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NUMBER TWO

THE NATIONAL GEOGRAPHIC MAGAZINE

FEBRUARY, 1957

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Sixty-four Pages of Illustrations in Color

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In addition to the editorial and photographic surveys constantly being made, The Society has sponsored more than 100 scientific expeditions, many of which required years of field work to achieve their objectives. It has aided and encouraged exploration literally to the ends of the earth, having contributed to expeditions of Rear Admiral Robert E. Peary, discoverer of the North Pole, and Rear Admiral Richard E. Byrd, first man to fly over the North and South Poles.

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The Society and individual members contributed \$100,000 to help preserve for the American people the finest of California's sequoias, the Giant Forest in Sequoia National Park.

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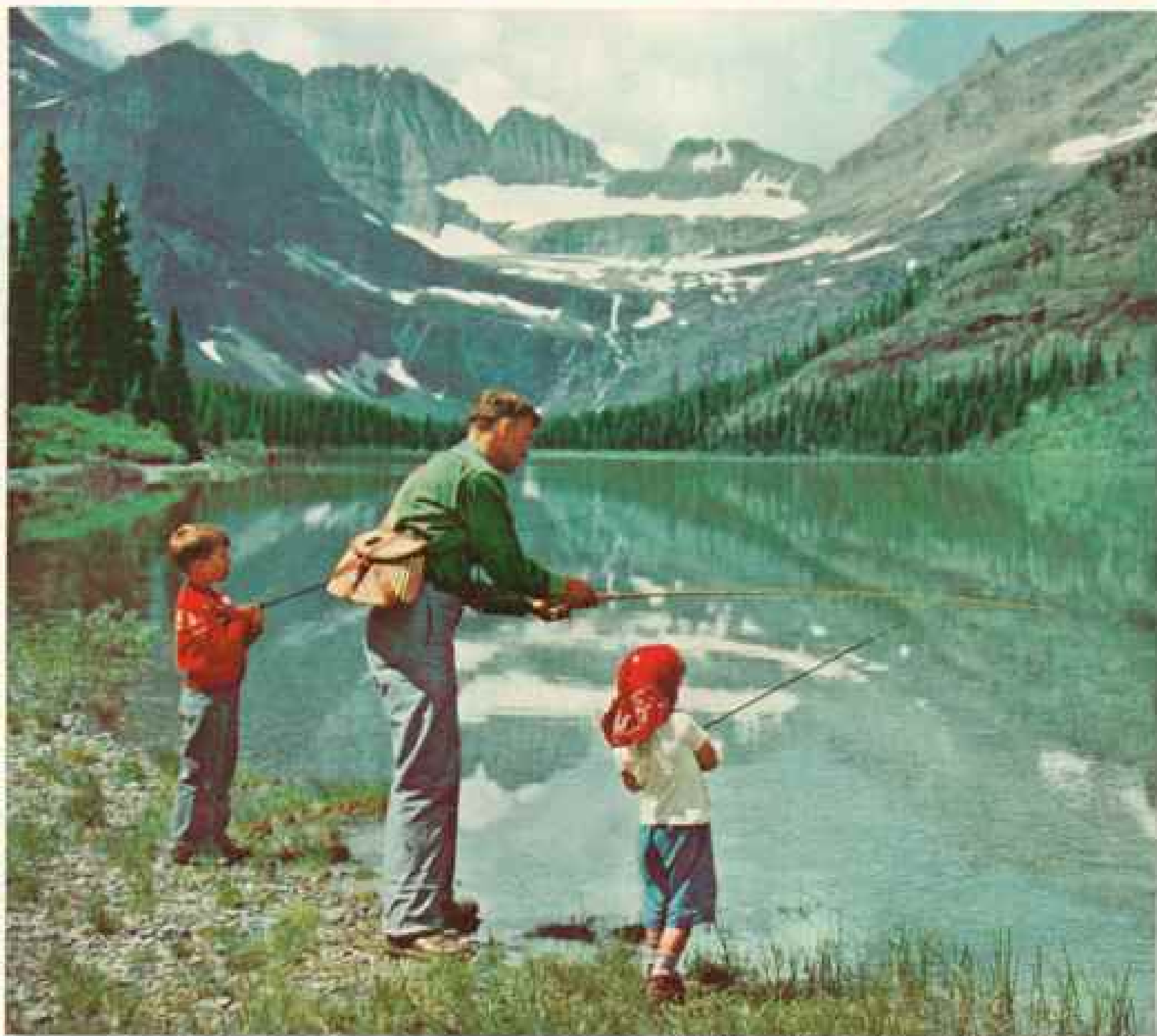
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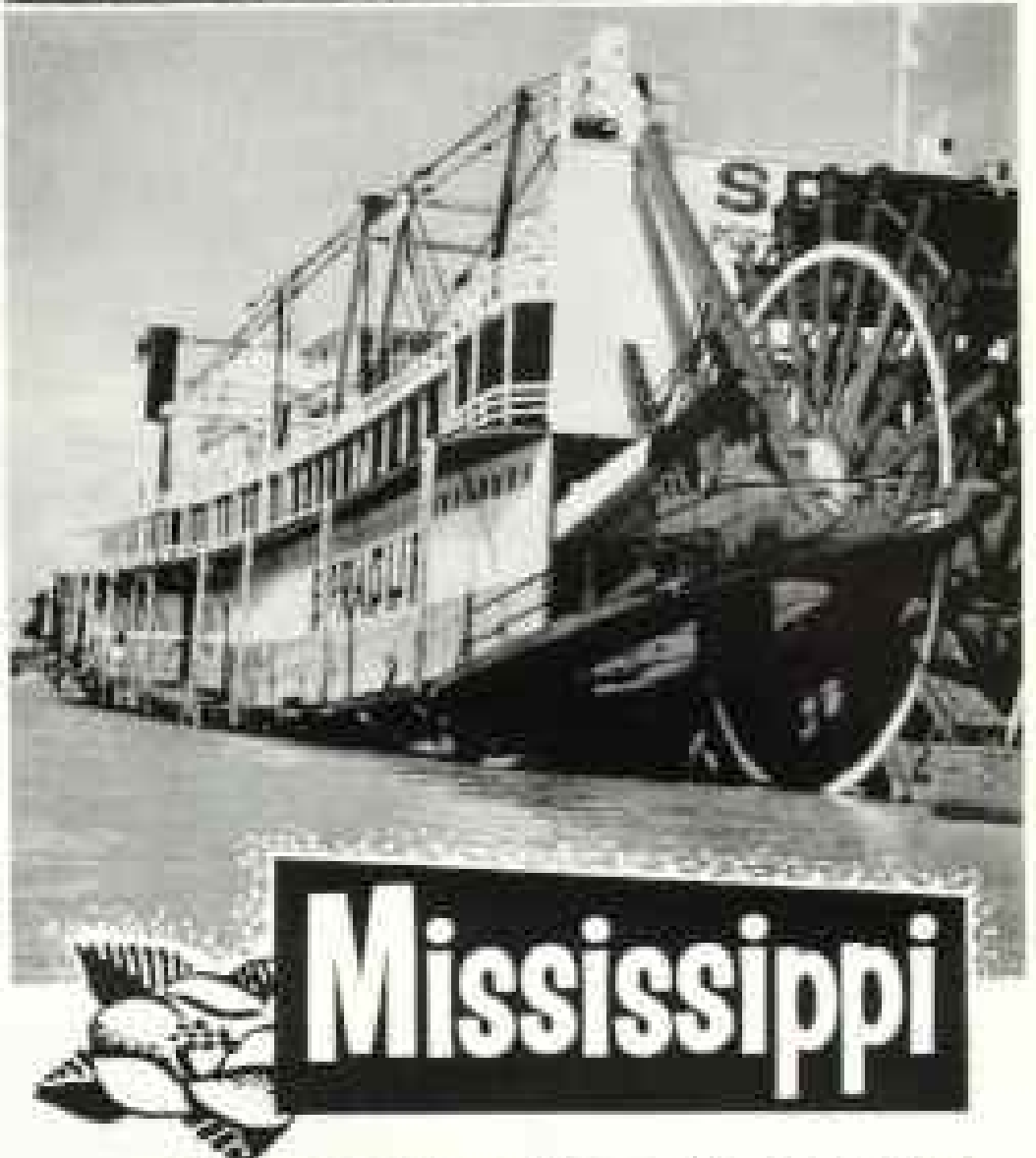
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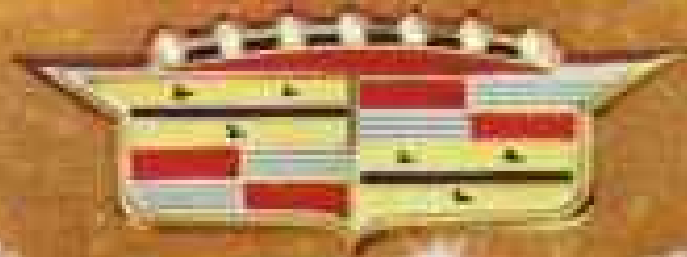
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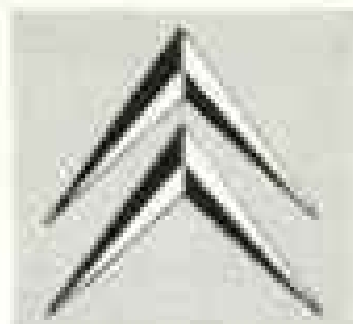
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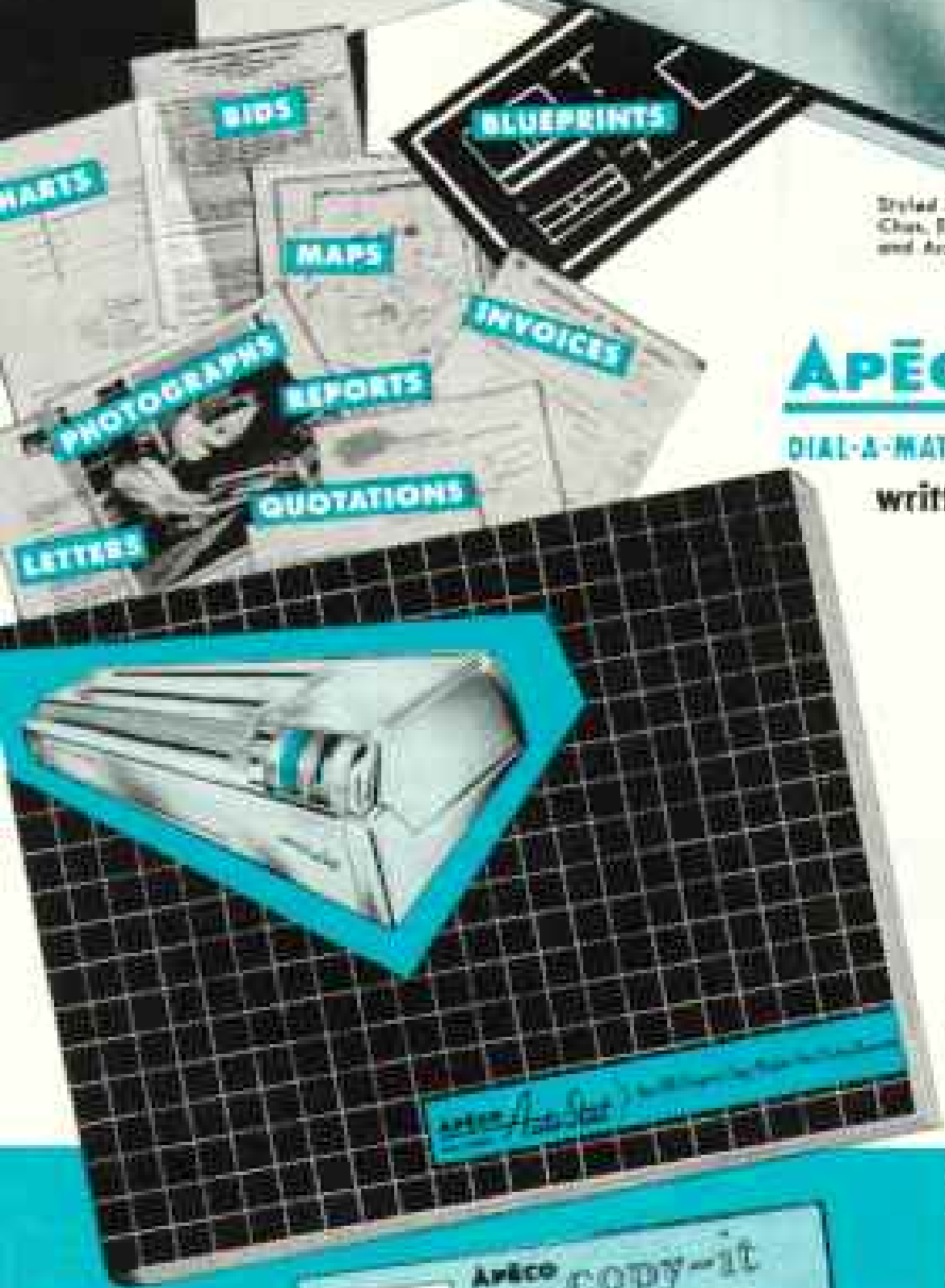
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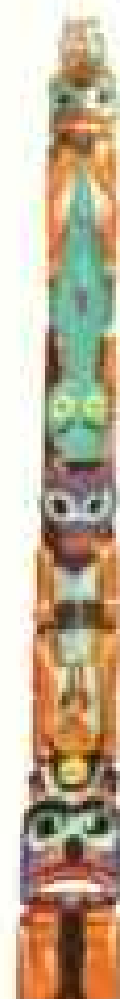
The new stormproof voiceway connects telephones throughout the United States with the recently expanded telephone network of the Alaska Communication System, a facility of the U. S. Army Signal Corps.

