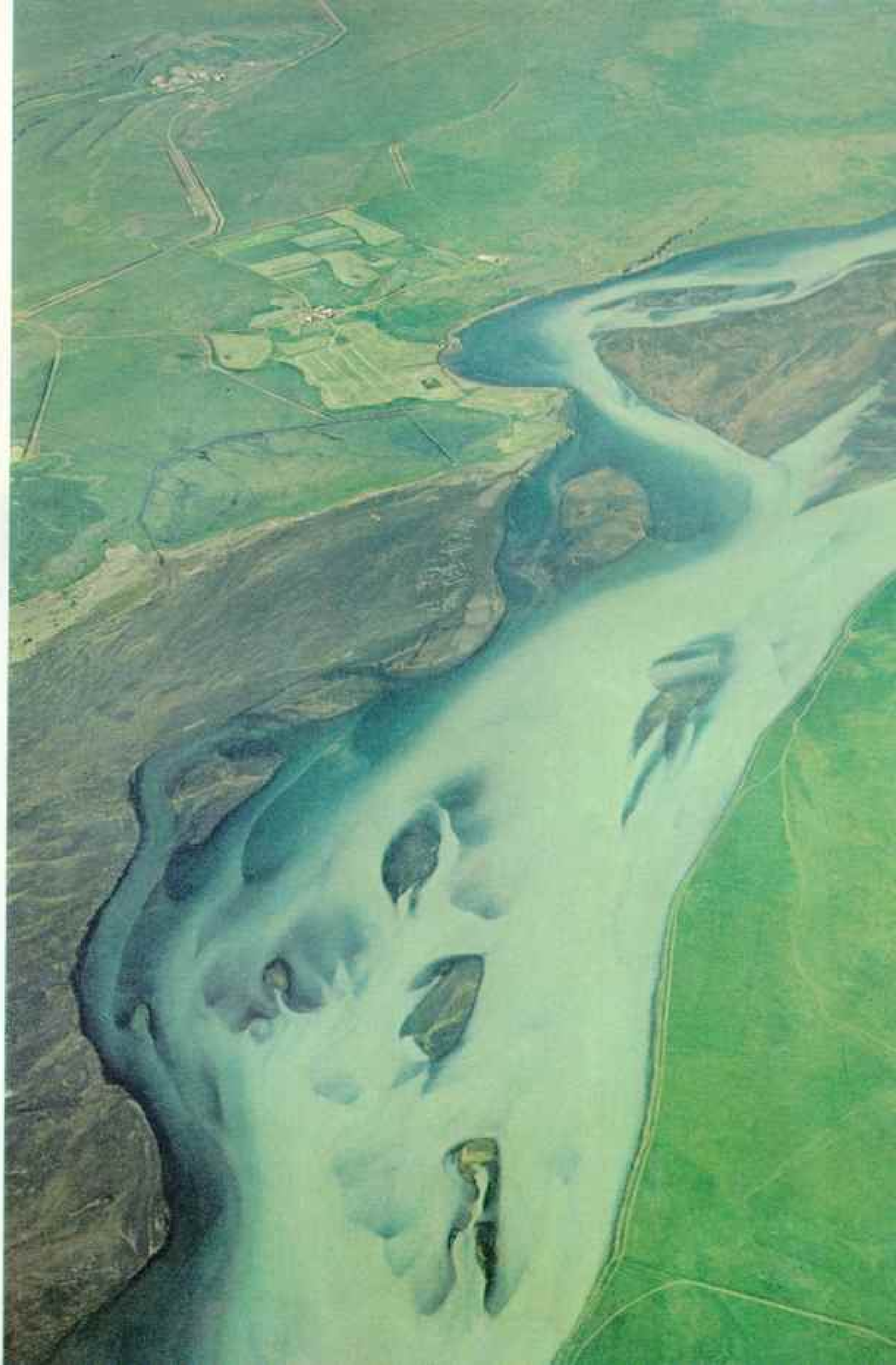
"*Bless*," they called, which in Icelandic is a way of saying "farewell."

The gale had once again impressed the Norwegian officer's advice upon us. We had planned to head west from Grimsey and round Iceland's Horn, or North Cape, as quickly as possible. But now I was worried about Pat. She was tiring too easily, and complained that her teeth ached, individually and collectively. Knowing that a doctor could be found in Akureyri, Iceland's second largest city, we headed for it instead.

Akureyri lies 35 miles up Eyjafjördhur, Iceland's longest fjord and, with a light northerly blowing, we hoped to make it in a day's sail. But just as we approached the fjord's entrance, a southerly gale hit us. Unable to reach Akureyri that night, we took refuge in neighboring Ólafsfjördhur. The next day we

Glacier-born torrent, the Hvitá river swirls through southwest Iceland to the sea. The swift surge, broken by shoals and cataracts, owes its milky appearance to sand and silt released by melt water flooding down cliffs of the Langjökull icefield. Although too fierce and shallow for navigation, Iceland's many rivers hoard potential hydroelectric power that the country has only begun to tap.

PHOTOGRAPH BY JULES FRIEDMAN, U. S. GEOLOGICAL SURVEY



tacked up Eyjafjördhur, rounded smartly into the wind before Akureyri, and found a berth for *Delight*.

Pat located a doctor who told her she deserved to feel bad.

"You're just worn out from undergoing hardships no woman can stand," said the good doctor. "This should teach you to stay at home, where women belong."

Feeling she had somehow to prove her womanhood, Pat made reindeer meatballs for dinner and served them flambé.

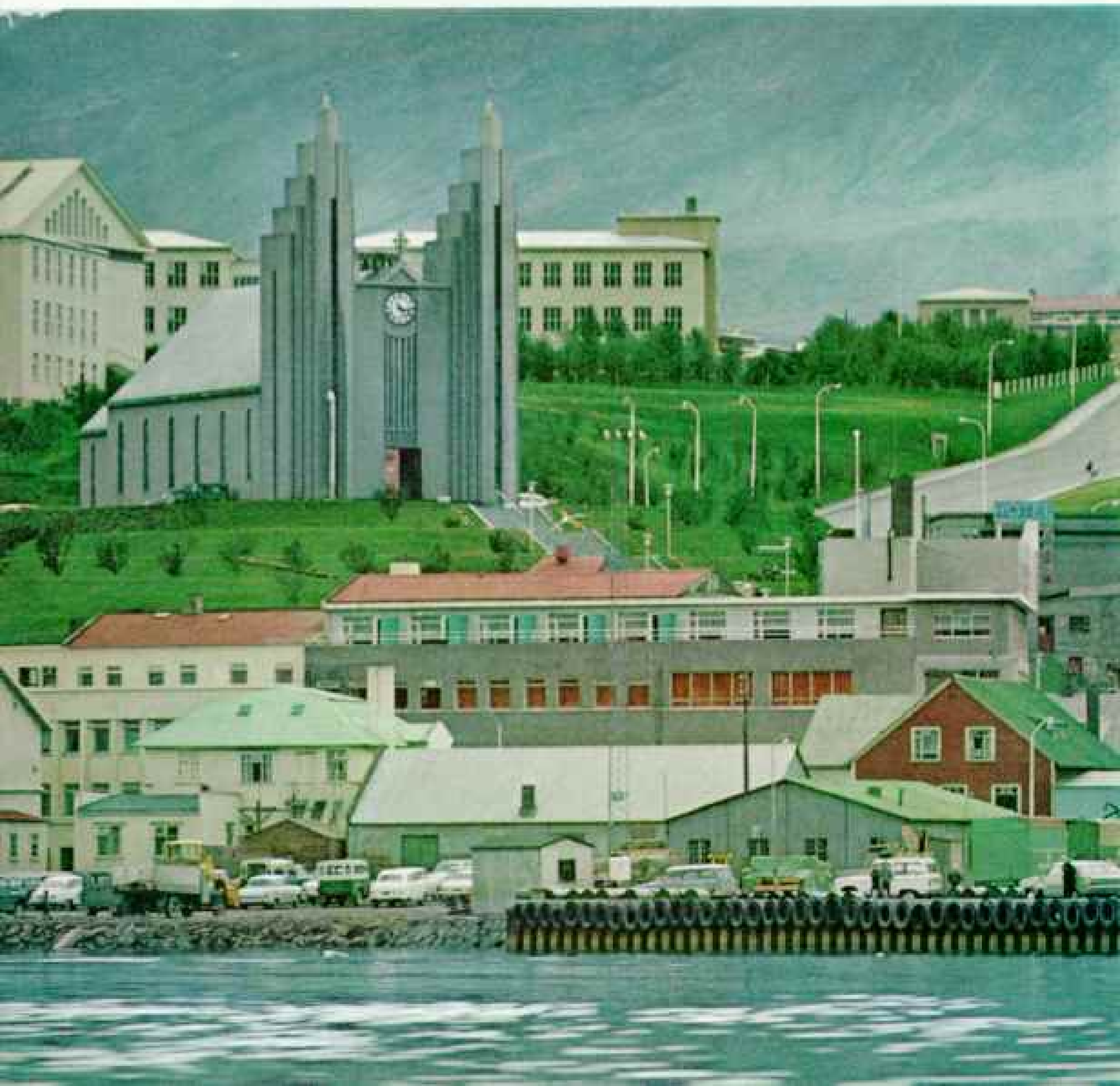
Icelanders Keep Language Pure

"*Delight*, ahoy!" An unmistakably American voice hailed us next morning from above. Col. Ragnar Stefansson hopped aboard. Born in Seydhisfjördhur but raised in Baltimore, the colonel brought his family back to Iceland after his retirement from the U. S. Air Force. Now he teaches English and ancient history at the Akureyri high school.

Our conversation soon swung to Icelandic, one of the oldest living languages of Europe. "It's changed so little," the colonel said, "that our children can read the ancient sagas as readily as an English-speaking person can read Shakespeare."

To keep their language pure, Icelanders discourage the introduction of foreign words. When a new word is needed, an official committee coins it by combining existing ones. Thus when television arrived on the scene, Icelanders rejected this alien word in favor of *sjónvarp*, derived from two old words: *sjón*—sight; *varp*—throwing.

The colonel had come to invite us to a dinner in our honor to be given that night by



Temporarily grounded—and enjoying it—young sailplane enthusiasts await a tow. Sailplaning has a devoted coterie in Iceland, which often sends contestants to international meets.

Powering to a berth in a fjord harbor at Akureyri, *Delight* finds refuge from bone-chilling gales and high seas that lash the perilous north coast of Iceland. Twin-spired Lutheran church dominates the waterfront of this town of 10,000, the commercial hub of the north and a popular winter sports center.

the city and the Icelandic-American Society. This group, pledged to promoting understanding between the two countries, certainly practices what it preaches. We enjoyed a most delightful evening.

We actually welcomed the gale warnings posted next day, for by remaining harbor-bound we could see more of this attractive city and its 10,000 hospitable people.

Factories, Not Fish, Support Akureyri

Most coastal communities depend largely on fishing for their livelihood, and in many of them cod is the big money-maker. Akureyri, on the other hand, bases its economy on a number of diversified industries. These include a shoe factory, a tannery, and a wool-processing plant. The city is the commercial center of the north and Iceland's winter sports mecca. To our surprise it also has a sailing club, perhaps the northernmost one in the world. It takes a hardy breed to sail these waters; the day we departed Akureyri our cabin temperature had tumbled to 33 degrees Fahrenheit.

Looking on the map like a gigantic claw reaching for Greenland, a large peninsula—Vestfirdhir—forms the northwest corner of Iceland (map, page 231). Vestfirdhir means "the western fjords." It is a fitting name, since the many fjords slicing into its interior make it almost as much water as land.

Once around Vestfirdhir, we would head south for Reykjavik and the end of the circumnavigation. Vestfirdhir was only 160 miles from Akureyri—but it would be a bumpy ride. Each day the winds grew stronger and the seas livelier. For hazards to navigation,

the peninsula's shores take second place only to the south coast.

On our second morning out the sun rose again as an ominous red ball. At 10 o'clock a northerly gale whistled in to lay *Delight* flat on the water. I brought in the mainsail, a task made unpleasant by snow driving almost horizontally across the deck.

Weary Sailors Face New Fear

Relieved, the yawl came to her feet and settled to her job, doing seven knots under jib and mizzen. Sleet, replacing the snow, slashed our faces; our heaviest clothing could not keep out the cold.

Pat had a chill. I sent her below. Alone at the tiller, I suddenly caught a glimpse of a stark black headland only a quarter of a mile ahead of us.

The Horn of Vestfirdhir? The taffrail log said it couldn't be; we had not come that far. I let *Delight* sail herself while we pored over charts and sailing directions. There could be no doubt about it: A magnetic anomaly had drastically affected the compass. We were well south of our course and headed directly for the Hornstrandhir, a place of wicked headlands, pinnacle rocks, and shoals we would never see until we drove upon them. We trimmed the sails flat as they would go.

Soon another black headland appeared to windward. Horrified, I realized we were well into the area of shoals; one of them could tear *Delight*'s bottom out any second.

Frantically I put her about. We plunged for the open sea, and after a tense 15 minutes gained the safety of deep water. Had we struck, it would have been the end.

Eric the Red built his first home on the Hornstrandhir; later he left for more fertile and hospitable Breidhafjördhur to the south. Only a lighthouse keeper at the Horn lives on the Hornstrandhir today.