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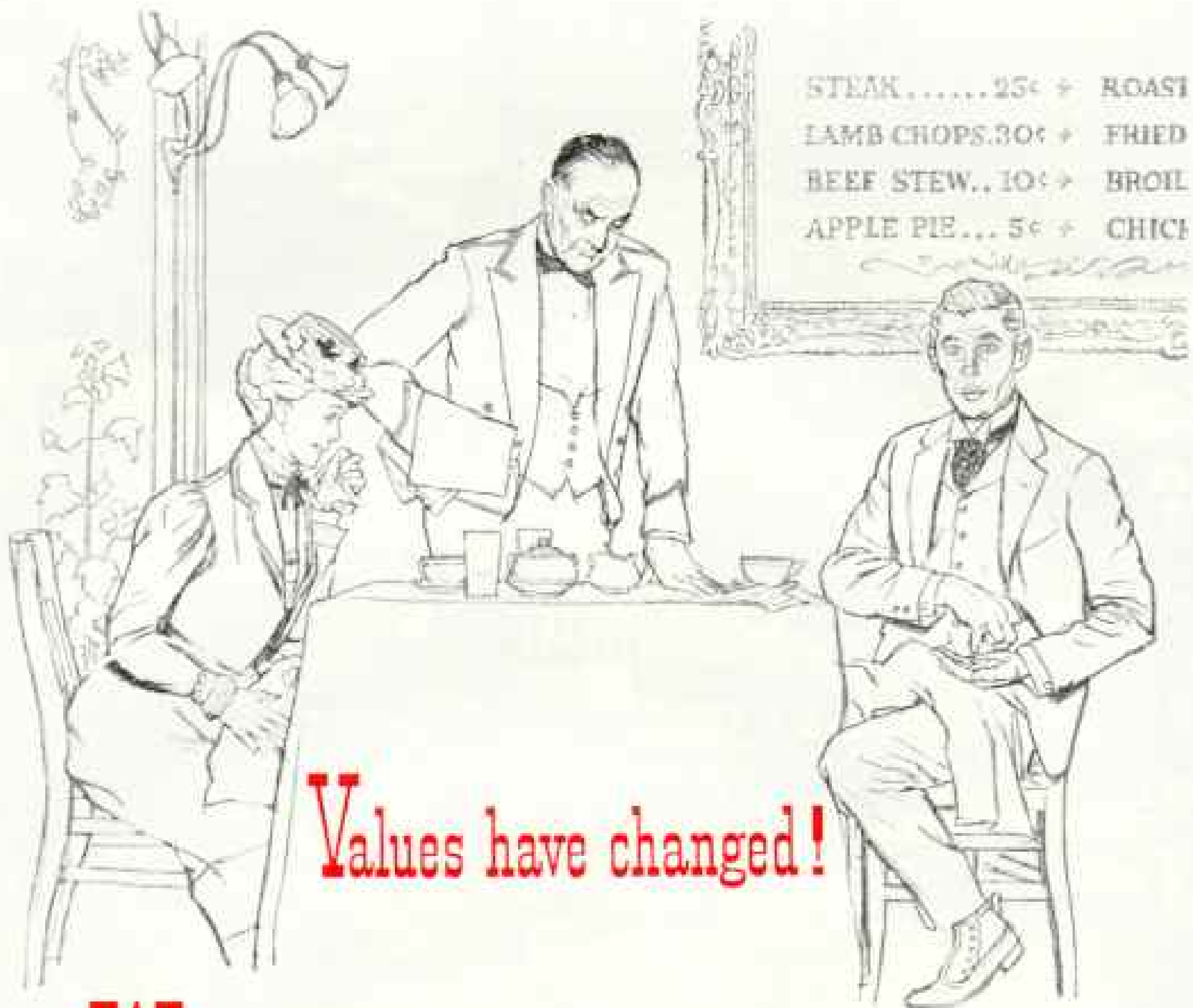
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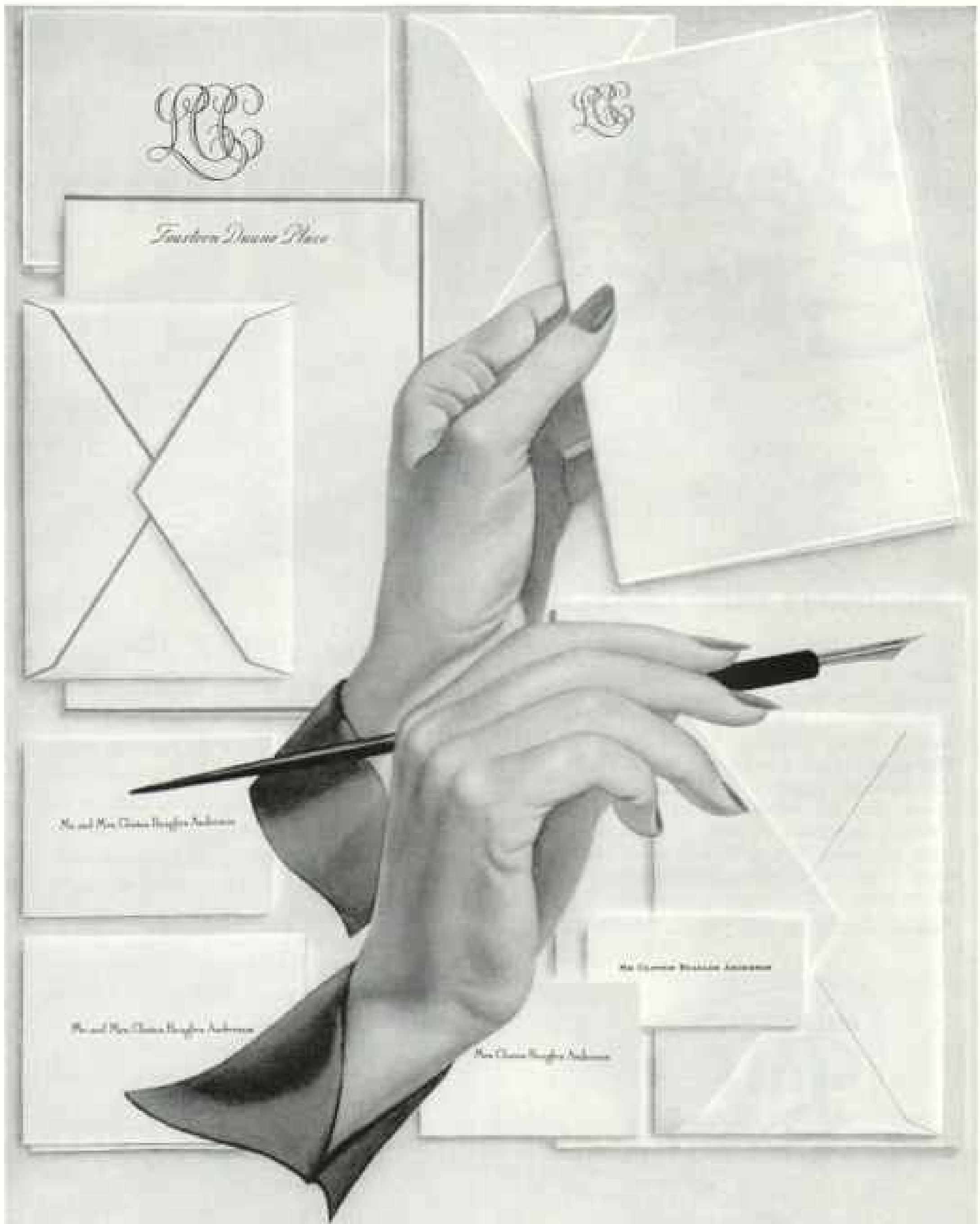


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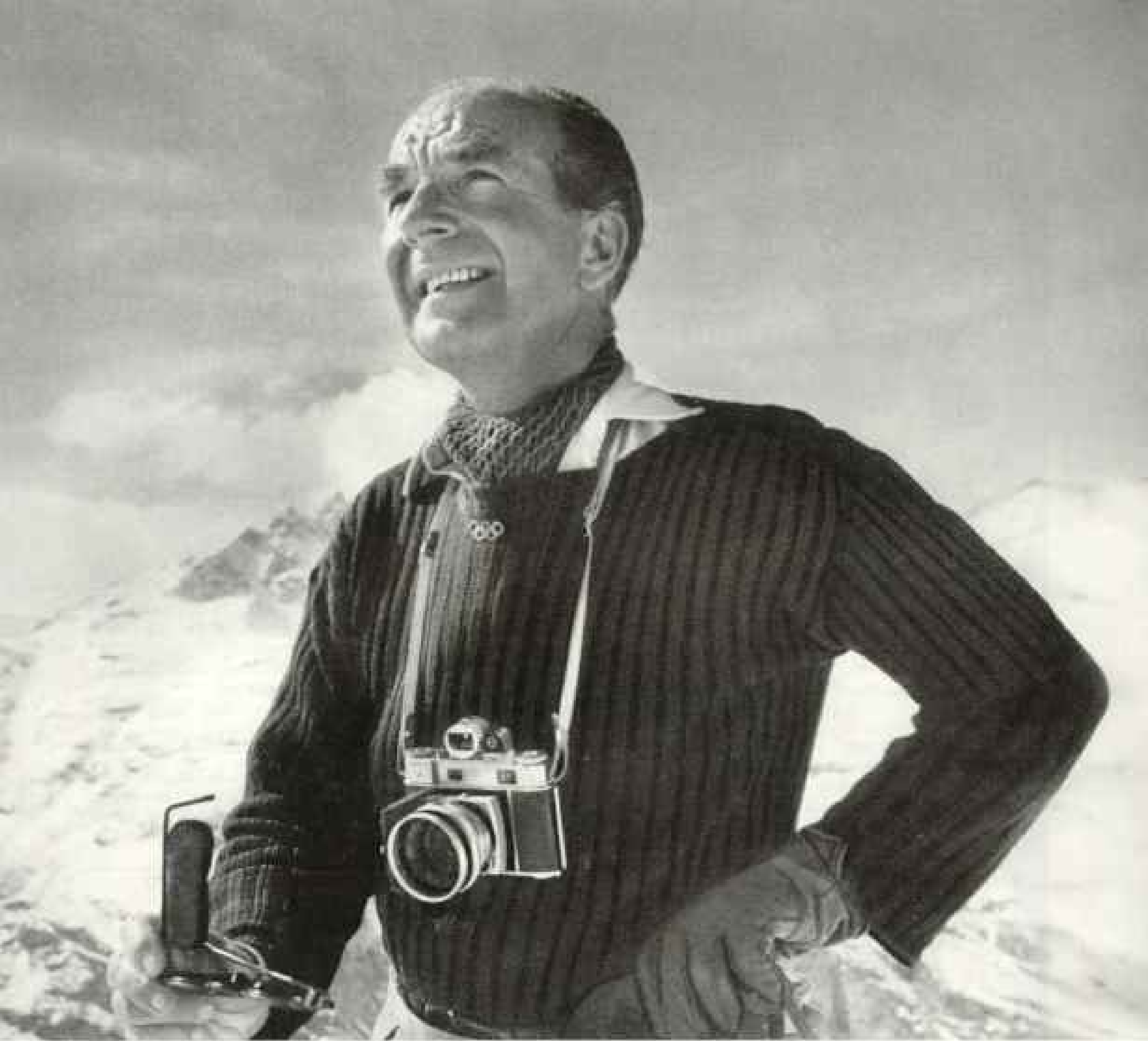
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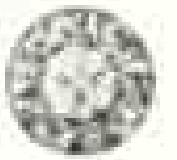
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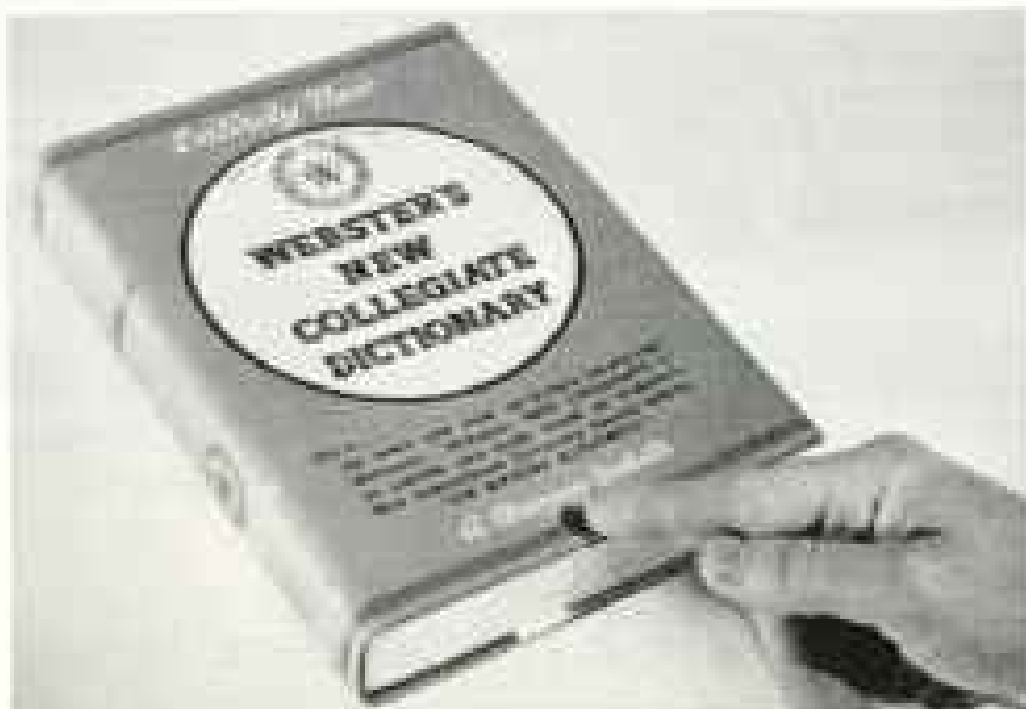
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How well do you know YOUR HEART?

ALTHOUGH heart disease is our nation's greatest health problem, we can face it today with increasing hope and confidence. Through research, a vast amount of knowledge about the heart and its functions has been accumulated.

As studies continue, there is every justification to anticipate further advances in diagnosis, treatment . . . and perhaps even prevention . . . of various diseases affecting the heart and blood vessels.

While heart disease is a challenge to medical research, it is also a challenge to you. If you are informed about the heart, you can help protect your own and the hearts of your relatives and friends. The following questions and answers may help you to know your heart better . . . and give it the care it deserves.

- **Is the heart strong and durable?**

Yes . . . the healthy heart is one of the strongest organs in the body and it has remarkable reserves of strength. Despite its immense task, a healthy heart can be nearly as efficient as the years advance as it is at age 20. Even at the older ages, a healthy heart is fully capable of meeting the body's needs.

- **Can you do anything to keep your heart in good shape?**

Yes . . . you can protect your heart by avoiding sudden or prolonged exertion, watching your diet, avoiding overweight, and by getting the sleep and rest you need. You should also have a medical examination every year. Then if heart trouble is found, prompt treatment may control it and make possible a long and nearly normal way of life.

- **Are all heart attacks serious?**

Not necessarily . . . because some are mild and the

heart can repair itself with care and treatment. In these cases, a person may usually resume normal activities. Even when there are serious complications, patients can often recover if the heart is helped to heal itself. In fact, four out of five of those who withstand their first coronary attack recover and continue to work full time for many years.

- **Are overweight and emotional tension bad for the heart?**

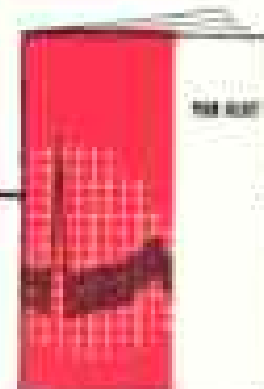
Yes . . . overweight taxes the heart and blood vessels, according to many scientific studies. So, try to keep your weight about equal to what you should have weighed between ages 25 and 30. Emotional upsets can make your heart beat faster and your blood pressure go up.

- **Can people with heart disease lighten the heart's work?**

Yes . . . if they learn how to care for an impaired heart. Plenty of rest, protection against infection, proper diet, and avoidance of hurry, worry and strenuous activities can all help the affected heart to carry on. Of course, treatment given by your doctor is important, but the patient himself can do most to safeguard the heart.

- **Is heart disease more prevalent now?**

No . . . not when you consider these facts: (1) more people are living longer and reaching ages when the heart's endurance naturally ebbs; (2) heart ailments are diagnosed now with greater accuracy, whereas in the past many deaths actually caused by heart disease were blamed on other causes.



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and jam and coffee. After breakfast you can set forth on a pilgrimage to other historic inns.

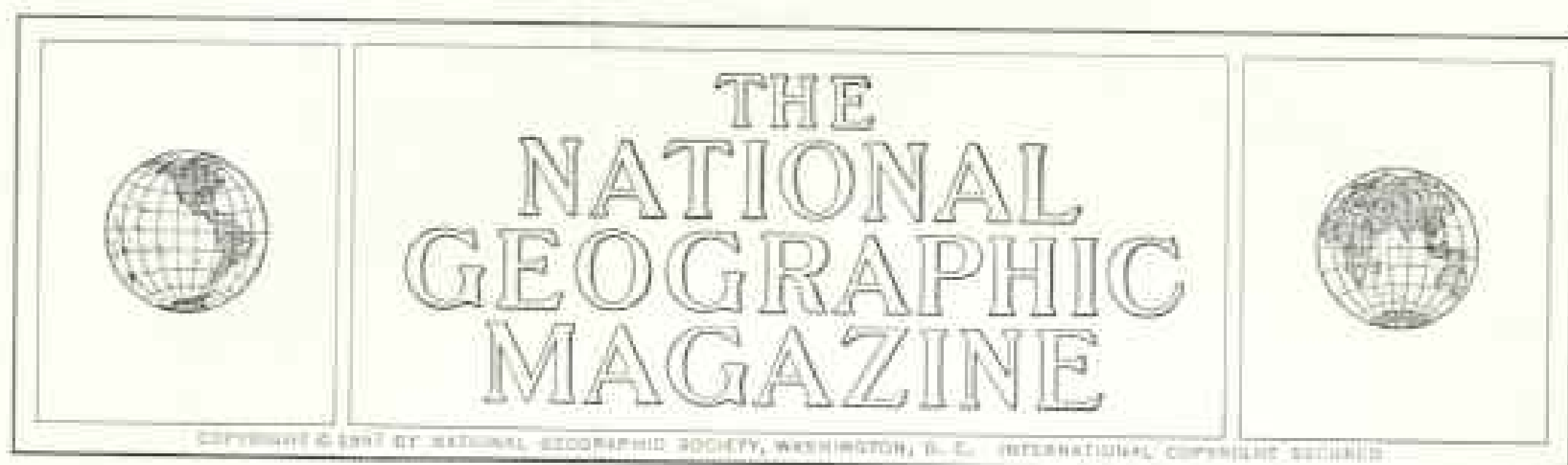
Here are some of the most famous and hospitable: The *Prospect of Whitby* in Wapping, the *Adam & Eve* in Paradise, the *Cat and Fiddle* in Hinton Admiral, the 1000-year-old *Fighting Cocks* in St. Albans, the *We Three Loggerheads* and the *Cardinal's Error* in

Tonbridge and, of course, Dr. Johnson's immortal *Cheshire Cheese* in London.

The beer is interesting and plentiful. The talk is good—and it's in English. You'll be welcome to play darts and skittles and shove-hapenny with the natives.

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For further information and free literature, write British Travel Association, Box 182, 336 Madison Ave., New York 17, N. Y.



Wisconsin, Land of the Good Life 141

Titan of Industry, America's Dairyland, Paradise for Sportsmen—
The Many-sided Badger State Is All These and More

BY BEVERLEY M. BOWIE

Senior Editorial Staff, National Geographic Magazine

With Illustrations by National Geographic Photographer Volkmar Wentzel

THE first white man to set foot in Wisconsin could hardly have been more surprised. He had set out in search of China.

Paddling through the Straits of Mackinac and across the blue reaches of Lake Michigan, Jean Nicolet had brought with him a magnificent damask robe in which to greet the mandarins of Cathay. As his canoe neared the head of Green Bay, young Nicolet donned his stately raiment and picked up a brace of pistols.

From the forest, however, emerged no Chinese officials but a welcoming committee of Winnebago. Putting a bold face on his discomfiture, Nicolet stepped ashore with "thunder in both hands." Squaws and children fled at the sound of his firearms, but the braves stood their ground, declared that Nicolet must be the *Manitouiriniou* (wonderful man) and invited him to a beaver banquet.

State's History Starts with a Bang

The recorded history of Wisconsin, in short, opened with a bang and went promptly on to dinner. It has been punctuated ever since by equally loud and joyous noises, by an air of exuberant discovery, and by openhanded hospitality.

I followed Nicolet's route to the Badger State on a freighter. I carried no pistols, and my mandarin robe was a leather windbreaker.

No one dubbed me "wonderful man," nor did the squaws flee in terror.

Yet I shared some of the Frenchman's wonder and delight, and, in the course of my 5,000-mile journey throughout this beautiful State, I was feasted upon things that tasted better than beaver.

On the "Fourth Coast" of the U. S.

Part of my sense of wonder came from the very fact that I had approached inland Wisconsin "by sea." The ocean-going Dutch ship *Prins Willem II* had carried me on 1,200 miles of waterway from Montreal, Quebec, to Milwaukee. She was one of an international convoy of freighters making the first spring dash to this "fourth coast" of the United States (color map, page 148).

But my feeling of astonishment only grew as I plunged upcountry. Obviously, Nicolet had been right in reconciling himself at once to discovering Wisconsin.

True, the explorer could hardly have anticipated that the forests he encountered in 1634 would be so quickly cleared and the whole region converted into one huge dairy. Still less could he have foreseen that Wisconsin would one day produce vast quantities of paper, brew rivers of beer, and turn out great brigades of farm tractors.

Yet he must have had some inkling that he had stumbled upon a good thing.



Madison's "Famous Mile" Stretches Between Bascom Hill and the Granite Capitol

An "inhabited forest," Madison had fewer than 100 residents when Territorial lawmakers first met here in 1838. Ice coated walls of the capitol, pigs squealed in the basement, and wild beasts roamed the grounds. This building was erected in 1906-17. A bronze figure symbolizing "Forward," the State motto, tops the dome.



Colonnades of Elms Drop a Golden Shower on the University of Wisconsin Campus

State and university, both launched in 1848, grew up together. Under the famed Wisconsin idea, initiated in the early 1900's, the school extends its services to all citizens to further health, industry, agriculture, education, and government. Today the university's fifteen colleges and schools attract some 16,000 students.

Already the St. Lawrence River-Great Lakes route permits 16 foreign lines to pick up choice Wisconsin items and distribute them to markets all over the world, from Liverpool to Bremen, from Istanbul to Rio de Janeiro.

When the billion-dollar seaway and power project is completed in 1959, ships of 25-foot draft, rather than 14, will be able to move through the deepened channels. General cargo brought into the lakes by ocean carriers will rise from today's 750,000 to an estimated 5,000,000 tons.

Wisconsin, thanks to the planning lavished on its port at Milwaukee, will find itself in a position to take a healthy portion of that trade (page 146). Harry C. Brockel, Milwaukee's municipal port director and a life-time champion of the seaway, told me why.

"Our port," he said, "is known for one of the fastest turnarounds in the world. I remember when the Hamburg-Chicago Line sent in their first cargo of steel. They allowed three days to discharge it; we did it in six hours, 105 tons per hour. They said they'd never known anything like it in their postwar operations."