After we rounded the Horn and Straumnes, 20 miles to the west, the wind died to a whisper; we had barely enough breeze to push us up a small fjord to the town of Isafjördhur (page 264).

Dark basaltic walls, rising to 2,500 feet, bracketed the passage. Unlike most fjords we had seen, this one—Skutulsfjördhur—is bisected by a narrow sandspit. Although the tongue of land is only half a mile long and nowhere more than a quarter of a mile wide, it is one of the few flat places on the entire peninsula and therefore home to most of the area's 3,000 inhabitants. We anchored in its sheltering crook and turned in for some much-needed sleep.

Next day a friendly Icelander, Mr. Sveinbjörn Sveinbjörnsson, offered to show us about in his Russian-built Moskvitch sedan. Driving with him through a verdant little valley, we came across a scattering of some 30 small houses. "Summer homes," our host explained in answer to our quizzical looks.

"Why do they bother," Pat asked, "when they're only a mile from town?"

"It's far enough," said Mr. Sveinbjörnsson, "to escape one's neighbors and the ever-present sea." It had never occurred to us that seaside living could become monotonous.

Pat was feeling so uncomfortable by now that it seemed unwise to delay the last leg of our journey any longer. Sheep browsed on the narrow beaches beside us as we again swung *Delight* into the fjord's narrow channel. The clouds above Vestfirdhir's glacier appeared afire in the crimson light of the setting sun. Night fell and the green fluorescence of the aurora borealis flashed and twisted across an incandescent sky. It was such an awesome and haunting sight both of us were loath to go below.

Quick Cure for a Now-rare Illness

The run to Reykjavik was a romp. The wind held fair, the compass behaved itself, and we had the feeling the gods of the northern seas had tried us, found us not wanting, and rewarded us with a perfect passage. Once in Reykjavik we wasted no time in finding Pat a dentist. His diagnosis: scurvy.

The disease stems from a lack of vitamin C in the diet; in the old days it affected the crews of wind ships long at sea. It can be averted by drinking fruit juice. Although we had cans of juice aboard, constant crises made it difficult to follow any schedule, and Pat had obviously consumed too little. But vitamin C tablets and fresh oranges cured her within a few days.

Sanctuary in a desolate domain, a Lutheran church at Skálholt huddles in winter's chill. Trenches in chevron patterns drain farm fields that would otherwise become bogs during spring thaw. Less than five hours of daylight brighten Iceland's face at midwinter. As if in recompense, the midnight sun often makes a glimmering twilight of summer nights.

Togetherness is a warm tub: Adults and children crowd a small public pool in Reykjavik to soak in natural hot water drawn from nearby springs. Although air temperatures range from the high 50's in summer to below freezing in winter, the water remains

BLOEDHORNE © NATIONAL GEOGRAPHIC SOCIETY

around 85 degrees. Numerous outdoor pools operate year-round, doing a brisk business even in cold weather. Those who have taken the plunge say that few pastimes are more exhilarating than sitting in the warm bath when arctic winds are swirling about them.

Our circumnavigation of Iceland was over; only the run to Great Britain lay ahead. It would be epilogue—but what an epilogue!

Winter weather had definitely set in. Gale followed gale, always from the southeast. They made the south coast we had to pass again on the way to Scotland a lee shore and the passage an impossible beat to windward.

Gales Hold Yacht in Port

Every morning in Reykjavik I checked the weather report. Day after day I returned to *Delight* and reported to Pat, "No go. What shall we do this afternoon?"

Some days we followed old trails of the Vikings, riding Icelandic ponies. Averaging only 13 hands, or 52 inches tall, these rugged beasts have changed little since the Norsemen brought the first ones to the island in the long ago (page 252).

On our thirteenth day in Reykjavik, I made my usual trip to the radio shack of the Iceland Coast Guard cutter *Maria Julia* for the weather forecast. I noted that the mountains were white with fresh snow. I groaned.

"Will we never get away?" I asked the old seaman on watch.

"Far from home is far from joy," he replied. "Winds today will not be too strong. You may not get another such opportunity until spring. You had better go. Bless."

We had sail on and were clearing the harbor within the hour. In three days, racing before a fresh northeaster, we made half of the 775-mile passage. We started to relax.

With darkness on the third day came a rapidly falling barometer. Gradually the wind veered to head us. It freshened. By 2 o'clock in the morning it was howling in, dead on the nose, at gale force.

Concrete phalanx of apartments in Reykjavik sprouts a forest of television antennas. Most early Icelandic dwellings—built of stone and timber and faced with sod—wore a summer thatch of green grass. The use of concrete in this century has signaled the demise of the old-style houses; few remain even in remote rural areas.

Television came to Iceland only three years ago. The nation's single channel beams local, European, and U. S. programs to 30,000 sets.

ATTACHMENT BY JAMES A. SUGAR © N.G.S.

His eye on the future, Skarphédinn Jóhannsson (above) seeks to free native architecture from the rigid grip of convention. His inventive design for the Iceland exhibit at Expo 67 in Montreal won international plaudits. Before him rests a working model for a school.

World-renowned author, Halldór Laxness won the 1955 Nobel Prize in Literature for his "vivid epic writing which has renewed the great narrative art of Iceland."

You do not try to beat a racing yawl into this kind of weather; you heave her to and hope not to make too much leeway until the wind comes fair once more. I furled the mainsail and bagged the jib, leaving only the mizzen standing.

We went below, made ourselves as comfortable as we could, and left *Delight* to the wind and sea. We stayed in the cabin, generally speaking, for 14 days and nights. Occasionally we made sail and tried again, but not for long. Once we barely got the canvas off before a squall, with winds gusting to 80 knots, sent us scampering below again.

Close Call With a Mid-ocean Rock

Having no sun, no stars, no way to figure position by dead reckoning, we had little idea where we were. We were to find out in a terrifying way.

It was one of the days when we managed to get the jib run up and go to sailing. Pat had the helm, I was clinging to my soggy bunk trying to sleep.

Then I heard Pat scream above the din of wind and seas, "Come quickly!"

I was on deck in time to see a gaunt black rock dead ahead, towering above our masts, a lather of foam at its base. Pat, using all her strength, was forcing the tiller to the windward rail. *Delight* fell off the wind, lay flat in the water as the gale caught her broadside, and struggled clear of the great cliff with possibly 200 yards to spare.

"So we know where we are," I said after I had recovered sufficiently to talk again. We both knew. The cliff was Rockall, 225 miles off Scotland's Outer Hebrides (map, page 230).

Rearing 70 feet above the sea and less than 100 feet in diameter, Rockall has taken a dreadful toll of lives. In June 1904 the Danish vessel *Norge* hit the cliff. More than 600 people, bound for America as immigrants, died in the disaster.

Had not Pat kept a good lookout, or had it been night—for Rockall is not lighted—*Delight's* bones and ours would have joined those already there.

The near disaster at Rockall reminded us that safety lies at sea. Danger comes from the land. We worried about our landfall on Scotland's Outer Hebrides if the gales continued. They did.

On our 19th day we sighted land through the fog and rain. The gale was driving us on a lee shore. Our only chance was to try to sail through the rock-studded Sound of Pabbay. If we missed the entrance, there would be no turning back. It was a wild, nightmarish experience. Surfing down the faces of giant waves, driven by gale and current, *Delight* leaped ahead, narrowly missed a small island, and then was in smooth water. Thankfully, we anchored behind Kismuil Castle off Barra Island. *Delight* was at last at rest. THE END

Dog-leg harbor at Isafjördhur, on the northwest coast, proved a welcome shelter to *Delight* after a harrowing escape from disaster on nearby ship-killing shoals. The author sailed into the danger area when his compass needle, affected by local anomalies, failed to read true.

Stinging spray douses Wright Britton as he races against time to complete the circumnavigation of the Saga Isle before the onslaught of winter. Once the feat had been accomplished, the modern-day Viking and his wife struck out for Scotland on the last lap of a 4,800-mile voyage that would have taxed the stamina of Norsemen of old.

"We will make our way
through the safe waters. . . ."

Swaziland Tries Independence

Article and photographs by VOLKMAR WENTZEL

National Geographic Foreign Staff

"NGGWENYAMA—the Lion"—his people call him, and I could see why. King Sobhuza II looked every inch a monarch. Powerfully built, he wore the traditional Swazi loinskin and shoulder cloth and sat barefoot upon a tasseled red chair. His greeting radiated the poise and authority acquired during 48 years on the throne of Swaziland.

He seated me on a couch near him, and for a brief moment we examined one another with frank, wordless interest—men of two different worlds, the king and I. He has been a king longer than any other living monarch. Yet, paradoxically, the little land of the Swazis next month celebrates the first anniversary of its independence, after 66 years as a British protectorate.

A peaceful place, Swaziland lies very much in the shadow of the Republic of South Africa, which adjoins it on three sides. To the east, stretching to the Indian Ocean, is Mozambique (map, page 270).

With only 6,705 square miles—less land than New Jersey—Swaziland is southern Africa's smallest country and one of the least known. Incoming mail, in fact, sometimes gets misdirected to Switzerland. The nation's biggest city and administrative capital is Mbabane (pronounced IM-ba-ban), a bustling town of 14,000 nestled in a sheltered valley of the western high veld (pages 274-5).

But in this miniature kingdom there are beauty, a temperate climate, and the ingredients for a prosperous economy. Rugged

Hailing the rebirth of his nation, King Sobhuza II speaks at a ceremony marking independence from Britain, ruler of Swaziland since the Boer War. Return of sovereignty last year for the miniature southern African kingdom of 400,000 fulfills the monarch's lifelong goal. Guiding his people along a path midway between traditional Swazi and Western cultures, the king here wears his finest trappings: dark tail plumes of the widow bird, red touraco feathers, otter-fur headband, and oxtail cape.