"How do you account for it?" I asked. "Fresh air and plenty of oatmeal?"

"Not brawn. Modern, specialized machinery." Mr. Brockel pointed to a huge gantry crane on a near-by wharf. "Lifts like that give Milwaukee its muscle," he said. "This one crane can hoist 90 tons, and we're thinking about bigger ones. But why don't you look around the harbor yourself?"

Seaport 2,000 Miles from the Ocean

I did. In a launch skippered by Capt. Raymond Knight, a veteran of 19 years on the lakes, I toured the 1,200 acres of sheltered anchorage that comprise Milwaukee's "seaport." We purred past mountains of coal and pig iron and scrap, tall grain elevators capable of holding 3,500,000 bushels, warehouses redolent with malt, and converted wartime tank-landing craft discharging Canadian newsprint for the *Milwaukee Journal*.

"What preparations are you making for the new traffic the seaway will bring?" I asked.

"Plenty. We're rapidly developing the entire 400 acres of municipal harbor property, with its two and a half miles of shoreline on Lake Michigan, for outer harbor piers and port facilities.

"We're handling about 80,000 tons of overseas cargo a year now," Captain Knight

added. "When the seaway's finished, we expect half a million tons of new cargo. We'll be busy—you can count on that."

The launch circled and then churned back toward the main docks. Behind the harbor's facilities loomed the stacks and towers and massive roof lines of Milwaukee's business and industrial center.

Wisconsin's industrialists have somehow acquired the reputation of being "giants masquerading as pygmies." But the disguise must surely be wearing thin.

For modesty cannot much longer conceal the scale on which Wisconsin provides the Nation with diesels, giant turbines and generators, gasoline engines, auto frames, pasteurizing machinery, tractors, beer. In Milwaukee alone, factory output is now running at \$3,000,000,000 a year.

Automation Got a Head Start Here

Like many another outlander, I had always associated the assembly line with Detroit. But I hadn't been in Wisconsin more than a few days before I was disabused of this notion. The first true automatic assembly process on a grand scale took place right in Milwaukee, at A. O. Smith Corporation, among the biggest users of steel in the United States. It made the first pressed-steel automobile frame in 1903, and 16 years later the process became automatic. The 50-millionth auto frame rolled off this line in 1955.

I went out to Smith's one morning to see for myself. The company, I found, is now deeply enmeshed in making a score of products, from glass-lined silos to oil-well casings.

In the South Plant I watched an assembly line swallow pre-cut steel plate at one end of the building and spew out intricately machined auto frames at the other, at the rate of one every eight seconds!

Here and there I spotted a few men supervising the operation, but the dominant figures were the machines themselves ranged along the conveyor lines. Like dancers in a huge industrial quadrille, they slid forward in unison, bowed over the steel bars, embraced them with a clank and a roar, and gradually retreated to await the next partner.

A giant that overshadows even A. O. Smith is Allis-Chalmers at West Allis. In this feverishly active complex of factories (97 acres under roof), I saw some 15,000 workers busy making everything from light tractors to a

(Continued on page 151)



Costumed Maid and Belled Cow Proclaim Festival Time in "Swissconsin"

Swiss from the Canton of Glarus settled in Wisconsin in the mid-1800's. Turning from wheat growing, they found good incomes in an old-country skill, cheese making. Annette Ehinger shows this Brown Swiss in New Glarus.



Oil-storage Tanks Mushroom on Jones Island, Heart of Milwaukee's Teeming Harbor

Bridged Milwaukee River, which divides the industrial and business sections, and Kinnickinnic River (left) unite at center and empty into Lake Michigan through the harbor's jettied entrance. Disposal plant at island's end makes fertilizer out of sewage that once polluted the lake. Maitland Airstrip (right) serves small planes. Tanker at pier pumps oil. In winter lake freighters moor in the basin (far left) dredged out of swampland.



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New Docks Await a Shipping Boom

In 1959 the St. Lawrence Seaway will open the port to deep-draft vessels.

→ Notebook in hand, author Bowie tours Milwaukee's coal piers on the Menomonee River.



Lake Superior

APOSTLE ISLANDS

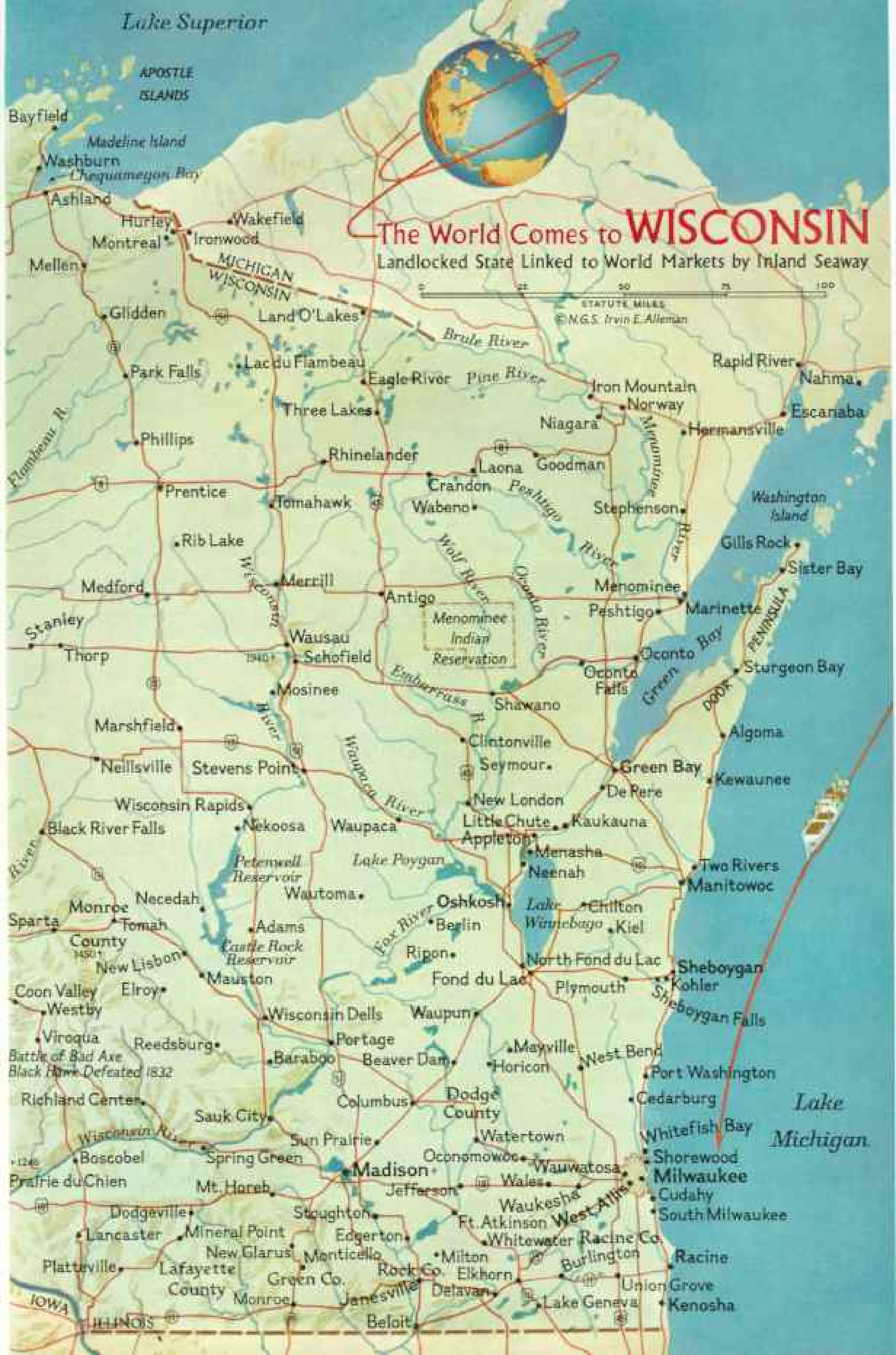


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Battle of Bad Axe
Black Hawk Defeated 1832

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ILLINOIS

Lake Michigan



Baseball-mad Milwaukee Packs County Stadium to the Bleachers, Parking Lots Bulge

More than 2,000,000 spectators a year have watched the Braves play in the last three years. Grateful club owners in 1954 paid \$225,000 rent on the stadium, though their lease with Milwaukee County called for only \$1,000. Recently the stands were enlarged to seat 43,000. Lots hold 11,000 cars.

300,000-kilowatt steam turbine-generator unit.

In the cavernous foundry, fires flickered from casting ladles, and molten metal pouring in a bright arc from the cupolas gave off showers of fiery particles like Fourth of July sparklers.

A 2,500-ton hydraulic press in the forge shop smashed down on a great white-hot ingot. At a smaller steam hammer, a man making axle shafts pounded a white-hot lump of steel into a monstrous collar button and then—to impress a passing girl—picked up a piece of discarded trim in his tongs and lit his cigarette with it.

State Lives Close to the Soil

The heavyweights of Wisconsin industry huddle together along the eastern border, from Green Bay and Sheboygan through Milwaukee and Kenosha. But no one can travel the length and breadth of the Badger State without being impressed by the healthy upcropping of sizable plants in modest towns all over Wisconsin.

Janesville, for example, is home to the Parker Pen Company, which was tooling up for output of its new capillary-action pen as I came by. Kohler, one of the best-known model industrial communities, has turned out enough bathtubs to bathe half the world—and has given the State two governors as well: Walter J. Kohler and Walter J., Jr.

I saw in Superior some of the world's biggest grain elevators and its biggest ore docks. At Wausau and at a dozen other points along the Wisconsin River, I saw dams and powerhouses and mills that make this one of the busiest, best harnessed streams in the Nation. At La Crosse and Eau Claire, Kaukauna and Oshkosh, Burlington and Beloit, I saw factories flourishing hardly more than a rifleshot from some of the lushest pasture land, the pleasantest lakes, the most game-filled woods in America.

Wisconsin workers, in short, have one foot in the countryside. They know where the best fish are to be had, the most likely spot to find deer and ducks in the fall, the snug-gest coves in which to anchor along the northern lake coast. And Wisconsin's farmers are no longer rural recluses; they are linked culturally and economically to the technology of the towns.

That's what Wisconsin means: town-and-country living. Eavesdrop on any conclave

of businessmen in Madison, say, or Racine. They may be talking of the rise in steel prices, but wait a moment and the conversation will swing toward the merits of the latest Evinrude outboard motor—significantly, a product of sports-minded Milwaukee. Try to talk crops with a dairy farmer, and you may shortly be hearing a lecture on the use of radioactive trace elements by university researchers exploring the mystery of photosynthesis in plants.

Love of the land, of down-to-earth knowledge, of discovery, of life itself—these qualities have been rooted in this buoyant, tough-minded State from the very beginning.

When Marquette and Jolliet with five men and two bark canoes set out through the Straits of Mackinac in May of 1673 to discover the "great River," the Mississippi, Indians warned them of "horrible monsters, which devoured men and Canoes Together." Yet they pressed on along the Fox-Wisconsin waterway, until, one month later, they saw the wide flood of the Father of Waters.

What did Marquette feel? "A Joy that I cannot Express."

There was the joy of discovery—and also that of mastery and freedom. Among the Potawatomi of Chequamegon Bay, the explorers Perrot and Baudry were treated as gods and paraded on the Indians' shoulders. Their hosts blew smoke upon them from the sacred peace pipe. Wrote Pierre Esprit Radisson of his own similar adventures: "We wear Cesars being nobody to contradict us."

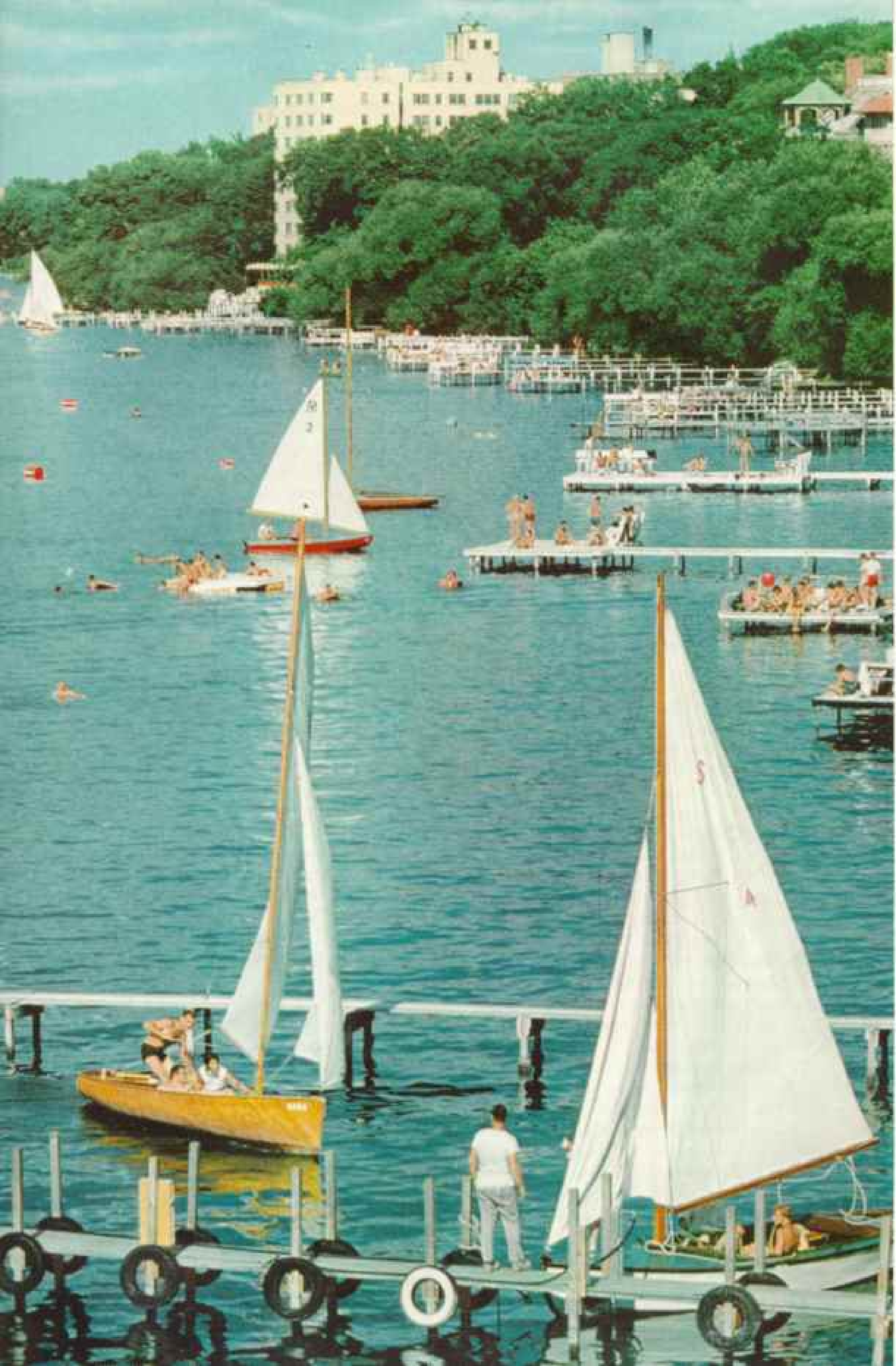
These were men who knew what it was "to have the belly empty, the weariness in the bones," and yet who, like Radisson, could find this new land a "laborinth of pleasure" and grieve only that the rest of "ye world could not discover such inticing countrys to live in."

A Land to Be Loved

It was a land to be loved, certainly. Radisson journeyed for days through forests "dark as in a cellar." Clouds of wild pigeons rose up before him, and the geese going over at night honked enough to keep a man awake.

Paddling down the Wisconsin, the Flambeau, the Chippewa, the St. Croix, the *voyageurs* swept by in their long bateaux.

Wisconsin seemed to have room for everybody. Southerners pushed up the Mississippi into the lead-mining area, bringing their slaves with them. Once the reluctant Indian



← Wisconsin University Summer Students Play in Campus-side Lake Mendota

Page 152: Swimmers crowd docks built by fraternities and sororities, whose houses border this Madison lake.

Sailors aboard a Thistle (left), an undocked craft of molded plywood, prepare to tie up near a Seagull at the university-owned pier.

Edgewater Hotel breaks the fringe of trees in background.

© National Geographic Society

Sails Fly Above Steel→

Dr. Alexander Graham Bell, inventor of the telephone, applied principles of flight to water craft. Using airplane engines and attaching thin, ladderlike strips of metal to the hull, he found that the vessel rose even at low speed. In 1919 one of Dr. Bell's hydrofoil speedboats bettered 70 miles an hour, a world record.

Here the sailboat *Monitor*, designed by Baker Manufacturing Company for the Office of Naval Research, skims over Mendota at 27 miles an hour.

The boat sails like any other until it attains 12 mph, when it mounts the steel blades. Stern foil acts as rudder.

Elwin Stein

rebel Black Hawk had been defeated in 1832, Yankee farmers drove their prairie schooners in, cracking 27-foot bullwhips over six yoke of oxen at a clip.

Cornish miners ("Cousin Jacks" or "Cussin' Jacks," as you prefer) settled around Mineral Point and quarried stone for their houses out of the green hills. Scots moved into eastern and northern counties; Welshmen brought hymns and chapels; the Irish, haunted by famine, poured into eastern and southern farmlands; the tidy Swiss founded cheese factories around New Glarus and half a dozen other points.

And then the Germans.

The "forty-eighters" were the first big wave—intellectuals, republicans, liberals driven from Germany by the failure of their resistance to autocracy. Most of them landed on their feet, blessed with skills for which Wisconsin had a ready use.

The next Germanic influx was to break be-



tween 1881 and 1884. Solid folk who knew what they wanted, these immigrants settled down quickly to become excellent farmers, tanners, brewers, managers of small factories. Concentrating especially on Milwaukee, they soon gave it—with their concerts, their *Sauerbraten mit Knödel*, their plays, their garden restaurants, their press—the reputation of the *Deutsche Athen* of the Midwest.

The roster grows as long and varied as the map of Europe: Swedes, Finns, Norwegians, Danes, even a group of Icelanders; Poles in profusion; Dutch, Belgians, Czechoslovaks, Italians; and, more recently, Greeks, Lithuanians, Hungarians, and Yugoslavs.

On special festive days many a Wisconsin town commemorates its Old World origins





↑ Barefoot Birlers Fight for Balance on a Spinning, Water-slick Log

To drive spring's crop of logs down flooded streams, Wisconsin lumberjacks used to ride the logs, leaping from timber to timber to break up jams. Thus the sport of birling, or logrolling, was born.

Here at Hayward, on the Namekagon River, Gary Kukla (left) and Ralph Metcalf, sons of lumberjacks, try to upset each other by changing the speed of the rolling log. Three hours and fifteen minutes is recognized as the longest logrolling contest on record.

Old-time lumberjacks used the wanigan (background) as a floating cookhouse. Following the loggers downstream, the wanigan daily dispensed six hearty meals and coffee by the gallon. A restored logging camp here preserves the sixty-year-old houseboat as a relic of by-gone days.

← Wisconsin Is a Land of Lakes; These Are Links in a Vast Chain

Air view shows the town of Three Lakes extending out to Maple Lake. According to one story, the community was named by surveyors who, starting off in three directions, found each way blocked by a lake.

← Page 154, upper: Chippewa Indians, following the method of their ancestors, harvest wild rice by boat in the Wisconsin River. As one man poles the canoe, his partner bends the stalks with a stick and threshes grain into the hull with another. Indians sell most of the harvest, which retails for about \$2.75 a pound. White rice costs only 20 cents.

Wild rice (*Zizania aquatica*) and white rice (*Oryza sativa*) are both cereal grasses but are not closely related.

with pleasant pageantry. New Glarus, home of the Swiss, re-enacts in its own pastures the folk tale of William Tell.* The Welsh of Wales, Wisconsin, hold each year their *Gymanfa Ganu*, a festival of religious song.

On the last Sunday of August the Belgians celebrate their autumnal kermis, baking giant pies and whirling about in those same harvest dances that weave so vividly through the paintings of Bruegel. Church holidays in Milwaukee, Racine, Kenosha, or Madison find the Italians staging jovial festivals in the streets, parading the Madonna and exploding firecrackers.

If you want to see all this fun and fervor concentrated in one rich kaleidoscope, you will do well to attend the Holiday Folk Fair held in early winter at Milwaukee.

Here for two full days, before packed audiences, men, women, and youngsters of three dozen national stocks put on distinctive dances, exhibit handicrafts, offer the most tempting samples of their rich and pungent cuisine—from Polish hunter's stew to Norwegian fluted pastry shells.

Wisconsinites seem always to have loved a good time almost as much as a good fight. With typical enthusiasm, Wisconsin's men of 1861 answered President Lincoln's call for volunteers by mustering 36 companies within a week.

Typically too, great singing societies, determined not to be nibbled to death by individual enlistments of basses and baritones, might join up as a unit and form their own melodious regiment.

They took their drums and fifes to war with them. They also took an eagle.

Eagle That Screamed in Battle

"Old Abe," mascot of the 8th Wisconsin Infantry Volunteers, died in the capitol basement in 1881, but you can still see a few of his feathers proudly preserved in the halls of the State Historical Society at Madison.

Bought for \$2.50 from an Indian for Company C of Eau Claire, Old Abe survived 22 battles and many skirmishes, perching defiantly on his standard. Once he flapped off across the lines, screaming his challenge above the thunder of the guns.

With or without their eagle, Wisconsin boys did all right for themselves in the Civil War. Said General Sherman: "We estimated a Wisconsin regiment equal to an ordinary brigade."

Sometimes even one man was worth more—like Lt. Col. Joseph Bailey, who used his northwoods experience to save a Union fleet stranded by low water on Louisiana's Red River. Corraling some 3,000 ex-lumberjacks from the 23d and 29th Wisconsin, Bailey in eight hectic days built a temporary dam above the fleet. Then he broke it and washed the Federal gunboats right over the rapids, safely past the Confederate batteries.

Bailey's approach was somehow typical of Wisconsin. Not much interested in heroics or grand strategy, he buckled down to the problem at hand and applied to it all the common sense at his disposal.

University Serves All the People

That's just what the University of Wisconsin has been doing for generations. No shy, reclusive ivory tower, it has plunged head-first into the problems besetting all the people in its bailiwick. Its motto is significant: "The boundaries of the campus are the boundaries of the State."

Sprawled upon the bluffs overlooking Lake Mendota at Madison, the university can boast not only a beautiful site but many an impressive building. Its true achievement, however, is expressed rather in the bold credo inscribed on a plaque near the statue of Mr. Lincoln on Bascom Hill:

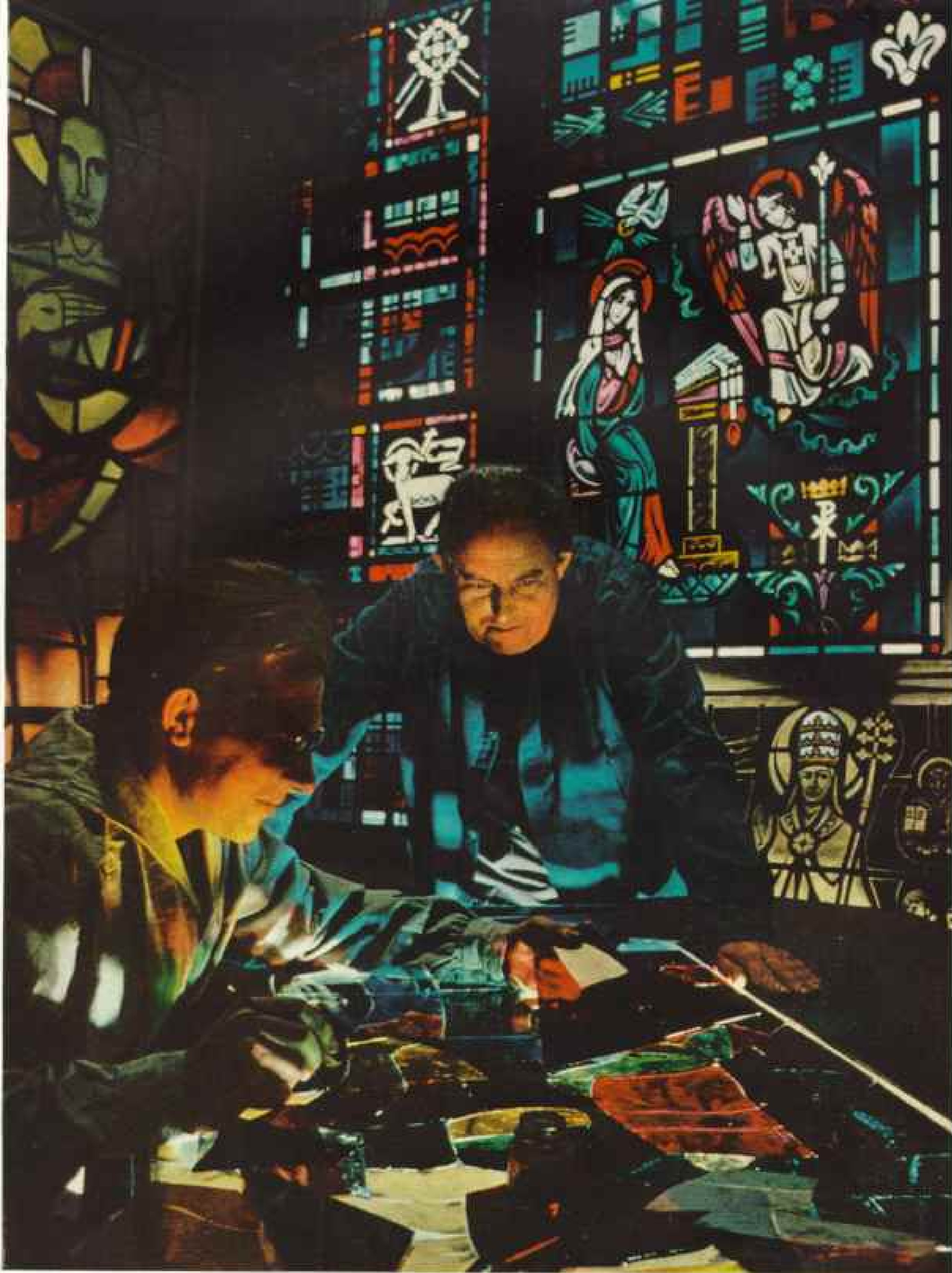
"Whatever may be the limitations which trammel inquiry elsewhere, we believe that the great State University of Wisconsin should ever encourage that continual and fearless sifting and winnowing by which alone the truth can be found."