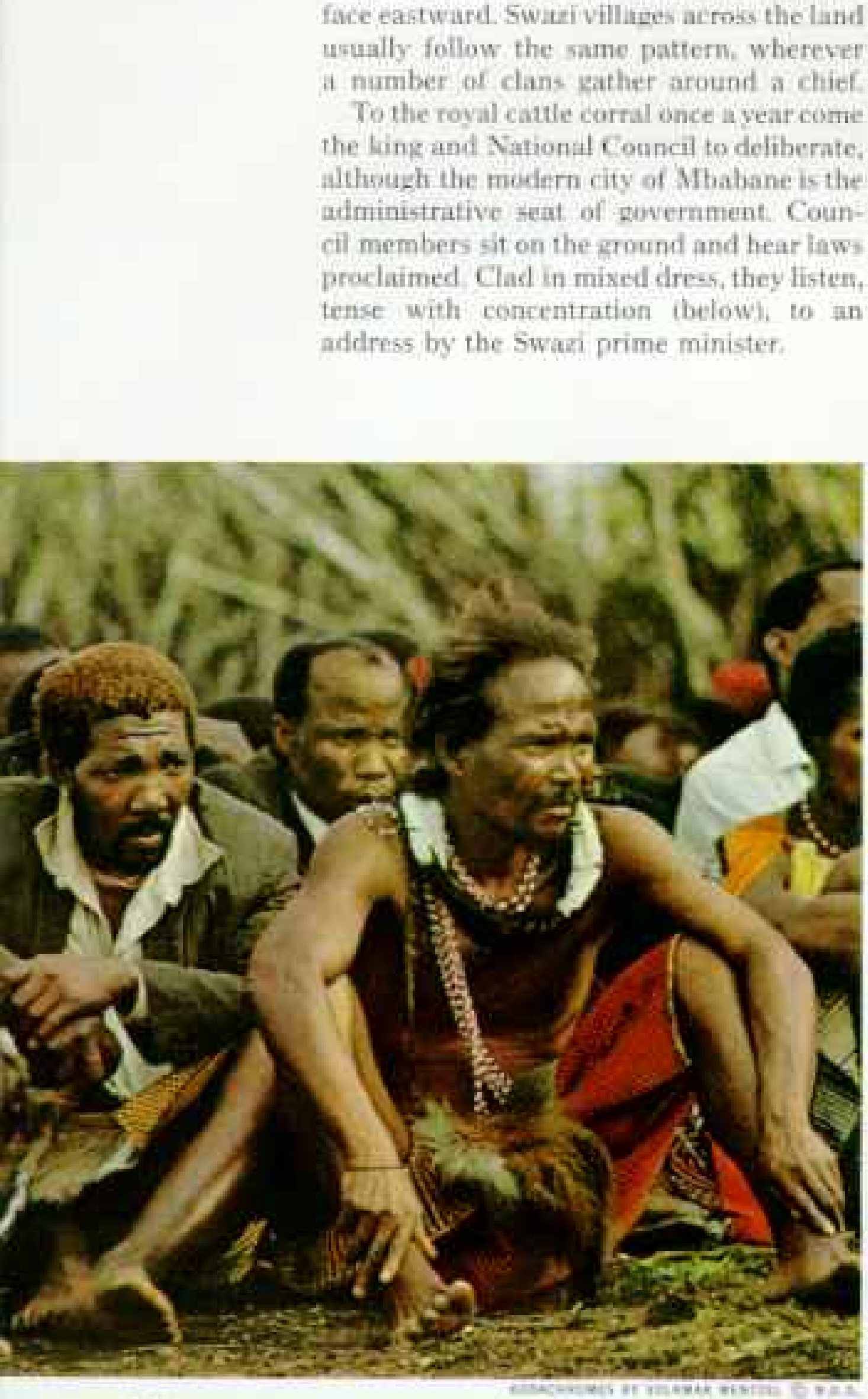

The Kingdom
of Swaziland

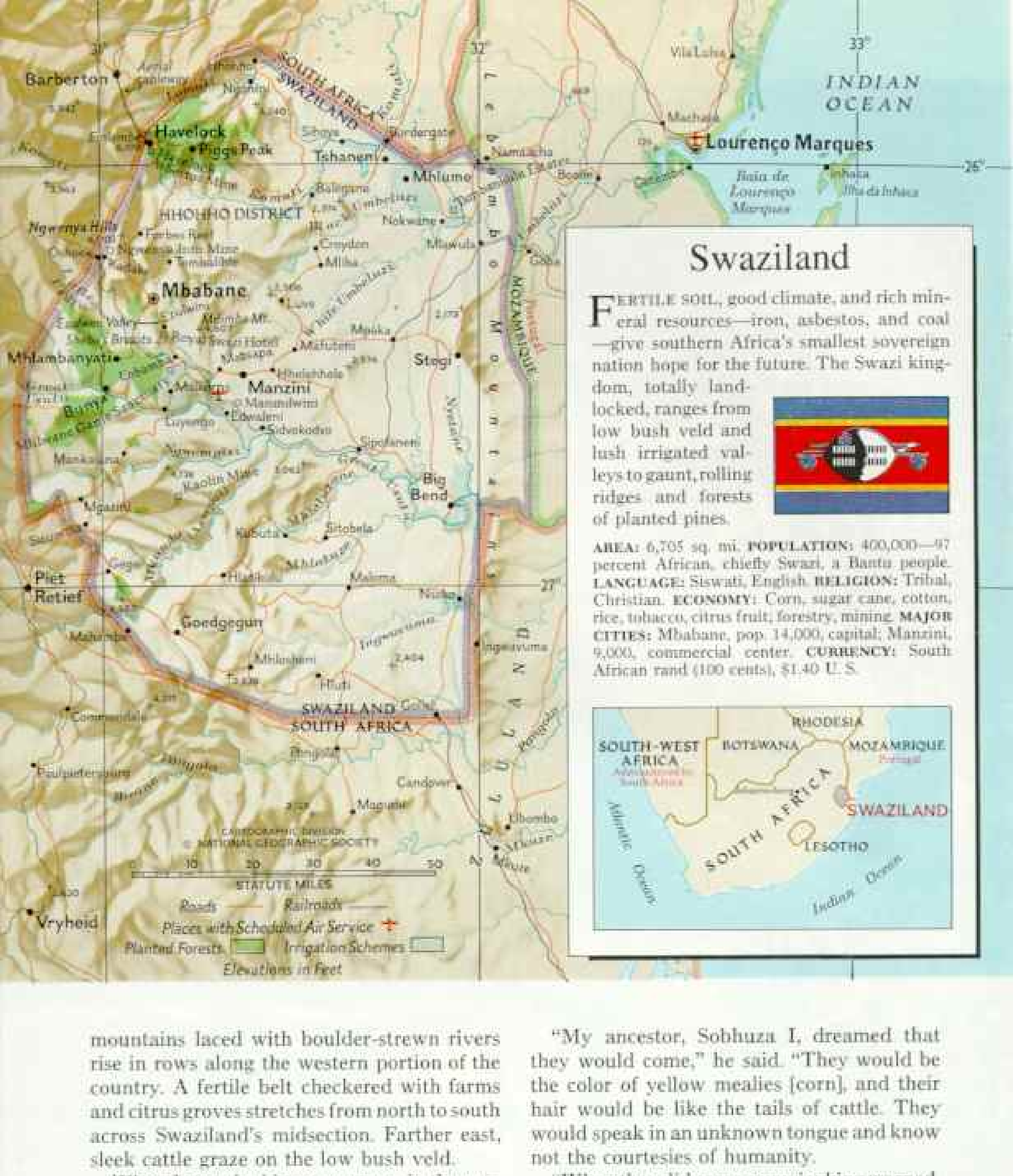
Lobamba: spiritual capital of the kingdom

ROUND THATCHED HUTS like beehives cluster close to a circular cattle enclosure at Lobamba. The village is home to two symbols sacred to the Swazis: the queen mother and the royal cattle, which traditionally represent the wealth of the kingdom.

Though her attendants live in huts, the queen mother enjoys a modern house, center —one of the Swazis' numerous and successful accommodations to a changing world. Large neighboring enclosure provides homes for some of King Sobhuza's wives; other huts serve as tribal embassies staffed by courtiers from Swaziland's nearly 200 clans. Custom dictates that the corral entrance, at far right, face eastward. Swazi villages across the land usually follow the same pattern, wherever a number of clans gather around a chief.

To the royal cattle corral once a year come the king and National Council to deliberate, although the modern city of Mbabane is the administrative seat of government. Council members sit on the ground and hear laws proclaimed. Clad in mixed dress, they listen, tense with concentration (below), to an address by the Swazi prime minister.





Swaziland

FERTILE SOIL, good climate, and rich mineral resources—iron, asbestos, and coal—give southern Africa's smallest sovereign nation hope for the future. The Swazi kingdom, totally landlocked, ranges from low bush veld and lush irrigated valleys to gaunt, rolling ridges and forests of planted pines.

AREA: 6,705 sq. mi. **POPULATION:** 400,000—97 percent African, chiefly Swazi, a Bantu people. **LANGUAGE:** Siswati, English. **RELIGION:** Tribal, Christian. **ECONOMY:** Corn, sugar cane, cotton, rice, tobacco, citrus fruit; forestry, mining. **MAJOR CITIES:** Mbabane, pop. 14,000, capital; Manzini, 9,000, commercial center. **CURRENCY:** South African rand (100 cents), $1.40 U. S.

mountains laced with boulder-strewn rivers rise in rows along the western portion of the country. A fertile belt checkered with farms and citrus groves stretches from north to south across Swaziland's midsection. Farther east, sleek cattle graze on the low bush veld.

When I met the king a year ago, in the parlor of his Victorian-style plantation house at Masundwini—"the place of the palm trees"—I could not help wondering about the country's future. Was this tiny land ready to move out from under British protection? How could it survive, caught between the opposing racial policies of the Republic of South Africa and the rest of the continent?

But the Lion King spoke hopefully of Swaziland's future. He talked, too, about the first white men—British and Boer traders—who had arrived almost 150 years ago.

"My ancestor, Sobhuza I, dreamed that they would come," he said. "They would be the color of yellow mealies [corn], and their hair would be like the tails of cattle. They would speak in an unknown tongue and know not the courtesies of humanity.

"When they did come, our wise king warned, it would be futile to take up arms against them, for their weapons could kill at great distance. So we received them peacefully."

Swazis Signed Away Their Heritage

King Sobhuza's account of what followed reminded me of our own wild frontier days in the United States—the gold strikes, the gamblers, the cattle thieves. Inevitably, the Swazis fell prey to slick concessionaires. As their king signed paper after paper, their land, their minerals, and their grazing rights melted

Doughty co-monarch, the queen mother leaves a council meeting in the Lobamba corral. Sobhuza's real mother having died, a former wife of the king assumes the post. Swazis revere her as the *Ndlovukazi*—She Elephant.

Dignified in ceremonial role, the king and his prime minister, Prince Makhosini, right, receive the representatives of foreign nations at the royal residence at Lobamba. The king wears the leopard loinskin reserved by Swazis for formal functions.

PHOTOGRAPHS BY JAMES H. PICKERELL, BLACK STAR (ABOVE) AND VOLKMAR WENTZEL, © N.G.S.

away. One document even ceded a monopoly for pawnbroking in Swaziland.

"Those marks that the British and the Boers had us put on their papers," the king said, "were strange to us, and we had no idea what they would lead to. They really conquered us with paper."

When the British assumed control of the territory in 1902, their chief contact with the Swazis was Queen Regent Labotshibeni, known to her people as Gwamile. Speaking of her, King Sobhuza said, "She was the first among us who reasoned that money and books were the key to the white man's power. She brought in a Zulu teacher from South Africa and built our first school. I, her grandson, was one of the first students."

There was a gentle smile on King Sobhuza's face. "We owe much to Gwamile. Swaziland will be her monument—a peaceful country living in friendship with its neighbors. White and black men will work together here."

As if to symbolize the king's hopes, two cooing pigeons walked in the door and strolled across the rug past his feet.

During his long reign, King Sobhuza II has fought to regain his countrymen's lost rights. Always he has used the white man's law as his weapon.

The king took a time-faded photograph off the wall and handed it to me. A dapper young Sobhuza appeared there, surrounded by men in top hats and striped trousers.

"In 1922, one year after I became king," he said, "I led this mission to London. By tribal levy, every Swazi man contributed toward our effort. We hoped to win back our lands from the foreigners in our country."

Looking at the framed photograph, I thought of other pictures. Formally dressed American Indian chiefs had posed self-consciously like that on our Capitol steps—engaged in similar futile missions.

The ancestors of this remarkable king were members of the Dlamini clan, powerful in southeastern Africa since the mid-18th century. The Dlamini had migrated south from central Africa to this area, conquering as they came. Defeated enemies were turned into loyal vassals. By the 1840's King Mswati, son of Sobhuza I, had completed his forebears' struggle to weld some seventy of these clans into the Swazi nation. The unity he inspired still typifies the Swazis.

Council Meets in Cattle Corral

That unity was evident the day the king spoke before the Swazi National Council in the royal village of Lobamba (pages 268-9). The council by tradition meets once a year in the queen mother's cattle corral, and members had gathered to hear the king speak about the responsibilities of independence.

Lobamba had never held such a crowd. Princes, chiefs, and men of lesser status—from all over Swaziland they had come. I joined the milling throng outside the meeting ground. But as we funneled toward the entrance, progress slowed to a crawl. I looked for a better way in.

A chief of royal rank walked by with purpose in his stride, and I left the crowd to follow him. There were no silks or satins, no ruffled collar on this aristocrat; just a loinskin and a red feather in his oiled hair to signify his nobility. From the slit in his earlobe a cigarette dangled, and a yellow transistor radio bounced on his hip.

Fortunately he took pity on me, a stranger. "Come this way," he said.

Together we squeezed through a hidden entrance into the cattle corral. Fierce-looking royal guards, their hair bleached by sun and sprayed with fat, shepherded the incoming crowd to seats on the muddy ground. Then, brandishing their knobbed sticks with authority, they cleared an aisle in preparation for the entrance of King Sobhuza II.

My new friend—I learned he was Chief Mkosini, a ruler in the lowland bush veld—steered me to an unoccupied square foot of mud next to a warm and fragrant heap of cow dung and motioned for me to sit.

Sit? I glanced down at my freshly washed khaki trousers, then dropped my aluminum camera case into the mud and perched on it.

But something was wrong. From all sides, angry stares were fixed upon me. A wild-eyed zealot of a guard loomed up. His scowl, the handcuffs clipped to his belt, and his gesture—wrists crossed—were plain enough. I was about to be arrested.

Just in time, Chief Mkosini came to my rescue. "On the ground! Before our king, all must sit on the ground!"

It was well worth muddying my last pair of clean pants, for immediately friendly smiles surrounded me again.

From the gate, now, came the sound of chanting. Thirty-five young warriors, naked to the waist, pranced down the path that the guards had cleared. In their left hands they held spears and cowhide shields. In their right they carried bundles of leaves.

"Are those leaves symbols of peace?" I asked Mkosini.

The question puzzled him for a moment. "Symbols of peace? Oh, no! The leaves are for the king and his councilors to sit upon. The ground is muddy, you know."

Indeed! I looked longingly over at my camera case and meditated for a moment on the prerogatives of royalty and the elite.

King Welcomed With Chant of Praise

Suddenly, all around us, people began buzzing and humming in a strange rhythmic way that was half song, half chant. The sound rose in a crescendo, the older men exhorting the others like cheerleaders at a football game.

"They are singing the praises of our king," Mkosini said in my ear, trying to make himself heard above all the praising.

The king and his royal council, the *Liqoqo*, had entered now, and were taking seats on the

Night haunt of the international set, the casino of the Royal Swazi Hotel lures visitors to the roulette table. Here the author found a diverse clientele of Portuguese from Mozambique, Italians, Swiss, French, a sprinkling of Swazis, and many South Africans, whose laws forbid gambling. Nestling against a mountainside seven miles south of Mbabane, the resort embraces a swimming pool, hot springs, and a scenic 18-hole golf course.

leafy carpet. Mkosini identified the most important ones to me—the elders, councilors, and ministers. Behind the 70-year-old king came the queen mother, surrounded by a retinue of beehive-coiffured ladies of the court. She was an impressive but rather dour-looking lady, wrapped in animal skins and wearing a headband of ocher-stained wooden pegs (page 271).

Traditionally, the woman who holds the office of queen mother wields almost as much power as the king himself. To the Swazis, she is the venerated *Ndlovukazi*—She Elephant. King Sobhuza's own mother being dead, a former wife has been elevated to the position. Because the king, an educated man, is a capable administrator, the queen mother's duties are now primarily ritualistic.

Dlamini rulers must believe in an equivalent of the old adage about the Habsburgs—

"Let others wage war; you, happy Austria, marry"—for the king's fertility and health are identified with the nation's welfare. He is expected to marry several wives each year from varied sections of the country, and to beget more children than any of his subjects. King Sobhuza II has more than fifty wives.