This "continual and fearless sifting" has turned up many an idea of high survival value. It was the Badger State, stimulated and assisted by university teachers, which pioneered in workmen's compensation laws, vocational education, corrupt practice acts, wage-hour regulations for women and children, income taxes, land zoning, industrial boards and commissions, and the efficient drafting of laws through a legislative reference bureau.

More spectacular have been the successes scored on the scientific front. In World War I, when U-boats were slashing at the Allies' Atlantic transport, Prof. Max Mason invented a pioneer submarine sound detector.

(Continued on page 165)

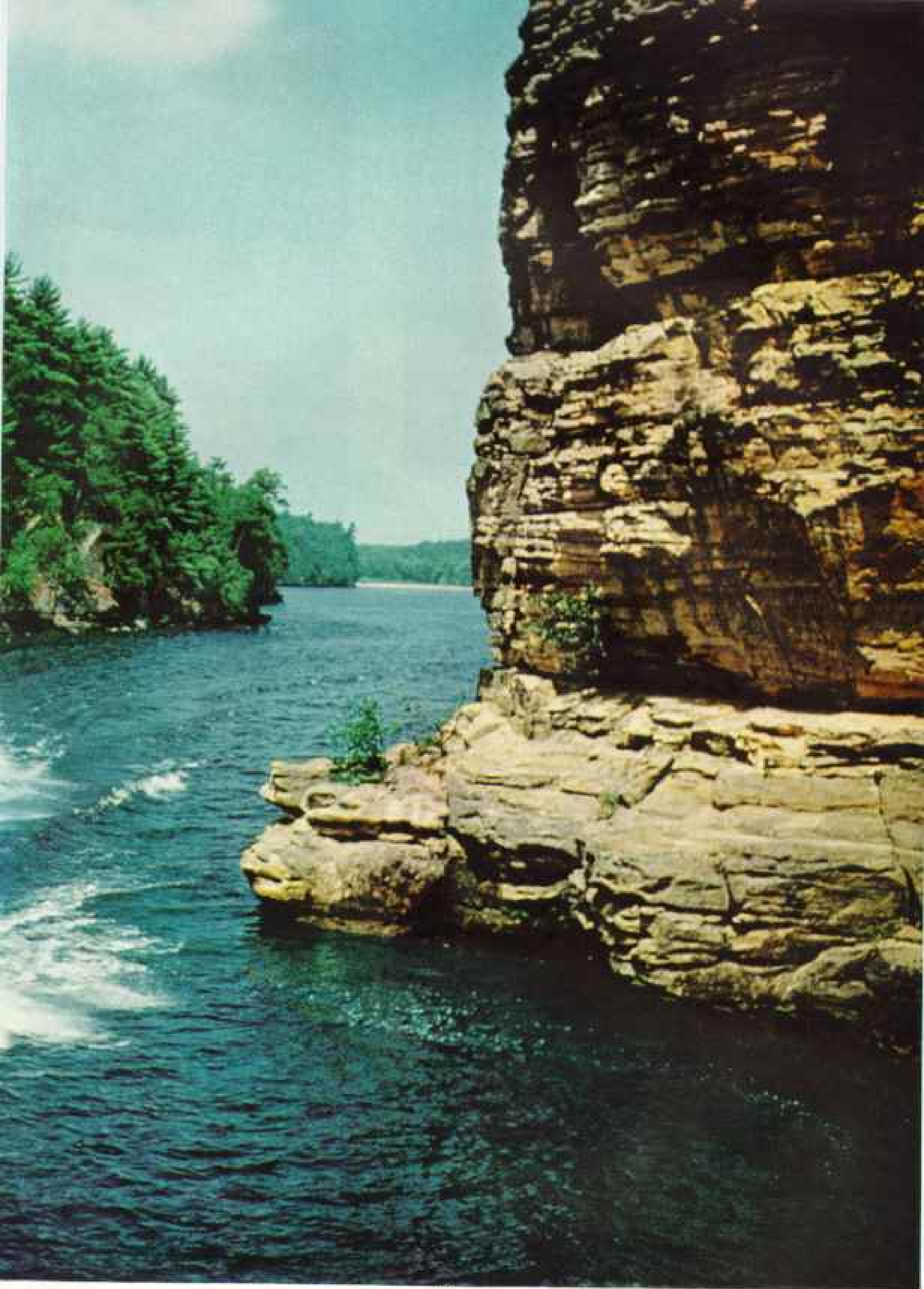
* See "Deep in the Heart of 'Swiisconsin,'" by William H. Nicholas, NATIONAL GEOGRAPHIC MAGAZINE, June, 1947.



Modern Artists in a Medieval Craft Create Jeweled Pictures with Stained Glass

Bayaria-born Erhard Stoettner (standing), master craftsman, executes work in handblown glass imported from Europe, where he repaired war damage to cathedrals. Johann Minten uses iron oxides to trace details of face and dress. Leaded glass panels are seen at the T. C. Esser Studios, Milwaukee. They show the Resurrection of Christ (left), the Annunciation to the Virgin, and Pope Pius X (below).







160

✦ To Lure Trout, a McGinty Fly Disguises Its Hook as a Tasty Bumblebee

Some 1,750 years ago Claudius Aelianus, author of *De Natura Animalium*, wrote of Macedonian fishermen: "They fasten red wool round a hook, and fit on . . . two feathers which grew under a cock's wattles. . . . The fish . . . opens its jaws . . . and enjoys a bitter repast." The Macedonian fly is thought to be today's Red Hackle.

Below: Celia Jakusz ties a McGinty in 3½ minutes, using the feathers of goose, mallard duck, and ostrich. She works at the Weber Lifelike Fly Company, Stevens Point. Peacock plumes are for another fly.

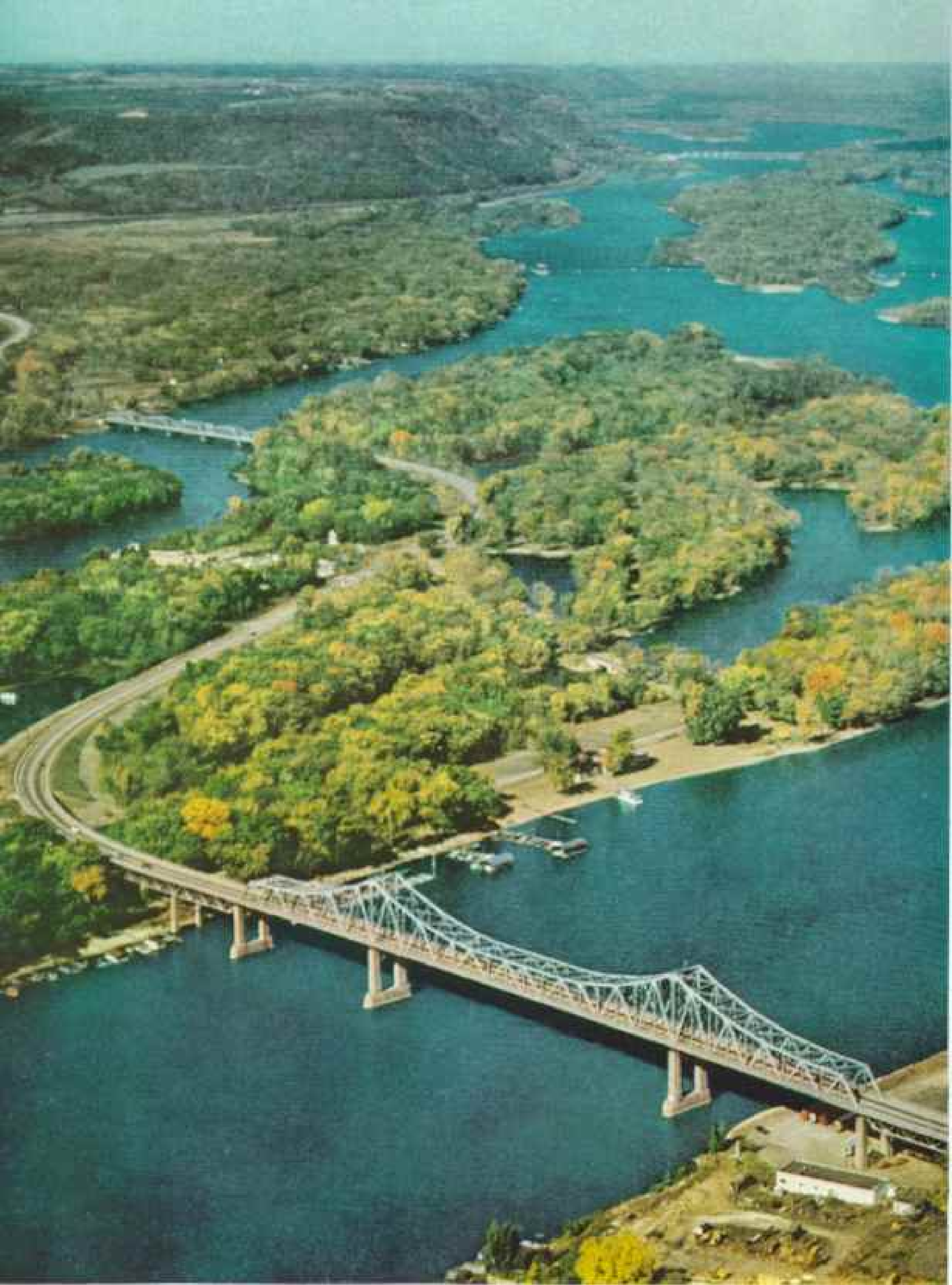
→ Gus Jauch, fly-fishing on the Waupaca River, captures a 5½-pound rainbow trout with a Hornberg Special.

→ Page 161, lower: Employees of the St. Croix Corporation, Park Falls, wind steel guides onto fishing rods of resin-impregnated glass fibers. Glass rods resist breakage and weather.