The royal lineage, understandably, becomes quite complex. Even the Swazis find it hard to follow; so one task of the queen mother is to keep track of the situation. Sons of the king—and sometimes even his nephews—become princes, and may have limited powers over outlying principalities.

In the mid-1800's the Swazis held much of the territory that now surrounds their tiny country, defending it against fierce raids by the Zulus. When the Swazis appealed to the British for help, Zulu pressure eased.

Soon Swaziland faced a new menace. South

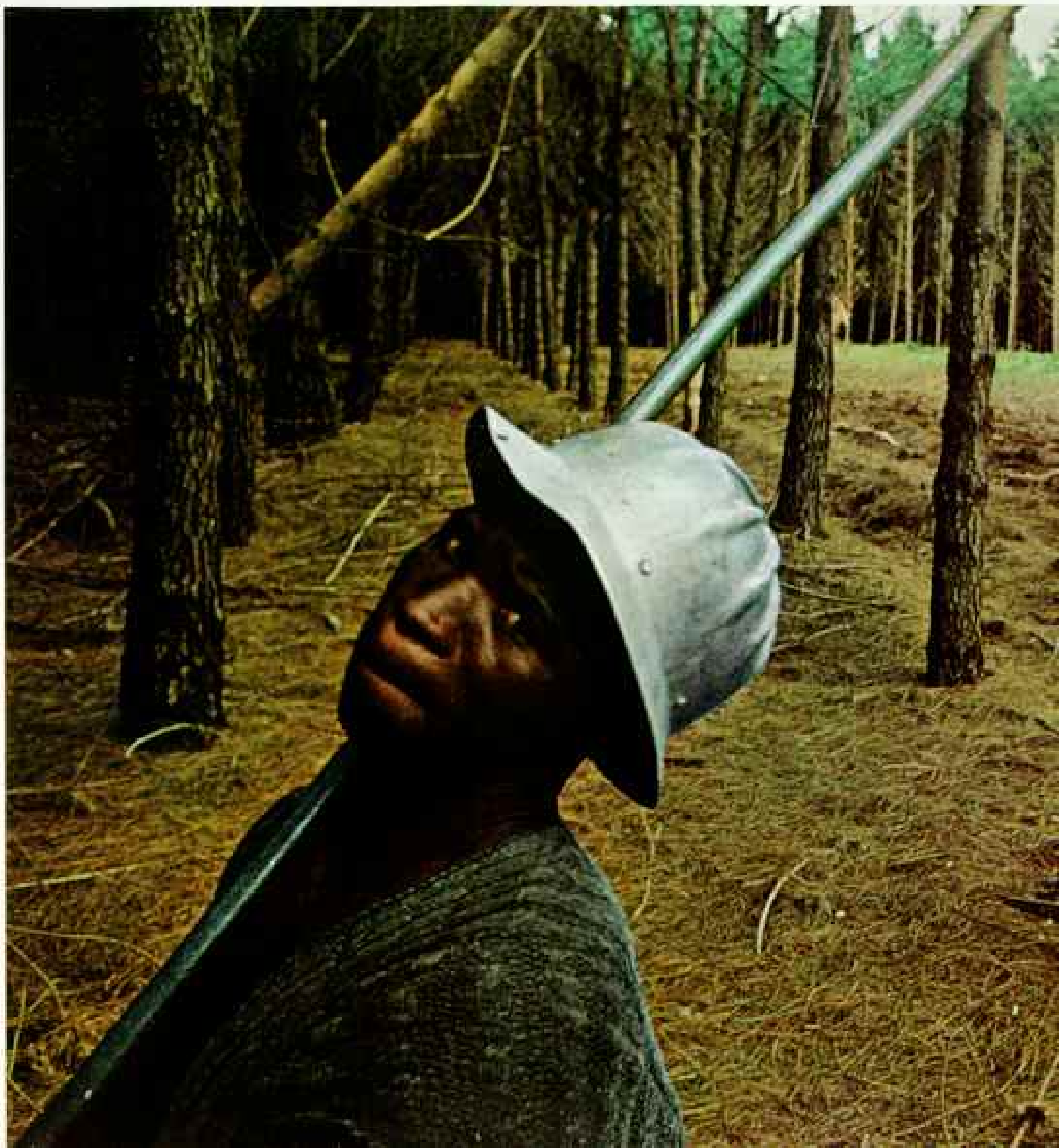
ROSAGRAMES © N.G.S.

Brightly blending two worlds, a village chief and one of his wives admire gadgetry at Mbabane. Window reflects bustling traffic. The woman's ocher-tinted, beringed hairdress identifies her as a diviner—one who tries to fathom the causes of disaster, illness, or death.

Metropolis of a micro-state, hill-girt Mbabane gleams in the bracing autumn air of the high veld. Home of 14,000, the city serves as administrative capital. From aloft its main street, which has the nation's only traffic light, resembles a thermometer bisecting the town.

Up from earth's depths, a shift leaves the Havelock Asbestos Mine. From one of the world's largest asbestos deposits, the Havelock yields 40,000 tons a year for the nation's second largest mineral export after iron. A cableway carries pans of ore 12½ miles across rugged peaks to the nearest railhead, in South Africa.

Teamwork on a tree farm: Leaning into a metal pole, a woodsman of the Usutu Pulp Company pushes a tree to keep it from pinching his partner's power saw. The crew can fell a tree a minute in the 104,000-acre forest planted by the British. In the luxuriant "mist belt" of the high veld, pines grow 60 feet tall in only 15 years.



African Boers rumbled onto the country's rich pastureland in their *voortrekker* wagons to settle. Once again a Swazi king asked for British help. The British Government was reluctant to interfere—but British prospectors and fortune hunters were less reticent. They flocked into Swaziland, searching for quick wealth. Many found it, for gold was discovered in the northwest between Forbes Reef and Hhohho (map, page 270).

And so two opposing groups of whites came into the land. After decades of maneuvering by Britain and the South African Republic, Swaziland, following the end of the Boer War, became a British protectorate. The Swazis—who had never fought either side and who had been promised freedom by both—found themselves without their sovereignty and with most of their land in foreign hands.

Not to Be Swallowed by Crocodiles

But now independence was on its way. Sitting there in the muddy corral, I gazed around to see the Swazis' reaction as their prime minister told of his recent negotiations with the British.

For more than an hour he stood there, in his Savile Row suit, microphone in hand, holding all the Swazi hierarchy spellbound. Only the king's attention wandered now and then, when one of his three little daughters wriggled restlessly at his feet or stood up to run her tiny hands through his curly beard.

Then King Sobhuza rose to speak. He too used Siswati, the national tongue. My friend Mkosini translated for me.

"Freedom will not change our country overnight," the Lion King of the Swazis said. "But change will come, and we must know the dangers. We have watched others cross the river—and we have seen some of them swallowed by crocodiles. But we have learned from their mistakes. We know the dangerous places, and we will make our way through the safe waters, away from the crocodiles."

Later, with the sound of chanting still in my ears, I left the corral and drove four miles north into the blackness of the Ezulwini Valley—"the place of heaven." Ahead of my Land-Rover, the Royal Swazi Hotel glittered like a luxury liner at sea.

After a shower and a welcome change of clothes, I walked into another world. Beneath elegant chandeliers, Portuguese from Mozambique, goateed Swazi princelings, monocled Englishmen, and prosperous descendants of the pious voortrekkers stacked their colored chips on roulette tables (page 272).

Where a mountain once reared, a man-made crater steadily deepens. Iron mining began at Ngwenya in 1964, after tests showed the Bomvu Ridge to be more than 60 percent iron-rich hematite. A consortium built 136 miles of railroad to carry the ore to Mozambique for shipment, and even developed coal deposits along the route to stoke the trains. Steel mills in Japan will devour virtually the entire mountain, taking an estimated 20 million tons of ore by 1974.

Rust-red stain from iron ore tints a moplike coiffure. Carbon-dating of Stone Age diggings in the mountain reveals that 43,000 years ago primitive Africans mined the ore, probably for use as body paint—the earliest mining operation known.

In the wee morning hours I witnessed the finale of an epic gambling spree. Starting with a mere $200, Sir R—a mysterious loner—had played three nights through and run his stake up to $50,000. The picture of cold and calculating concentration, Sir R wore out one set of bleary-eyed croupiers after another. He kept winning and winning.

Sir R finally cashed in his chips and left. But the less fortunate, ever hopeful, stayed to pump the levers of the whirring slot machines right into a coffee-scented bacon-and-egg dawn. Outside, the sun rose over Mdimba Mountain, and the cocks crowed in Lobamba.

Two iron mines scar the Ngwenya Hills, 10 miles northwest of the Ezulwini Valley. One is a very modern operation. The other is the oldest known mine in all the world.

I visited the new Ngwenya Iron Mine first, a huge terraced pit sunk into a mountain crest (above). The chatter of air drills drifted up from that mammoth hole, and giant electric

PHOTOGRAPHED BY VOLKMAR WENTZEL, NATIONAL GEOGRAPHIC STAFF © N.G.S.

shovels fed the yellow trucks that bustled around like busy ants.

Donneford Wentworth, manager of the mine, told me how it came into being. "We are a United Nations operation in a practical sense," he said. "Britishers, Japanese, Portuguese, Norwegians, Swazis, and South Africans—like myself—all working together.

"We blasted tunnels through the mountains and built a 136-mile railroad. It links our mine to a modern ore-loading wharf in Lourenço Marques on the Indian Ocean. And we've developed coal deposits down in the bush veld to fuel the trains."

Within a decade, I was told, much of the mountain will be gone—gobbled up by furnaces of Japanese steel mills, 8,000 miles away to the northeast.

Don and I drove down the mountain to an attractive crescent-shaped village built for the mine's Swazi employees. There I met a young scientist who was mining the past.

Peter Beaumont, archeologist from Witwatersrand University in Johannesburg, was busy classifying hundreds of Stone Age artifacts. When he offered to show me their original resting place, I accepted with delight.

The trip to the site, though, proved far from delightful. We clawed and slipped our way down a cliff face on a precariously steep trail until we reached a cave dug into the mountainside.

Early Men Mined "Blood of the Earth"

Peter gestured at the gouged and broken cavern walls. "This is by far the oldest mining operation ever found," he said. "The ash layers have been carbon-dated at Yale University and Groningen University in the Netherlands. They prove the mine was worked as long ago as 43,000 years."

It seemed incredible to me. Stone Age men mining metal ore?

But Peter explained. "The fact that this hematite is iron ore obviously meant nothing to them. I—and my sponsor, Professor Raymond Dart of Witwatersrand University, who sent me here—believe those ancient men were attracted by the ore's color."

He picked up a fragment of ore and handed it to me. "The clue lies in its name. In Greek, hematite means 'bloodlike'—or 'blood of the earth.' Skeletons of early men smeared with this reddish stuff have been found in both Africa and Europe. Africans still use it, in a ritualistic way."

I remembered, then, the ocher-colored pegs I'd seen in the queen mother's headdress. Blood of the earth.

"Early men knew that when they stuck something through a living creature, blood gushed out and the victim fell down, never to move again. Perhaps they smeared the bodies or the bones of their dead with this hematite 'blood' in an attempt to bring them back to life. Perhaps, even, to ensure some kind of immortality—that might have been the first religious ritual."

Modern Swazis use iron to shape elegant points for the *assegais* (spears) that tribesmen still carry. I saw these everywhere. To see how they were made, I sought out a blacksmith.

Guided by Solomon R. Mavimbela, a bearded man who sold spears in the market at Mbabane, I headed my Land-Rover into the mountains east of the city. The steep, deeply rutted trail finally flattened out onto an undulating mountaintop strewn with giant granite boulders. Among them, linked by winding paths, clustered groups of thatched beehive huts, each with its patch of corn and pumpkins. Blue smoke filtered through the thatch

Medicine man's bedside manner: Frenziedly dancing, bellowing, and brandishing a spear as four of his wives beat drums, herbalist Lukhas Nkambule works himself into a trance to treat a patient. Ornamented wig and ocher-stained necklace help summon a father spirit, which empowers Nkambule, with the help of roots, bark, and medicinal herbs, to work his cure. Herbalists and diviners often earn a cow or an ox for their ministrations and become relatively well to do. When the author departed, Nkambule and the father spirit were haggling with the patient over the cost of the treatment.

Catching the spirit of daddy's practice, a son of "Doctor" Nkambule breaks into dance.

to rise in the morning air. I reflected that this was Swaziland as it must have been before the white man came.

Suddenly, someone shouted: "*Sakubona, utekwentani Lomlungu laphai*—We see you [hello], why does the European come here?" Only then did I notice two Swazi girls hoeing a parched corn patch in the distance.

"He has come to propose to you," Solomon answered them with a laugh.

I heard their answering giggles. "We will marry him because we want a tractor to help our parents. That will be our *lobolo*."

Solomon explained to me that the average lobolo—bride price—is about twelve cattle. "But these girls have a high opinion of themselves," he said. "And they just don't know what a tractor costs."

The practice of lobolo, Solomon pointed out, is completely misunderstood by most whites. "They think it means buying and selling women like slaves," he said. "That's wrong. We appreciate our women, and take pride in our family names. At the time of a

marriage, the family of the bridegroom pays lobolo to the bride's family—not to buy the woman, but to compensate her relatives for allowing her children to acquire the father's surname. By virtue of the lobolo payment, the children can become members of the husband's family."