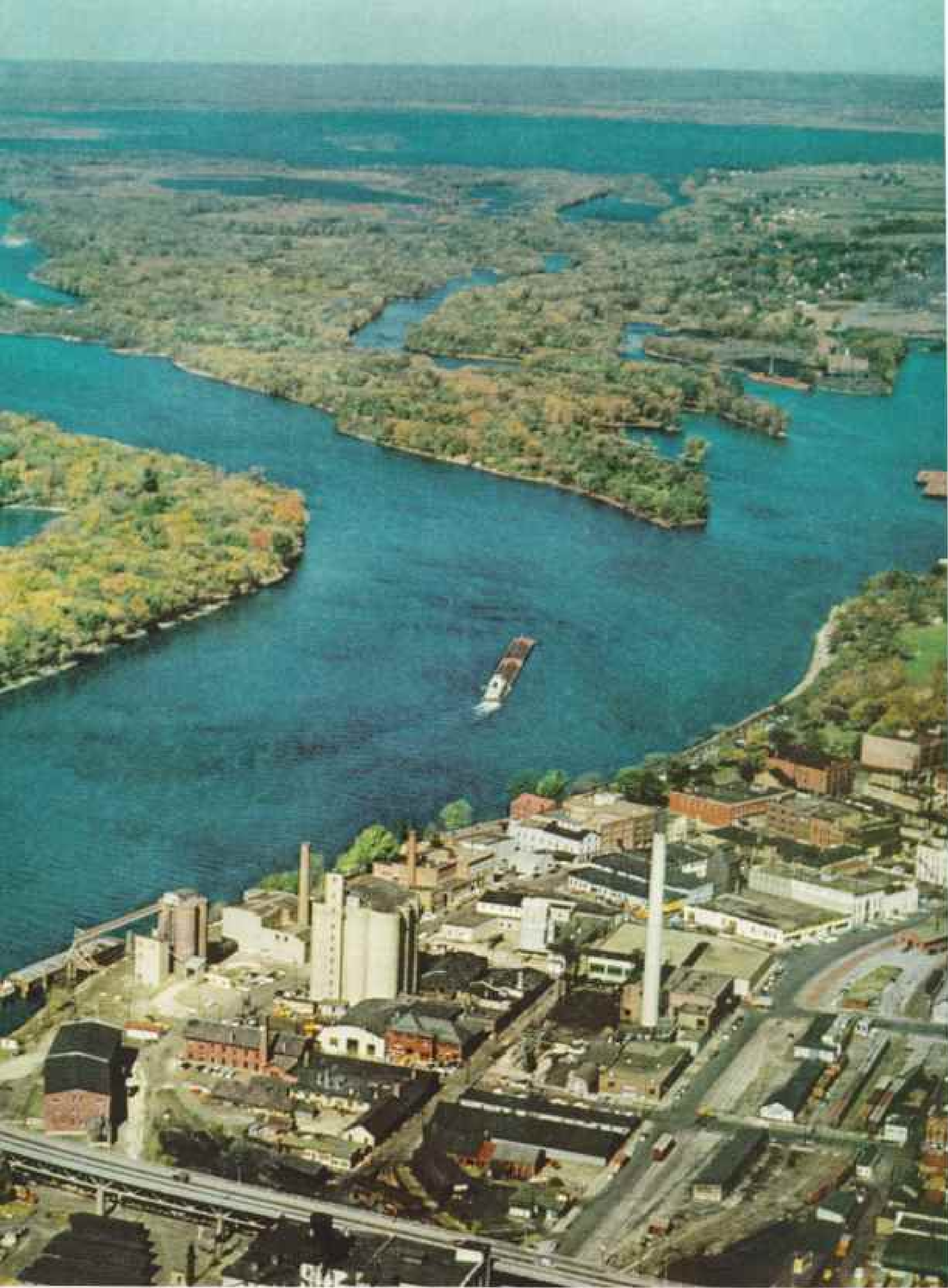
© National Geographic Society







La Crosse Looks over the Mississippi to Jungled Islands and Labyrinthine Channels
Highway bridges on left link Minnesota and Wisconsin. Barron Island (center) is operated as Pettibone Park; skaters use its lagoon in winter. Dam in background helps maintain a nine-foot river channel.



Old Man River Gulps the Waters of His Partners, the Black and La Crosse (Right)

French traders named the townsite after seeing Indians here play the ball game lacrosse. Today the city counts 50,000 people and about 85 industrial plants. West La Crosse sits on French Island (upper right).



Perhaps the most prolific discovery, however, was that of Dr. Harry Steenbock in 1924. Looking for a cure for rickets, the crippling disease of malnourished children, Dr. Steenbock experimented with rat feed. When he exposed some hog-millet ration for just 10 minutes to the rays of a sun lamp and fed it to baby rats, he found that in a few weeks they nearly tripled their weight. But those that ate untreated ration stopped growing!

The Scientist Who "Trapped the Sun"

Dr. Steenbock, in Paul de Kruif's vivid phrase, had "trapped the sun." Ultraviolet irradiation of foods to produce vitamin D became a crucial weapon against disease. A breakfast cereal company promptly offered Dr. Steenbock \$900,000 for his patents.

He didn't accept. Instead, he turned over his rights and royalties to set up a foundation to support—more research. This organization, called the Wisconsin Alumni Research Foundation (WARF), has in its turn proved to be one of the most fertile research groups in scientific history.

Here are a few of the university's achievements which WARF has supported: Dicumarol, an anticoagulant that prevents blood clotting and combats hemorrhagic and thrombotic diseases; warfarin, a fantastic rat poison, relatively harmless to domestic animals and humans but bringing certain death to the rodents; Q-176, a strain of penicillin that permitted laboratories all over the world to double their output overnight; and nicotinic acid, a cure for pellagra.

These and many more developments have allowed WARF to plow more than \$10,000,000 back into topflight university research projects. As a former president, Charles R. Van Hise, once declared: "The discoveries

at the university bring vastly more wealth to the State each year than the entire expenditure for the institution."

If research and inquiry have paid off for the university, they have proved absolutely vital to such major Wisconsin enterprises as lumbering, pulp and paper manufacturing, and dairying.

To early timber cruisers, the notion that the State might ever run short of wood or have to learn new uses for scrub growths would have seemed raucously amusing. Wisconsin, with its billions of board feet of white pine, led all States in annual lumber production. The woods rang with the bellows of the bull-buckers, cat-skinners, and boomers who cut it.

Now this virgin pine is almost all gone; the only sizable patch towers in the Menominee Indian Reservation near Shawano. The north-woods towns that once awaited the lumberjacks Saturday night invasions with mingled avarice and dread seem almost prim.

They used to say the four toughest places in the world were Cumberland, Hayward, Hurley, and Hell. I haven't yet visited the fourth, but I found the other three last summer more interested in selling sporting goods than in raising a rumpus.

Peshtigo Fire Claimed Nearly 1,200 Lives

Perhaps the most tragic aspect of the great lumbering off was that only a fraction of that wonderful timber ever reached a mill. The rest was wasted by fantastic fires and reckless logging. The great Peshtigo blaze of 1871 throws a lurid light on those statistics.

Few people ever heard of Peshtigo's ordeal, even at the time. For it took place the same night that Mrs. O'Leary's cow started that well-known conflagration in Chicago. The fire at Peshtigo wiped out all telegraphic communications, and it was many days before the news broke in the Nation's press. By that time, it was considered too dated for prominent display.

Yet nearly 1,200 persons—five times as many as perished in Chicago—died, and whole villages went up in smoke.

It had been a tinder-dry summer, and a few fires had already broken out in north-eastern Wisconsin. But no one in the village of Peshtigo that October Sunday evening was unduly concerned. On the porch of the saw-mill's boardinghouse, bachelors chatted serenely. A few strollers looked up at the

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← World's Largest Iron-ore Docks Load a Great Lakes Freighter in Superior

Trains of 190 cars haul Mesabi Range ore onto the pier and drop it into concrete bins. Four piers (two obscured in this view) can simultaneously feed cargo into 16 bulk freighters. Large steel arches mount floodlights for night work. Smaller arches are cranes that shake hopper cars to loosen frozen ore.

Here the 19,400-ton *Sparrows Point* starts a loading that took about two hours, as against the record time of thirty minutes. From Superior, the vessel sailed to Bethlehem Steel Corporation's Lackawanna plant at Buffalo, New York.



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Fox River Waters, Diverted Through Paper-making Kaukauna, Flow to Green Bay

Wisconsin leads the Nation in paper production. Its own forests thinned, it draws upon Canada and the northwestern U. S. Woodpiles in upper center feed mills of the Thilmany Pulp & Paper Company.

sickly-yellow sky, shrugged, and went on.

With a roar, the fire suddenly flashed across Peshigo. A storm of sparks rained down as thick as blizzard snow. Men rushing down the street turned into human torches. Houses exploded in flames as if bombed.

Scarcely pausing, the great fire, merging with others, leaped onward. Overnight the holocaust cut a searing swath through six

counties, ravished 1,280,000 acres, and burned millions of pine trees.

From such hammer blows and the steady inroads of careless cutting the forests of Wisconsin have never fully recovered. But today the lumber industry, abetted by paper mills and power companies, is striving heartily, and with growing success, to put its operations on a "sustained yield" basis.



Motoring through the State, I came upon dozens of industrial and school forests green with maturing pine and hardwoods. Hundreds of youngsters, rallying behind the program of Trees for Tomorrow, Inc., not only help plant acres of seedlings but go to summer forestry camps and learn good wood-lot management.

Just as important is the concentrated effort of the U. S. Forest Products Laboratory at Madison to throw the full weight of scientific research into finding out more and more about wood, especially our second-growth

hardwood scrub, and what new uses can be made of it.*

In this nine-acre installation, prefabrication of wooden houses was really born. Taking a leaf from the aircraft industry, with its stressed-skin construction of wings and fuselage, the FPL's technicians built lightweight wall panels that were strong, well insulated, and easy to erect.

The original test house still stands on the laboratory grounds. An even more modern companion stands close by. Its rooms are formed of new sandwich-panels faced with tough, dense surfaces of fiber or aluminum or porcelainized steel, and bonded to honey-comb cores of balsa or paper.

House Held Together with Glue

There's another reason why architects and contractors keep an eye cocked on this house: glue holds it together. New synthetic-resin adhesives, set by high-frequency electricity, make prefabricated joints that are even stronger than the wood itself.

In one corner of the lab playful technicians hung a set of scales on which visitors may weigh themselves. Nothing odd about the scales—except one item: They are attached to the roof by just two drops of glue.

While lumbering itself is no longer Wisconsin's chief industry, papermaking is a leader. The Badger State produced 1,700,000 tons of paper in 1955.

More and more, Wisconsin's companies are turning away from production of run-of-the-mill kraft and newsprint and are focusing on highly specialized and varied papers. To see some of them, I called one day on genial Elmer H. Jennings, president of Kaukauna's Thilmany Pulp & Paper Company (see illustration at left).

Perhaps the most impressive feature of the big plant was its woodpile.

"We keep about four to five months' supply on hand," said Mr. Jennings. "When you figure that we chip some 10,000 cords a month, it does make quite a stack."

We looked at machines flicking out 300 glassine-lined bags a minute, decorative wrappings pouring forth in any one of 400 different colors; reflective aluminum foil being laminated to paper and creped for insulation, tough wet-strength paper being laminated and treated to protect the tin plate of steel mills from corrosion.

* See "Our Green Treasury, the National Forests," by Nathaniel T. Kenney, NATIONAL GEOGRAPHIC MAGAZINE, September, 1956.

"This country uses more than 400 pounds of paper per person, every year," Mr. Jennings said, "and the rate is still rising. Where are we going to get all the trees? Well, you might check in at the Institute of Paper Chemistry over at Appleton for one answer. Ask them about polyploids."

Armed with this baffling question, I drove to the institute six miles away and button-holed E. W. Schoenberger.

The institute, with a budget of \$1,800,000 a year and support from 130 paper companies, operates a high-powered teaching and research program geared to a picked body of graduate students enjoying scholarships of \$2,000 or more.

Science Produces Miracles in Forestry

Polyploids . . . I soon found out what Mr. Jennings had in mind. Virtually all trees, it seems, contain two sets of chromosomes. But in Sweden not long ago some alert tree breeders discovered "giant" aspens with three sets. Compared with the ordinary, or diploid, aspen, these rare trees of polyploid heredity tended to have greater height, thicker girth, larger wood fibers, and possibly more cellulose—traits to make papermakers water slightly at the mouth.

Foresters were soon in the woods in quest of American aspens with three sets of chromosomes. Shortly the first triploid turned up, and institute scientists, continuing the search, are uncovering more.

But that isn't all. Technicians at the institute have begun to use—poison. Actually, it's colchicine, and they apply this violent toxin, diluted, to cells in division in very young seedlings.

Colchicine's mysterious effect: to turn the usual diploid into a tetraploid, or four-chromosome-set tree.

The rude question that might pop to the lips of an old Wisconsin lumberjack would be: "So what? Aspen's nothing but scrub anyhow, not much better'n a weed."

Well, not any longer. Modern technology has shown that the lowly aspen can be used effectively in papermaking. But even if it were commercially worthless, it might yet prove genetically priceless. For experiments with this fast-growing forest tree, the most widely distributed in the United States, may unlock the secret of how to breed in other species the right tree with the right fiber for the right need.