My would-be brides resumed their hoeing, and we drove on in search of our blacksmith. We finally found him beneath a rocky overhang. Out of the smoky semidarkness, where fire glowed and bellows hissed, stepped Joseph Gama. He nodded, then went back to his forge to work on a piece of metal that glowed red-hot. I asked, hopefully: Was it made from hematite ore? No, it had once been part of an automobile spring.

Removing it with a wet piece of wood, he laid it on a stone anvil and skillfully pounded it into a spear tip. One of his young sons, meanwhile, pumped a goatskin bellows to keep the forge glowing. Hematite or not, an assegai spearhead lay in the back seat of my Land-Rover when I finally drove back down the mountainside.

PHOTOGRAPHS BY VOLKMAR WENTZEL (C) N.G.S.

"This Is a Good-natured Country"

Mbabane was made the capital by the British after the Boer War. Its winters are bright and sunny, its summers warm and thunderous. With tree-lined streets, cricket field, and meeting places of Parliament and the High Court, Mbabane is a bit of England and Africa combined (pages 274-5). Mornings, I found, can be as chill and foggy as those of London.

One bright morning I stood near the "robot"—Mbabane's only traffic light—to watch the crowd swirl by. Smartly dressed wives of white farmers and engineers, Swazi princes in shiny black Mercedes cars, market-bound Swazi women balancing baskets of produce on their heads, and countryfolk with loinskins and shoulder cloths—the parade was as varied as it was interesting. As I turned to leave, a tribesman on horseback clattered through the traffic, hurrying to beat the light before it turned red.

Later, I nursed a cup of good English tea in Government House while Sir Francis Loyd, the British Commissioner, spoke of the future.

Statue-still, senses straining, an impala scans for danger in the Mlilwane Game Sanctuary. Once a verdant land teeming with game, Swaziland saw overgrazing denude its grasslands and hunters slaughter its game for meat and hides until many species vanished.

In 1961 Terence Reilly, son of a former tin miner, began collecting and protecting animals on the site of the family's exhausted mine. Five years ago he formally opened to the public a 1,100-acre tract—Swaziland's first park. Today Mlilwane shelters growing populations of giraffes, rhinos, hippos, crocodiles, ostriches, zebras, and antelopes, many brought by Mr. Reilly from other African preserves.

The word *impala* entered English dictionaries from the antelope's name in Siswati, the Swazis' melodious tongue.

Pattern for progress: Irrigated farms landscape former grazing land in the fertile Malkerns Valley. Elephant grass windbreaks shelter young citrus trees—orange, grapefruit, lemon. Beyond pineapple and vegetable plots stand mature citrus and avocado groves. Though costs restrict irrigation farming

"Small as it is," he said, "Swaziland can exert quite an influence on the rest of Africa. A calming influence. This is a good-natured country—one without the usual tribal tensions, because the Swazis are all one people. The country is fortunate, too, in having a leader like King Sobhuza—a skillful diplomat, and very popular."

Swaziland, Sir Francis told me, had made impressive economic strides since World War II. A huge man-made forest—104,000 acres of pine and eucalyptus trees—has been planted along the cool, rainy slopes of the high veld (pages 276-7). One of the fastest-growing forests in the world, the trees are processed by the Usutu mill at Bunya into wood pulp for export.

Citrus groves and vast pineapple fields thrive in the temperate climate of the middle veld (left). Large irrigation projects have turned much of the bush veld as well into productive fields of sugar cane, citrus, and rice.

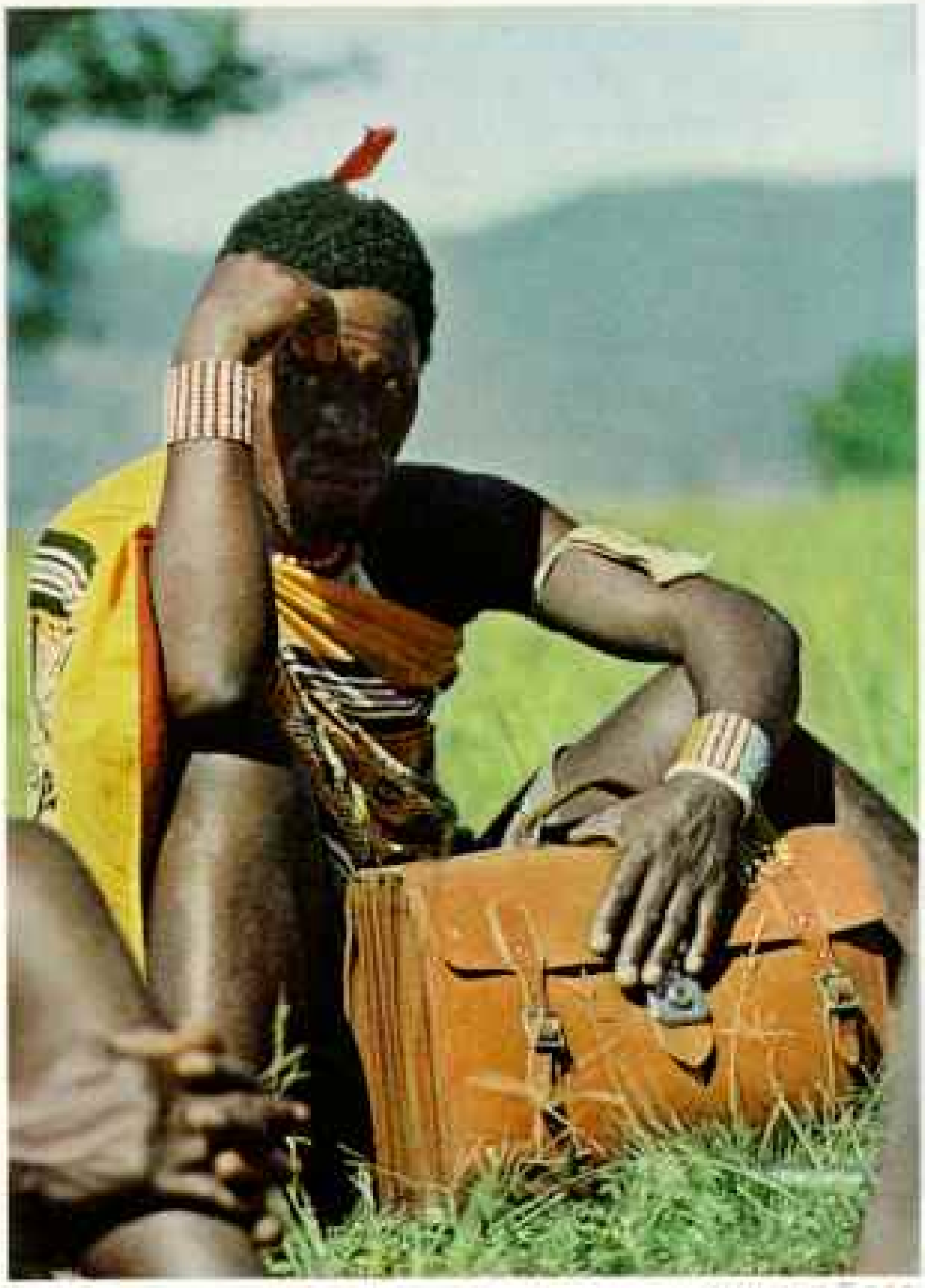
So Swaziland is not dependent on a one-crop economy. Iron ore, asbestos, sugar, wood pulp, cotton, beef, and fruits give it a respectable array of exports for such a tiny nation.

But Sir Francis was quick to point out that the picture had its dark side too.

"Cash crops come mostly from the large farms," he said, "and few of those are owned by Swazis. The average small farmer raises just enough corn for his family to eat and enough sorghum to brew his beer. What cattle he owns

largely to landowners of European descent, the Swaziland Agricultural College vigorously carries modern methods to the villages.

Breakfast grapefruit for Britons and other overseas importers fills a wagon at Tambankulu Estates, where 100,000 citrus trees thrive on irrigated bush veld.



Harried executive, a headman frowns his concern over the price of improvement. At a council of chiefs, his district commissioner urged him and his peers to finance a new secondary school by assessing each headman two cows. With such self-help schemes, the kingdom strives to spread education in a land plagued by 75 percent illiteracy. Royal touraco feather and bulging briefcase give double distinction to this headman of the western Hhohho District.

are kept for paying lobolo and for ritual purposes. His cattle overgraze the land, encouraging erosion; his farming methods ruin the soil.

"Still," he pointed out, "the Swazis have made fast progress. The illiteracy rate is 75 percent, but it is falling. They have new schools and a fine agricultural college now."

Like most of the country, the fertile middle veld is a patchwork of Swazi- and European-owned land—a result of that 19th-century paper conquest. Gradually, the Swazis have bought back land from the foreigners, through the Swazi-sponsored Lifa, or "heritage," Fund. Established 20 years ago, the fund served a dual purpose. Cattle were culled from the larger Swazi herds—an action which, of course, reduced overstocking. When the animals were auctioned, part of the proceeds went to the Lifa Fund to buy land. More than a quarter of a million acres have been bought this way and apportioned out to Swazi farmers.

The intermingling of Swazi and European farms has resulted in a remarkably smooth relationship between Swazi farmers and their white neighbors. Sir John Houlton, owner of papaya plantations in the Malkerns Valley, explained it to me. "Farmers of both races understand each other and get on very well. They face common problems—droughts, hailstorms, cattle diseases—and fight them together."

Sir John, in addition to farming, presides over Swaziland's Senate, upper chamber of its Parliament. Like many Englishmen, he devotedly serves the country's fledgling government.

Doctor Drives Spirits Away

Leaving Sir John's comfortable home, I drove across the Little Usutu River to Manzini, Swaziland's second largest town and commercial hub of the country. Here again one finds the old Africa and the new—a teeming native market and suburban streets bordered by split-level houses with swimming pools.

East of Manzini, the road winds gently over a ridge at Hhelehhele. According to local legend, a wizard named Zimu roamed these hills to tear out the hearts of unsuspecting travelers in the dark of night. Belief in magic, even today, rules much of Swazi life. Sorcerers, the Swazis believe, can use lightning as a weapon, and raise the dead in the form of tiny flickering shadow spooks.

I had heard much of Swaziland's medicine men, or herbalists. Isaiah Magagula, one of the king's councilors, took me to pay an office call on one of them, Lukhas Nkambule, who practices his esoteric art near Mpaka—a bone's throw from the domes of a new British nuclear-detection station.

"Dr. Nkambule is very good with enemas, bloodletting, poultices, and vapor baths," Isaiah remarked. "He also sets bones and can talk with many spirits."

"Doctor" Nkambule greeted us cordially and directed us into one of his huts. In the gloom of its interior, four women were monotonously beating large oxhide drums.

"The doctor's wives," Isaiah explained. Then

he pointed to a figure slumped on the floor. "There is the patient. His family has paid the doctor to drive the spirits from him."

The drumming burst into a frenzied beat as the doctor, now a terrifying figure, appeared silhouetted against the low entrance of the hut (page 280). He entered, brandishing a spear in one hand and a wildebeest-tail whip in the other. Under a mop of ocher-tinted hair, his eyes flashed like fire.

A baby cried in the background as this mad apparition bellowed, grunted, and darted about the hut. At times he quivered as if he himself were possessed by a spirit. Suddenly the drumming stopped, and a high-pitched, Donald Duck voice quacked away, sounding like a phonograph record played at too fast a speed.

Isaiah nudged me and whispered, "Now you are hearing the spirit."

Of course I asked for a translation of this other-world pronouncement. Isaiah listened carefully. Then in his slow, measured way, he replied, "The spirit, he is wanting more money now." When I left, the haggling was still going on.

Two miles down the road we visited another dealer in the occult—a lady named Mabhodweni Lubisi, a diviner. Seated cross-legged in front of her hut, she was surrounded by a half circle of clients. She gnawed busily on a stick, pausing periodically to say something to her group. Each statement was punctuated with a most unladylike belching sound.

"They have come to find out about some stolen money," Isaiah said. "Lubisi will know who took it."

Her technique, I learned, was to throw out statements to the group. Each time, in response, her clients would clap rhythmically and chant "*Siyavuma, siyavuma*—We agree, we agree." Sometimes the chant was loud, confirming her statement. But when her audience chanted softly, she took the answer as negative.

Like a good lawyer, she tried to piece the evidence together and find the answer by process of elimination. But her technique apparently wasn't working too well today, for she sent her apprentice to fetch "the bones."

They were real bones, not dice, but dice players back at the casino could learn technique from this woman, I thought. Spitting on the bones three times, she flicked them out with a flourish onto a straw mat. Besides small bones of animals, her cast included sea shells, coins, stones, nuts, and a jumble of less identifiable bits and pieces.

"The shells are the spirits," Isaiah explained. "That tortoise-shell piece is a wizard." He pointed to a scattering of antelope metatarsal bones. "The big bones are men and women. The little ones are boys and girls."

Plowing for mealies, the small-eared corn of the Swazi farmer, beaming Solomon Dlamini rests from a seasonal task repeated by tribesmen across the land. A team of eight oxen, guided by one son and whipped by another, pulls his plow. The grain will be ground and mixed with pumpkin to make a porridge that forms a basic Swazi dish. Despite the fertility of the soil and good rains in summer, most farmers eke out only a bare subsistence from the land.

Whipping up a small-scale stampede, herdboys turn their cattle toward the broad Komati River to drink. Rangy Swazi dogs, cousins of the greyhound, join in the dust-raising melee.

Warming to his subject, Isaiah initiated me into the divining art. "Now, if a man or a woman bone falls between two spirits and they are face down, this means death. If a wizard touches a woman, that proves she is bewitched. And if the black stone is next to her, she will die from the wizard."

Very interesting; still, it seemed to have little bearing on the crime. "Who stole the money?" I asked.

Isaiah pointed to an age-yellowed bone that had landed in front of a Portuguese coin. "That means an old man took the money, and that he ran away in the direction the bone is pointing. That way, toward Mozambique."

I drove in the same direction, not to catch a

Lean Nguni cattle, poor in milk, probably will be used for ritual slaughters and *lobolo*—payment to a bride's parents to assure that children of a marriage belong to the man's family.

thief but to pay a call on Mkosini, the red-feathered chief who had helped me avoid arrest that day in the queen mother's cattle corral. The road led eastward across the flat bushland of the low veld to Mkosini's home at the foot of the Lebombo Mountains.

Mkosini ducked out of the doorway of a beehive-shaped hut as I approached. Solemnly, he shook my hand and said, "*Sakubona*, we see you." He wore skins over his red loincloth, like the sporrans of the Scots.

I wanted to photograph Mkosini's home, and to give him an idea of the kind of pictures I had in mind, I handed him a copy of NATIONAL GEOGRAPHIC. The chief riffled through the articles without pausing—until

ILLUSTRATIONS BY GOLDMAN WENTZEL (ABOVE) AND JAMES A. PICKERELL, BLACK STAR © N.G.S.

Last-minute touches groom attendants of the queen mother for a royal function at Lobamba. To style their elegant beehive coiffures, women tie their hair in tufts with concealed strings, then tease the ends with a porcupine quill.

Maidens en masse brandish flashlights and knives in a high-stepping dance at Lobamba. Gathered here for Independence Day festivities, they perform the traditional reed dance. In this annual rite, girls go forth in the night with lights, and cut reeds to repair the windscreen around the queen mother's hut, thus reaffirming their allegiance to the She Elephant. It is the king's right to choose another wife from among the maidens.

he reached the advertisements. Engrossed, he pored over pictures of sleek cars and other Western luxuries, while I gave lollipops to his children—all 16 of them. Solemnly, politely, each child stepped up to receive the candy, then flashed me a shy smile of thanks.

Chief Mkosini laid the magazine aside with one last, longing look, and became the gracious host.

Because the chief heads several families, his home was a village in itself. The main hut, where his mother lived, was the family shrine. Around it clustered smaller huts. Mkosini led me to a group of huts numbered 1, 2, 3, and 4. "These belong to my wives," he said, pushing open the door of hut No. 1.

I peered in. A woman's touch was evident. The stamped-earth floor had been swept carefully. A flowered spread decorated the polished brass bed, and there were curtains on the windows.

In the corner, next to a portable sewing machine, colorful clothing hung from the rafters. The chief saw me glance at the wardrobe. He sighed. "Our women used to be happy with one pleated cowhide skirt every five years. Now they want much bright foreign cloth every few months. No man can keep up with them!"

In a Swazi polygamous household, the husband normally has no hut. He uses his mother's great hut as a daytime base of operations, and visits the huts of his wives in rotation. Each wife cooks for her own children and cultivates her own patch of land for food.

But Mkosini was a modern man, with a hut to call his own. All the farming and family cooking were done cooperatively.

We peeped inside one of the chief's most notable achievements, a mud-and-wattle school. A dozen young children crowded long rustic benches. Under the teacher's guidance, they were busily molding numerals and animal figures from clay. Barren, almost bookless, this schoolroom was still a place of learning. An eagerness for knowledge was there, and the ingenuity of the teacher helped make up for the lack of school supplies.

Mkosini's farming land was larger than most of his neighbors'—some 800 acres—and more productive. He owned a tractor and was installing an extensive irrigation system. Proudly he showed me a printed certificate stating that he had successfully completed a five-day course in growing cotton and corn at the Swaziland Agricultural College.

Mkosini's country gained its freedom last year. How has it fared, this infant nation?

Quite well. While the rest of the human race has busied itself with more dramatic events, King Sobhuza's people have made their quiet way "through the safe waters, away from the crocodiles."

Much remains to be done. Almost all of Swaziland's major income-producing industries are still owned by British and South Africans. But the new country is gaining rapidly in technical education and practical training and experience, and Swazi-owned industries will surely grow.

What other changes have come to pass? More schools are being built—and there's a drive-in theater now near Lobamba.

Will there be another precious year of freedom, and another, and another? It will take all the wisdom that King Sobhuza and his councilors possess. Still, the wise old ruler already has managed to achieve a stable relationship with his country's giant neighbors.

Raised Hearth Symbolizes the Future

When I think about Swaziland's future, I remember a mud hearth I saw being built one day in the Malkerns Valley. It was during my visit to the Swaziland Agricultural College. Mrs. Constance Khoza, a home-economics teacher, stood beside me with shining eyes.

"To you, this may look like just a backyard barbecue," she said, "but here it is as revolutionary as the wheel. You see, it will be a raised hearth and oven—off the ground—and it will get the food out of the dirt [above].

"Think of the change," she went on. "Cooking will mean fewer sore knees and aching backs. Next our women will want tables, and then chairs, and then houses—and a new world for our Swazi people."

I can picture that fire hearth in my mind now, and I see it as Mrs. Khoza did. It has become my own symbol of Swaziland's future.

A nation of gentle people is making its way step by step toward a new life. THE END

Enemies beware! Would-be warriors lunge in the *sibhaca*, a dance that girds men for battle. Shaggy with mohair, and holding spearlike sticks, they will end the dance by falling to the ground —the fate they wish on their foes.

Simple but significant: With bricks of mud and cow dung, women students from the agricultural college build a raised hearth at a homestead in the Malkerns Valley. Iron bars tapped in the top will hold pots above the flame. As they work, teacher Constance Khoza, right, explains the hearth's meaning: No longer must villagers build their cookfires on the ground, inviting germs and backache; now cooking can be comfortable and hygienic. Spreading the method from village to village, the teachers implant the type of modest, gradual improvements on which the kingdom stakes its future.

BOOKENDINGS BY SOLOMAN MENTZEL (ABOVE) AND JAMES H. PICKERELL, BLACK STAR © N.G.S.

SOLVING THE MYSTERY OF

Mexico's Great Stone Spheres

By MATTHEW W. STIRLING

Photographs by DAVID F. CUPP

THAT SUMMER EVENING in 1967 the man telephoning me at my Washington, D. C., home identified himself as Ernest Gordon, a mining engineer.

"Dr. Stirling," he said, "I am calling you about five giant stone spheres I've found in Mexico. These are six-to-eight footers, so perfectly round they seem to be man-made, and they resemble the stones you studied in Costa Rica." *

My interest was quickly aroused. As an ethnologist and archeologist, I have spent much of my life probing the ancient civilizations of Central America. Some of the most fascinating and puzzling artifacts that the early Americans left behind are carved spheres of stone. They range in size from a few inches to giants seven feet in diameter weighing 12 tons; many are smoothly and beautifully finished, and almost perfectly round (page 299).

In 1945, working among 3,000-year-old Olmec ruins in Mexico's state of Veracruz, I had found man-made spheres of basalt as large as three feet in diameter. Later, near Palmar Sur in Costa Rica, I had measured and marveled at much larger ones—some taller than a man. Sculptured of hard granitic rock, even the biggest varied less than a quarter of an inch from being spherical; they were placed in rows and formal groupings. Who made them? How, and when, and why were they carved? No one knows.

The newly found spheres, Mr. Gordon said, were on a mountainside in Jalisco State, in west central Mexico (map, page 297). He had once been superintendent of a silver mine there. At its entrance stood a single stone sphere, and the mine was accordingly named Piedra Bola—Stone Ball. At that time Mexican bandits had infested the mountains near the digging, and Mr. Gordon had not explored the area.

Now, on a recent prospecting trip to the same region—the Sierra de Amecá, 50 miles west of Guadalajara—he had revisited his old

*Dr. Stirling's findings were reported in "Costa Rica, Free of the Volcano's Veil," by Robert de Roos, NATIONAL GEOGRAPHIC, July 1965.

Fit for a game played by Aztec gods, this huge sphere lay hidden in the mountains of west central Mexico for ages. Investigating, author-archeologist Matthew W. Stirling speculated that human hands might have shaped it—until he discovered hundreds in the vicinity. Later, Dr. Robert L. Smith of the United States Geological Survey, here examining the pitted face of the eight-foot-high ball, established its true origin.

Geological sleuth, Dr. Smith studies a spherulite, a stone with a visible growth structure formed in obsidian. He saw thousands along Route 70, west of Guadalajara (map, opposite). Since the giant balls do not occur in obsidian and lack such growth patterns, he reasoned that they are not overgrown spherulites.

In 1930, mining engineer Ernest Gordon, right, had found a single giant at the Piedra Bola mine, whose Spanish name means stone ball. After locating others nearby, he notified Dr. Stirling, who had seen similar spheres in the vicinity of Palmar Sur, Costa Rica.

Country of the colossi: Dr. Smith's party had to travel by mule, horse, and burro to reach the richest site (page 298).

Remote ravines in the Sierra de Ameca yielded the largest spheres yet discovered. Dr. Smith's familiarity with small naturally formed balls in volcanic ash flows near Los Alamos, New Mexico, helped him solve the Mexican riddle.

mine; the bandits were long since gone. Roaming only a mile from the site, Mr. Gordon had found the new group of stone balls, some half buried, all so symmetrical he thought they must be man-made. He was returning to Mexico; if I was interested, he would send me photographs and further information.

I was more than interested. When I received his photographs, I showed them to the National Geographic Society's Committee for Research and Exploration, of which I am a member. The spheres, superficially at least, strongly resembled those I had seen in Costa Rica. They seemed well worth an on-site examination.

New Stones Lure Experts South

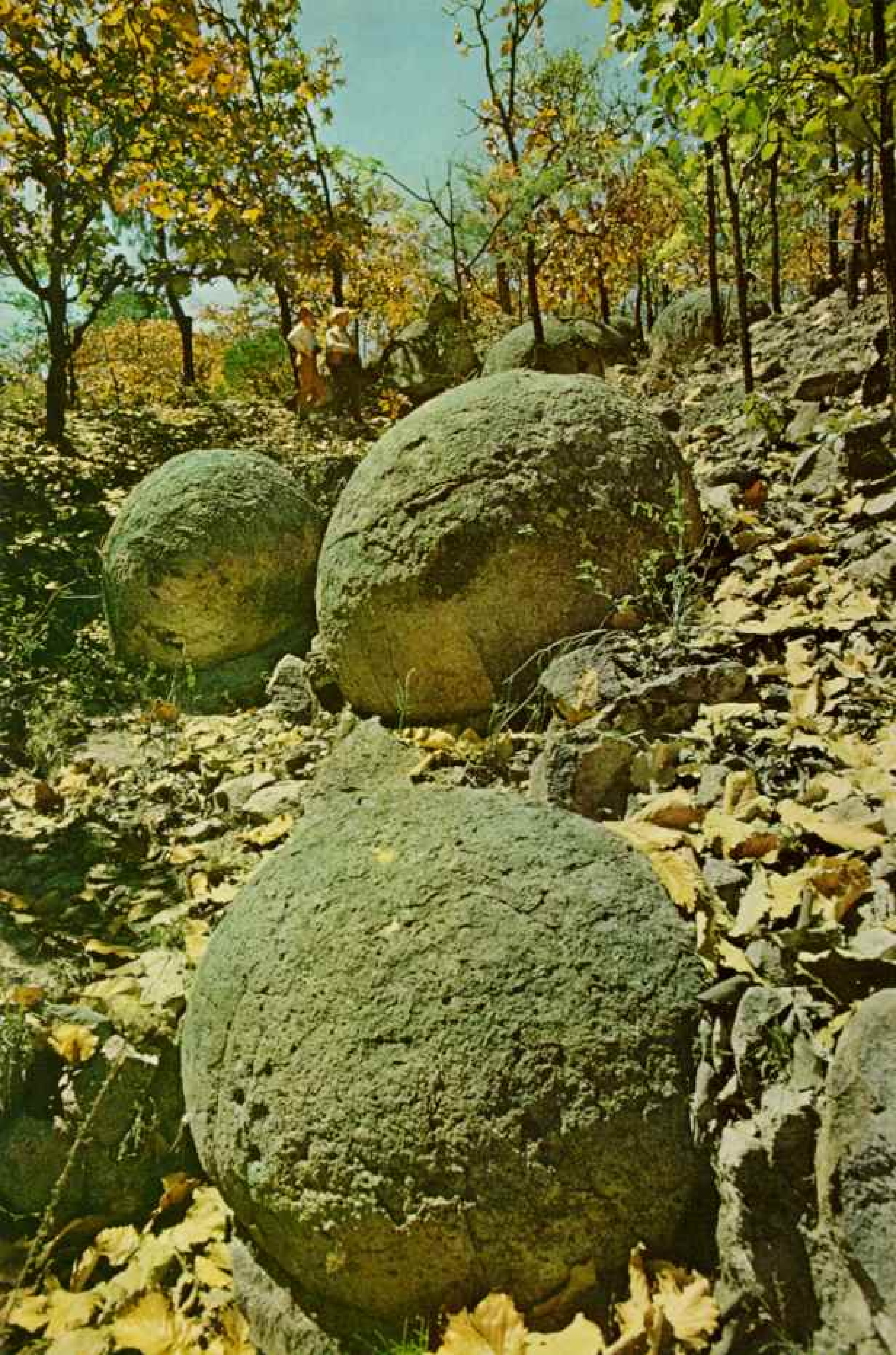
The following December Mrs. Stirling and I flew to Mexico and met Ernest Gordon and his wife in Guadalajara. Dr. Doris Stone, the archeologist who had published the first scientific paper on the Costa Rica stone balls, also joined the expedition.

We drove to the ruins of the old mine headquarters, then climbed on foot to an elevation of about 6,000 feet. There, atop a mountain spur, lay the five spheres.

Three of them were half buried, the fourth, washed clean of rubble, stood in an arroyo, and the fifth perched on the top of the ridge. It had a bulge on one side; it was split in two, as if broken while being shaped and left incomplete. All appeared to be made of soft volcanic stone similar to the mountain itself.

That evening, near the town of Ahualulco de Mercado, we hired three brothers by the name of Lopez and another Mexican to work with us for a few days.

The following morning we began digging out the three half-buried spheres and in their vicinity found six other buried ones. We



discovered 11 more large stone balls the following day, bringing the total to 22 at this site. They varied in diameter from four-and-a-half to six-and-a-half feet.

At lunchtime our workmen built a fire and toasted tacos. Hot and delicious, they were offered to us on lace doilies!

On the flat excavation area someone, sometime, had built a small rectangular foundation of stones. We could not determine its age, but it seemed an ideal spot for a ceremonial site.

I was nevertheless bothered by the fact that we found not one fragment of pottery or any other artifact indicating human occupation. And the spheres, though almost perfect in form, did not exhibit the fine surface finish of the Costa Rica specimens.

Remote Site Yields Another Bonanza

On the third day Jesús Lopez straightened up from his shovel and asked why we were doing all this digging and mapping.

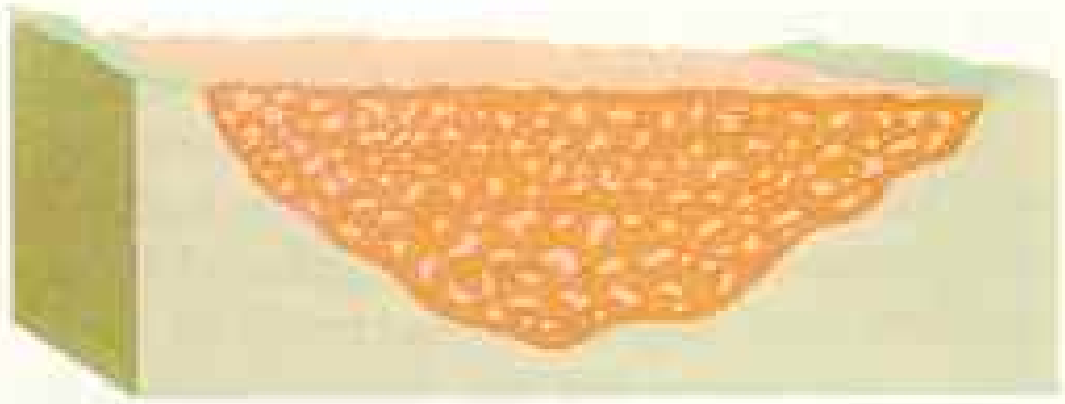
"At Agua Blanca, just over the top of the hill," he said, "there are many, many of these balls lying in the open on the ground."

Still another site? I was skeptical at first, but decided to investigate. We arranged for horses in the village of Tiro Patria below the old mine entrance and set forth.

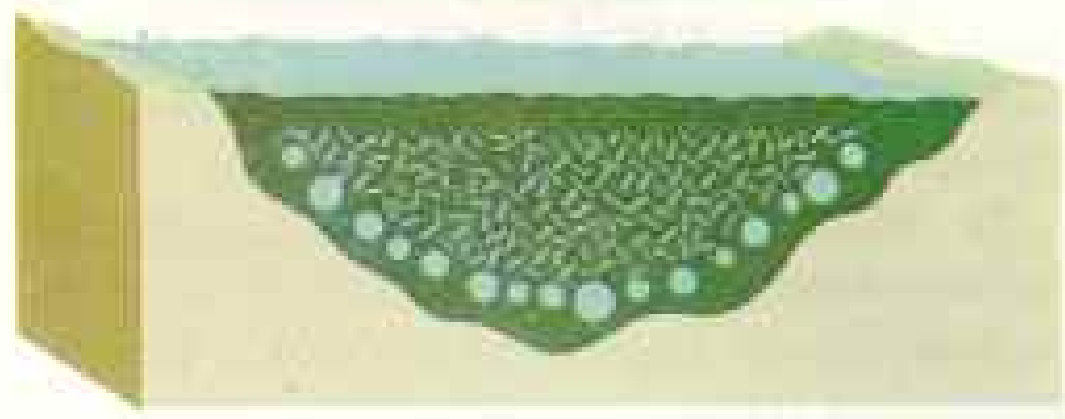
A two-hour ride took us up a mountainside through forests of oak, pine, and acacia with inspiring views of distant valleys. As the ground leveled off at the wild and lonely crest of the Sierra de Ameca, stone spheres came into view. First they appeared singly, then in clusters where they had accumulated in small arroyos—more and more, until we estimated there were hundreds (opposite).

A spectacular sight! The scene suggested some giant's bowling alley or the ball park of the Aztec gods. The spheres lay fully exposed; they ranged in diameter from about two feet to one giant of more than 11 feet. The average I estimated at five or six feet.

The profusion of stone balls at Agua Blanca completely changed our concept of their origin. Such great numbers surely indicated natural formation. Some of the stones were pear-shaped and a very few were joined as twins or



Like a searing avalanche, fiery ash composed of glass particles and gas—1,000° to 1,400° F.—floods a valley.



As the interior cools, crystallization begins—a change similar to ice forming from water. Around countless points, or nuclei, the ash crystallizes in constantly expanding spheres that finally merge into a solid mass, shown by slashed lines. But near the edge of the deposit where cooling is more rapid, spheres cease growing and fail to coalesce with their neighbors. Thus created, the balls await the passage of time.

After millenniums, erosion exposes the giant spheres; some still lie embedded in uncrystallized ash, shown in green.

Artifact of ancient man, a 12-ton granitic globe is measured by Dr. Stirling and his wife Marion near Palmar Sur, Costa Rica. Hand-worked, the perfect seven-foot sphere reflects the skill of unknown pre-Columbian craftsmen, who sometimes placed such stones in ritual formations.

Rare handiwork of nature, the giant spheres close to the Sierra de Ameca crest line are crystallized ash-flow tuff, concludes Dr. Smith, who explains the origin of the stones at left in the diagrams above. Author Stirling recalled: "Great spheres littered the arroyos as if flung by a huge hand. One was more than 11 feet in diameter."

had a dumbbell shape, and these sports certainly tended also to deny human fabrication.

But if the spheres were not man-made, then how had they been formed? Where had they come from in such fantastic numbers? We realized that our expedition had made an astonishing discovery—but that the explanation for it would have to come not from an archeologist but from a geologist.

Back in Washington I consulted two experts: first, Dr. William Melson of the Smithsonian Institution and then Dr. Robert L. Smith of the U. S. Geological Survey.

In March 1968 a National Geographic Society-Smithsonian Institution-U. S. Geological Survey expedition under Dr. Smith's leadership set out to study the puzzle of the Sierra de Ameca. His field examination and subsequent petrological analysis determined beyond any reasonable doubt the origin of the stone balls.

"The spheres were formed during the Tertiary geological period," Dr. Smith reported, "by crystallization at high temperatures in a matrix of hot ash-flow tuff. An avalanche of this hot ash, not a sifting down from the sky, overwhelmed the area.

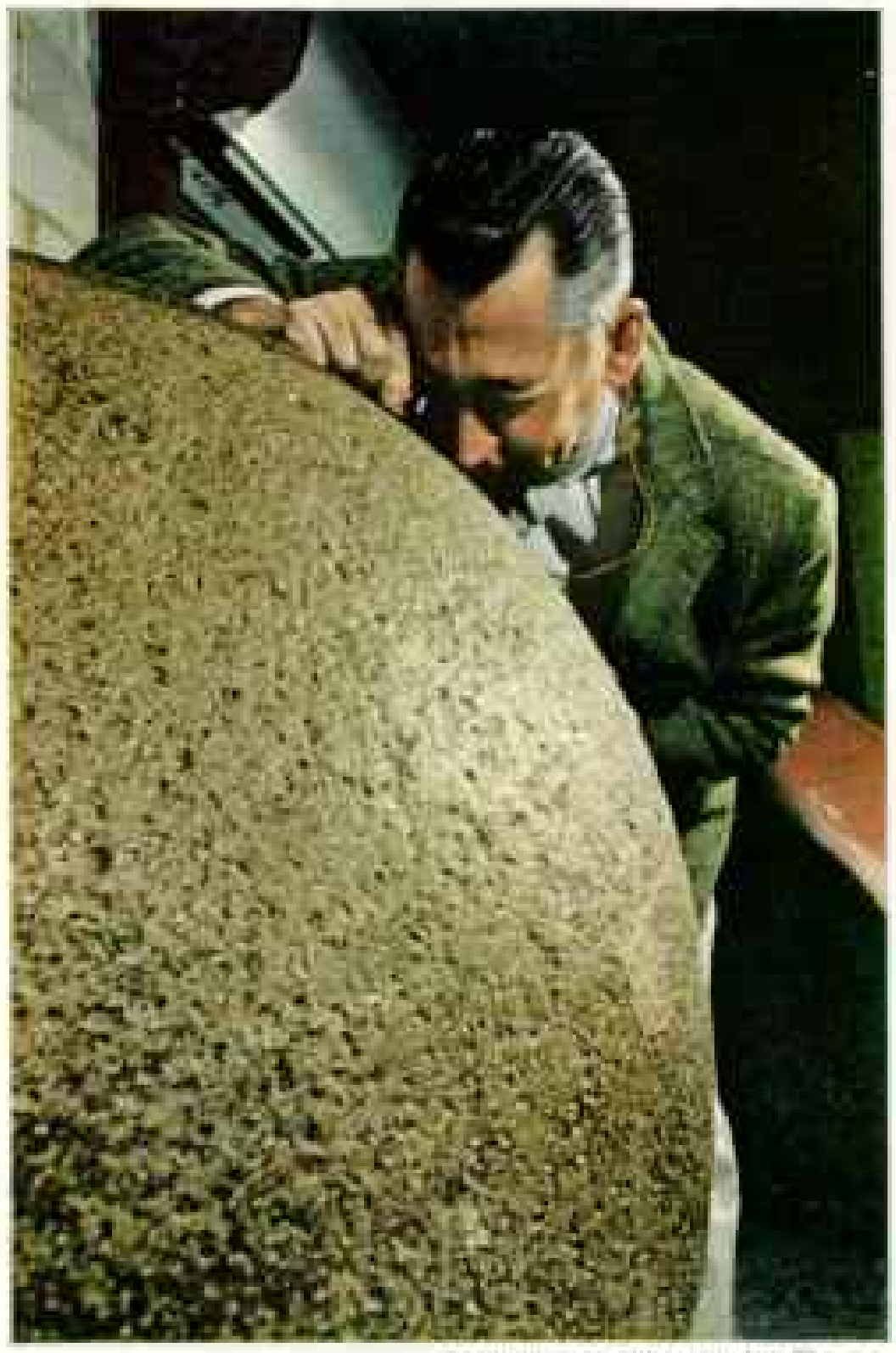
"By analogy with other ash flows, we know that the material here was about four-fifths hot volcanic glass particles by weight, with pore space composing somewhat more than half its bulk. At the presumed temperatures of between 1,000 and 1,400 degrees Fahrenheit, with slow cooling, the glassy volcanic ash could crystallize.

"Crystallization of the Jalisco spheres," Dr. Smith continued, "began in nuclei of single glass particles. Gases released from the glass moved outward in all directions, promoting crystallization of adjacent glass particles and thus forming the spheres. This process continued until stopped by cooling or coalescence of spheres [diagrams, preceding page].

"I found one sphere still enclosed in an undisturbed ash matrix which, although consolidated, was softer than the stone ball. But from most spheres the matrix had eroded away, leaving only completely exposed relics.

"I know but one other area of occurrence of similar spheres in ash deposits. This is near Los Alamos, New Mexico, where my colleague R. A. Bailey and I have found about six sites within an area of 500 square miles. The largest stone ball there measured only two feet in diameter. The Jalisco spheres, which range in diameter from two to more than 11 feet, may be unique in the world."

So came the solution of the mystery of the great stone balls that perch, cool and aloof, on the Sierra de Ameca—40 million years removed from their fiery origin.



"Man-made monolith," says Dr. Smith, inspecting a 2½-foot stone ball from Costa Rica, now in the permanent collection of the National Geographic Society. "Granitic rock never occurs naturally in large perfect spheres."

NEW VOLUME OF *RESEARCH REPORTS* NOW AVAILABLE

The National Geographic Society announces publication of the second volume of *Research Reports*. This 275-page book contains concise accounts of 34 scientific projects sponsored by your Society in 1964, their subjects ranging from oceanographic research to a Himalayan expedition, from the Ainu of Japan to the California condor, from a Viking site in Newfoundland to the migrations of the pink shrimp in the Gulf of Mexico. In most cases the accounts are written by the scientists themselves, and among those reporting are such authorities as Matthew W. Stirling, Durward L. Allen, George F. Bass, John and Frank Craighead, Jacques-Yves Cousteau, and Louis S. B. Leakey. This volume of *Research Reports* for 1964, and the earlier one for 1963, may be obtained for $5 each, postage paid, from Dept. 61, National Geographic Society, Washington, D. C. 20036. Request later billing if desired.

Now the finest costs less than $200.

We're talking about Kodak's finest—the Instamatic M9 movie camera. Now you can own one for less than $200.

And what a camera it is. Just drop in the film cartridge and you're ready to shoot. The 5-to-1 zoom lens lets you capture the long shots by telephoto, and gives you the broad view by wide angle. You've got your choice of fingertip power zoom or manual zoom.

Four filming speeds from slow motion to fast action let you set the pace. Through-the-lens CdS electric eye gives you the correct exposure automatically. And the sports-type finder lets you see action outside the area you're filming. There's even provision for remote control and for single-frame exposure for animation.

The Kodak Instamatic M9 movie camera with ultra-fast *f*/1.8 power zoom lens is waiting for you for less than $200. See your Kodak dealer.

Price subject to change without notice.

Kodak Instamatic® M9 movie camera.

Kodak

Don't just listen to the salesman.

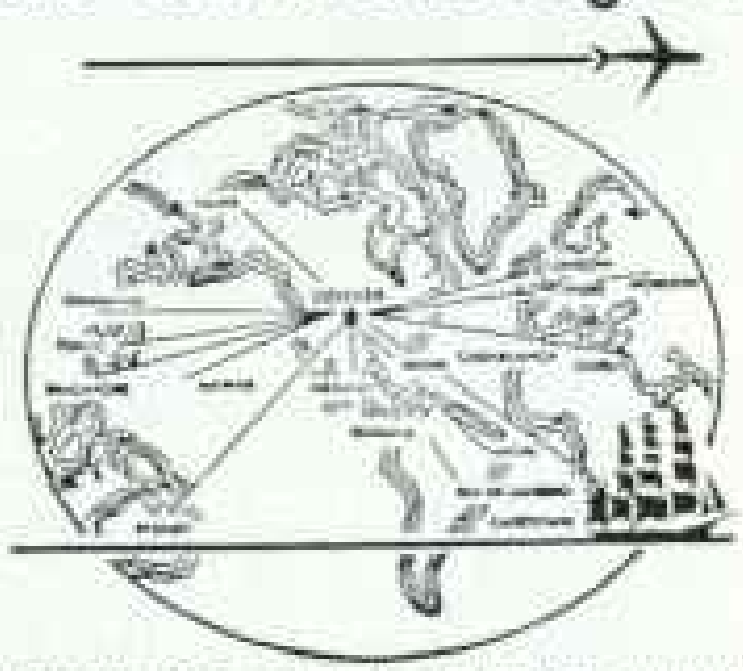
Listen to the piano.

Listen to the tone. Its strength. Its subtlety. Try a gentle étude. Some Rachmaninoff fireworks. Listen to the crystal clarity of a Bach partita.

Now you know. That's how Yamaha won over the aficionados. That's why Yahamas are in major universities and conservatories across the country. That's why a Yamaha is the official piano at the Newport Jazz Festival.

That's how Yamaha got to be the largest piano manufacturer in the world. YAMAHA

where the world registers



• IMPECCABLE SERVICE • SUPERB CUISINE
• TRADITIONAL WESTERN HOSPITALITY
• A TOTAL HOTEL
IN THE GRAND HOTEL MANNER

THE Brown Palace HOTEL

DENVER, COLORADO

FOR RESERVATIONS CALL 825-3111

Karl W. Mehlmann, General Manager

Member A Network of the World's great independent hotels

Represented by Robert F. Warner, New York City; Glenn W. Fawcett, Los Angeles. Or, contact your travel agent.

CHINA DOLLAR

only 10¢

Uncirculated nickel silver dollar minted in 1960 to Commemorate 50th anniversary of The Republic of China (Formosa) . . . only one to a customer . . . a beautiful coin and only 10¢. SUPPLY LIMITED! SEND TODAY.

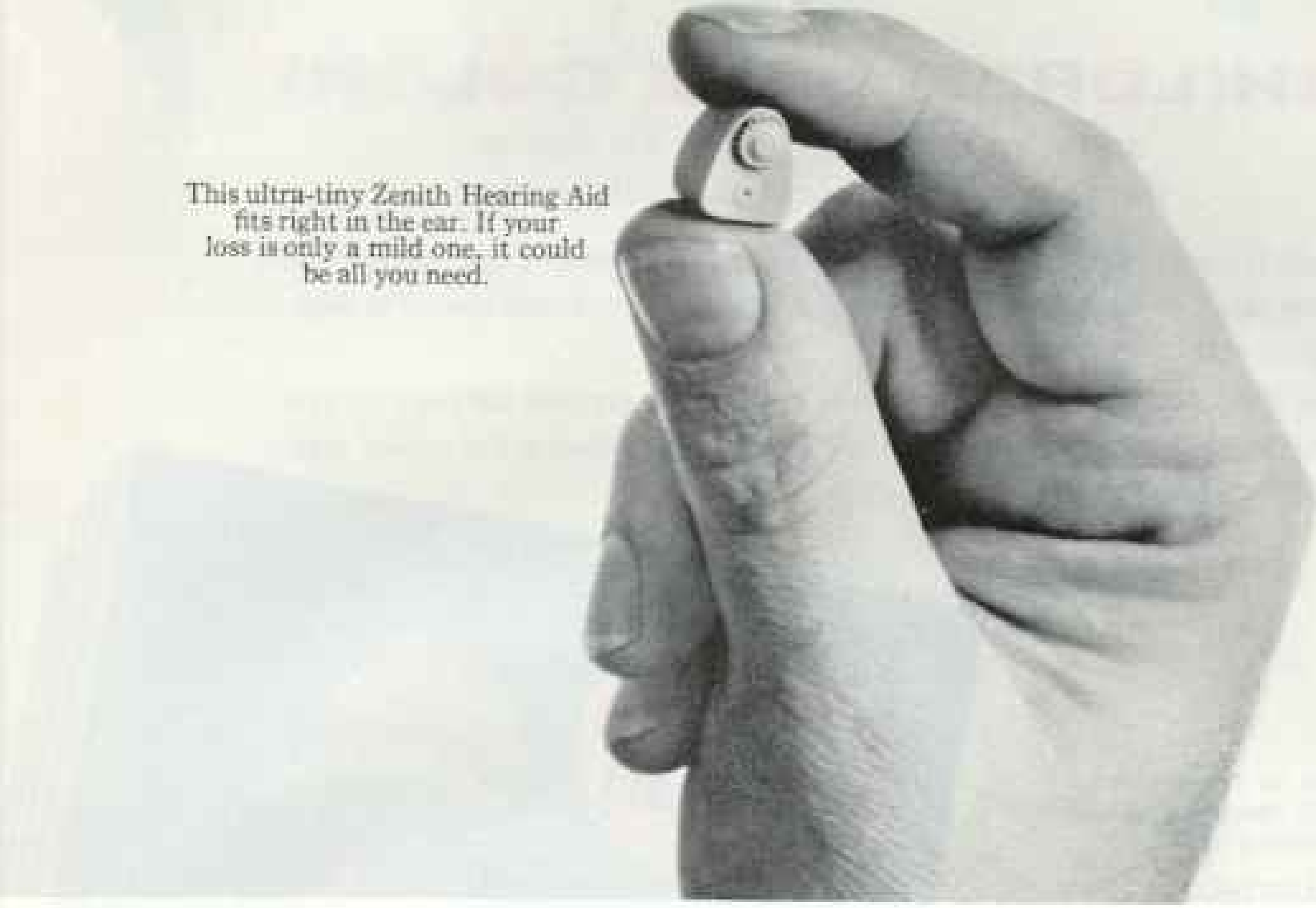
Sent with illustrated coin catalog, plus selections of coins to examine. Buy any or none, return balance. Cancel service at any time. Send name, address, zip number and 10¢ for your China Dollar to: Littleton Coin Co., Dept. CK-12, Littleton, New Hampshire 03561. Offer good in U.S.A. only.

RUSSIA STAMPS Only 10¢

This Fabulous High-Value Collection, Catalog Priced at $2.50 — only 10¢! Remarkable and Valuable Collection of **32 different genuine Russian postage stamps**, some over 50 years old! Includes scarce Commemoratives, Czarist issues, Airmails. Catalog price $2.50. Special introductory offer — to show you the great pleasure of America's Most Rewarding Hobby — **only 10¢!** Also, selections of unusual stamps to examine free. Buy any or none, return balance, cancel service anytime. EXTRA: "How to Get Beautiful Stamp Album and Valuable Stamps FREE". Send 10¢ today!

H. E. HARRIS & CO., DEPT. L-69, BOSTON, MASS. 02117

When you have a hearing loss, Zenith tries to give ears a second chance.



This ultra-tiny Zenith Hearing Aid fits right in the ear. If your loss is only a mild one, it could be all you need.

Your hearing loss is personal. Different from anyone else's. Maybe it's the high sounds you're missing. Maybe it's the lows. Whichever it may be, if your loss can be helped by a hearing aid, there's a beautiful chance a Zenith Hearing Aid will be a "second chance" for you.

Zenith wants you to hear again, as naturally as possible. That's why we make so many different types of hearing aids. 18 different models. Fifteen of these may not be for you at all. But of the remaining three, one is probably just right for your hearing loss.

Your Zenith Hearing Aid dealer is carefully trained to help you choose that one Zenith Hearing Aid. More than that, he can skillfully adjust its performance to your particular needs.

You can buy a Zenith Hearing Aid for as little as $75* and be assured of Zenith quality. Some of the more miniaturized, inconspicuous models, however, cost about $300*. All are covered by Zenith's exclusive 10-Day Money-Back Guarantee. If, within ten days of purchase, you don't feel the best is good enough, return it to your Zenith dealer and your money will be refunded.

Visit your nearby Zenith Hearing Aid dealer. He's listed in the Yellow Pages. He'll be happy to work with you to help you choose the Zenith Hearing Aid that's best for you.

ZENITH®
Hearing Aids

The quality goes in before the name goes on.

*Manufacturer's suggested retail price. Zenith Radio Corp., 6501 W. Grand Ave., Chicago, Illinois 60635

CHILDREN LOVE COLOR!

and what better place to find it than in the National Geographic School Bulletin!

Here is your child's *own* magazine—with full-color photos and lively stories from all over the world. Written especially for him, it will make the postman's visit an exciting event!

The 16-page *Bulletin* is priced below cost at only pennies per copy—a fine investment in your child's future. 30 weekly issues during the school year. Use the order form below.

Features like these quicken a child's interest, make geography the pleasure it can be

"THE OLD EXPLORER" talks conversationally to Bulletin readers about the exciting world they live in.

GEO-GRAPH—a quickly solved crossword game that teaches as it amuses.

LOOK AROUND—an invitation to be alert to the small wonders of a big world.

GLOBAL NOTEBOOK—little-known facts about well-known subjects.

NATIONAL GEOGRAPHIC SOCIETY • Dept. 60 • Washington, D.C. 20036

Enclosed find $ _____. Send School Bulletins to:

☐ 1 Year $2.25
30 issues
U.S., $2.25
Elsewhere, $3.00

☐ 3 Years $6
90 issues
U.S. only

NAME _____

STREET _____

CITY, STATE, ZIP CODE _____

For other children on your list, please use a separate sheet.

A smooth way to rough it: The new six-place Beechcraft Bonanza 36.

Goodbye and farewell to the old highway safari! Never again will you spend leisure time filed behind a truck somewhere on County "J".

Just load up your gear, the family, or some pals, and take off in your big new Bonanza 36. It makes a clean getaway, far out and fast. A couple of short hours and you're back to nature, where the loudest sound is the plop of a lure! Or the delightful din of the kids having a good, wet time.

Your vacations really count now, and weekends are wide for the sporting life. Camping, fishing, golfing, sailing, skin diving, island hopping. The works!

Everything is easier and everywhere is closer when you have a 6-place Bonanza 36. It has a nonstop range of 980 miles and speeds to over 200 mph. It can go to thousands of places the airlines won't and the freeways don't.

Your Beechcraft Dealer can show you 7 different Bonanza models. Look for his red, white and blue sign of Beechcraft quality sales and service. Or write Beech Aircraft Corp., Marketing Services, 9721 E. Central, Wichita, Kansas 67201.

Then answer that call of the wild!

Be there!

Beechcraft

We're watching your weight with the Special K Breakfast.

(Less than 240 calories... 99% fat-free)

A good breakfast is an essential part of any weight-control program. Get back into things with Kellogg's® Special K® Breakfast. Delicious!

THE SPECIAL K BREAKFAST

4 oz. tomato (or orange) juice
1½ cups (1 oz.) Special K
1 teaspoon sugar
4 oz. skim milk
black coffee or tea
(less than 240 calories)