In his *Book of Nonsense*, Edward Lear once declared that:

There was an Old Man who said, "How
Shall I flee from this horrible cow?
I will sit on this stile,
And continue to smile,
Which may soften the heart of that Cow!"

The Wisconsin farmer was not unlike that old man, in the first quarter century of the State's growth.

To sentimentalists, the cow might be "God's jolly cafeteria." But the usual settler wanted to grow wheat, and the notion of nurse-maizing a herd of sickly, scrawny bossies didn't appeal to him much.

Two men changed all that. One was William Dempster Hoard, who told the farmer he should do more than smile and hope the cow would go away.

Hoard's slogan: "Speak to a cow as you would to a lady!" His program: better breeding, better feeding, better sanitation, and markets to process the product. His achievement: to found, in 1872, the Wisconsin State Dairyman's Association.

The other and indispensable man was Prof. Stephen Moulton Babcock. It was Babcock who invented in 1890 a simple, reliable machine to test the butterfat content of milk.

Doesn't sound like much, does it? But, at one stroke, Babcock gave farmers a yardstick on which to base the breeding of top milk producers and the culling of herds, and an adequate measure by which to sell milk.

The dairy boom was on. By 1919 Wisconsin led the Nation in the output of milk and milk products. It still does. In 1955, Wisconsin's cows loyally gave forth more than 16,500,000,000 pounds of milk—enough to fill some 64,000 average-sized swimming pools!

(Continued on page 177)

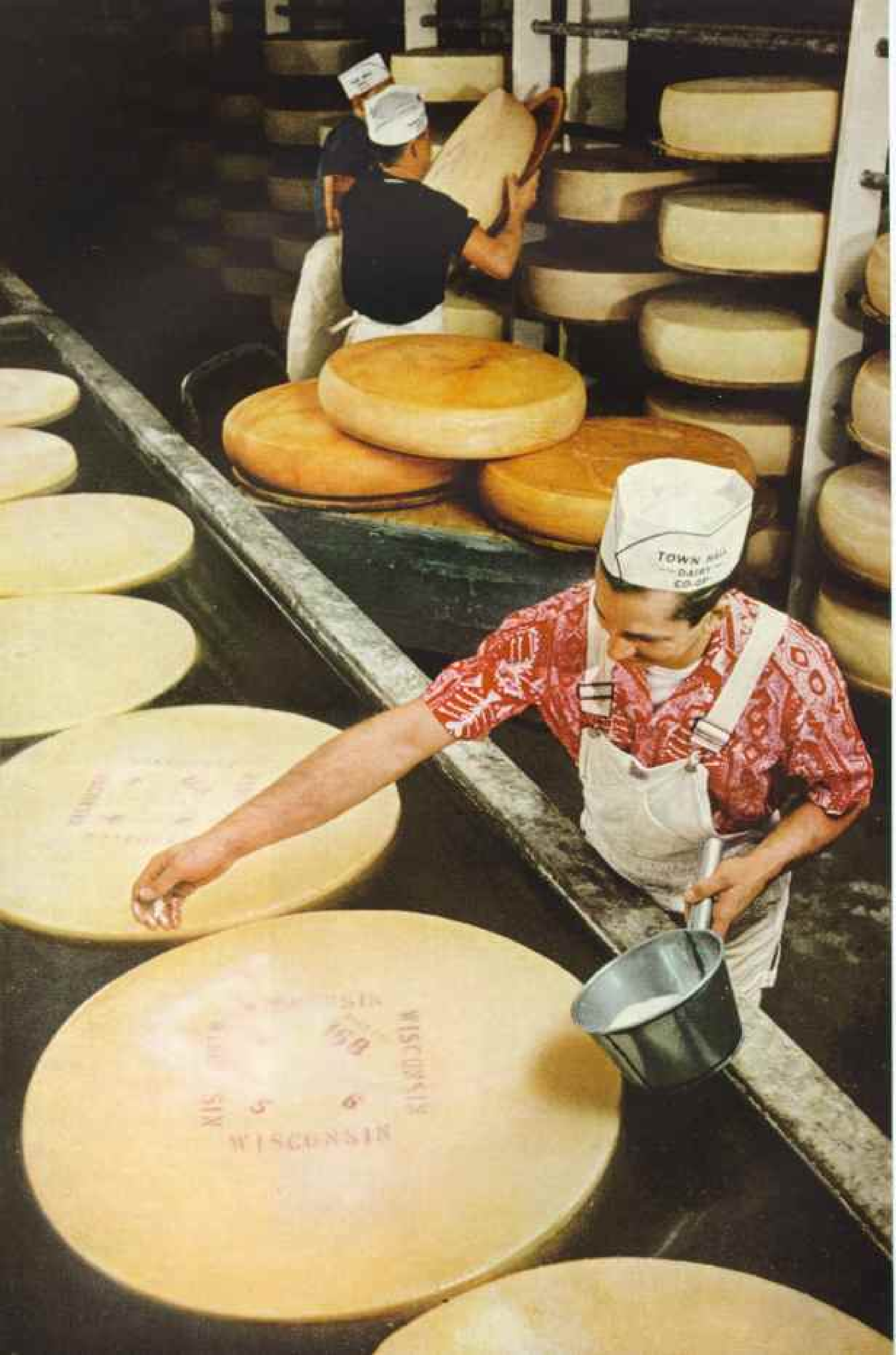
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Cheese Maker Salts Wheels of Swiss → Afloat in a Cool Bath of Brine

Each of these 200-pound cheeses requires 290 gallons of milk. At this stage the curd has been pressed for 18 hours to expel whey and form the mass into a wheel. Brine bath and salt now make the rind and determine flavor.

Soaked for three days, the wheel goes to the curing rack (background). There bacteria, working like yeast in bread, create the eyes, or holes. Ripening requires a minimum of 60 days; the longer a cheese ages, the sharper its flavor.

These Wisconsinites work in the Town Hall Dairy Cooperative, Monticello. Near-by Monroe, market center for six counties, ships nearly one-third the Nation's Swiss cheese.





↑ New Glarus Recalls Its Swiss Beginnings

Each Labor Day week end the town presents Schiller's *Wilhelm Tell*, a drama depicting Switzerland's fight for independence. These girls, each in the costume of a different canton, rehearse a dance.

Flags of Switzerland and the United States hang from the balcony of the chalet, which typifies a home in Emmental. Pre-1912 U. S. flag has only 46 stars. Cantonal banners represent Luzern (left), Valais, Neuchâtel, and Aargau.

← Washington Islanders Have Norse Roots

Immigrants from Norway, Denmark, and Iceland settled on the Lake Michigan island in the mid-1800's. These youngsters performed in their annual Scandinavian Folk Festival.



✦ Milwaukee Teenagers Bend and Leap in a Polish Mountaineer Dance

During the last sixteen years more than 1,500 youngsters have performed with the Mazur Polish Dancers, an amateur group directed by Alfred Sokolnicki, Marquette University professor. Members of the troupe, who train like athletes, present about seventy-five performances a year, usually for charity.

In this dance from the Tatry Mountains of southern Poland, climbing sticks alternately cut beneath the feet and over the heads of the two "brigands."

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Frosted Floats of the Circus Parade, Gone Forever from American Main Streets . . .
Old Woman in the Shoe, Columbia Band Wagon, and Mother Goose are displays in a proposed circus museum.





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↖ **Washington Island Offers Gourmets
Lake Chub Smoked over Maple**

↘ For years Carl C. Marty, Jr., of Three Lakes has tamed wild foxes, otters, raccoons, and bears. These orphaned fawns visit him by night to beg food and to play with his dogs. Each drinks three quarts of milk daily. Red collar warns hunters of a pet.

**Coon Valley's Verdant Farms Reward →
Twenty-four Years of Soil Saving**

Page 175: Here in 1933 farmers embarked on the Nation's first large-scale soil and water conservation program. Contour strip-cropping, terracing, rotation, and fertilizing greatly increased crop yields on 35,000 acres. Hay and grain stubble color these fields.







← Pendarvis House Stands in Memory of Mineral Point's Cornish Miners

Page 176: Immigrants from Cornwall arrived here in the 1830's to work lead mines. An abundance of limestone enabled them to build cottages like those they had left behind. Quarrying from his back yard, the builder of this house constructed walls 18 inches thick.

Pendarvis House faces a street called Shake Rag, so named because the miners' wives once called husbands to meals by shaking rags out the front doors.

Town historian Robert M. Neal, here seen greeting guests, restored the house in 1935.

About two million "outsiders" cross Wisconsin's borders each year to fish or hunt or swim in one of its innumerable lakes. I'm sure most of them appreciate, as I did, Hoard's and Babcock's contributions to the landscape.

There are, surely, few pleasanter vistas in the world, winter or summer, than the tenderly cherished pastures of Wisconsin's dairy-land. For dairying is no enemy of the soil; it preserves the earth's green cover, nourishes it, skillfully paints it in subtle patterns of corn and grass, grain and grove.

To the casual motorist, these dairy farms of Wisconsin have a Currier and Ives look of old-fashioned simplicity. But their serenity masks a revolution.

At the university-operated Electric Research Farm near Madison I saw firsthand what is being done to take the work out of dairy chores. Instead of having to climb up into the slippery silo with rubber boots, risking the danger of a fall, a farmer can now just touch a button and watch the silage tumble into his cart.

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← Architect Frank Lloyd Wright Shows His Model of an Art Museum

For the Solomon R. Guggenheim Museum, now under construction in New York City, the architect designed an open gallery with walls supporting a continuous ramp from top to bottom.

Visitors may take elevators to the top of the five-story ramp and walk down the gentle incline, whose outer walls are hung with pictures daylighted by a ceiling of translucent glass. Complete air conditioning and automatic dust collectors at entrance will make it possible to show art works without glass covers or frames.

Fifty-five to sixty young apprentice architects from about twenty nations study under Mr. Wright at Taliesin, his country estate near Spring Green. Two of them here hold the exhibition section of the model, while the architect displays a section of the ramp. The vertical shaft accommodates elevators and stairs.

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A mechanical barn cleaner, which actually is a conveyor belt, takes manure to a spreader—no shoveling necessary. A thermostatic ventilator keeps the barn's air fresh and at the correct temperature and humidity. A pipeline milker, of course, circulates the milk from cow to tank.

Hay isn't pitched; it's chopped in the field, blown up into the loft, and dried. Nobody swats flies; a built-in barn "fogger" sprays the interior with pyrethrum.

Grain for cows is planted, cultivated, harvested, dried, stored, ground, mixed, and dispensed mechanically.

"The last time a farmer here touches the corn," said Lynn Brooks of the university, "is when he lifts a sack of seed in the spring and puts it into the seeder."

Result? Not only a better life, but higher output. Wisconsin's farms in the past five years have dropped in number by 15,000—but milk production is up by 1,751,000,000 pounds! The number of tractors has increased by nearly a third, and the number of horses and mules has been more than cut in half.

New Techniques Speed Farm Changes

Wisconsin's agricultural revolution, in short, is on its way. New developments in producing, concentrating, and handling dairy products, new techniques of marketing and distribution, new uses of trace elements and nuclear products may speed it along. Today's farmer must be part mechanic, part scientist, part veterinarian—and all business.

The same technological forces have transformed even the age-old trade of cheese making. To be sure, scores of modest factories in country towns still make, rather haphazardly, the specialties of their region by techniques little changed in 50 years. But the bulk of the Badger State's output—largest in the land—is now produced in plants as spick-and-span, as elaborately controlled and equipped as any laboratory.

From Monroe, Green, and Lafayette Counties come Swiss and Limburger; from Dodge County, northwest of Milwaukee, much of the brick and Muenster cheeses; from many counties, cheddar.

In Plymouth I watched long stainless-steel vats of milk heated with steam, saw the rennet (from the membrane of a calf's stomach) added to start coagulation, looked on as the master cheese maker scooped the curds from the tank with his finely perforated ladle.



Glass Ceiling Filters Natural and Artificial Light Through a Forest of Columns . . .

Webbs of incandescent tubular lamps in skylights make the room all but shadowless. Heating units in the floor and air conditioning ensure comfort the year round. Pillars swell from 9 inches to 18½ feet in diameter.



... in the Great Workroom of Johnson's Wax Administration Building at Racine. Architect Frank Lloyd Wright (page 176) designed the revolutionary office building in the 1930's. This room for 225 clerical workers stretches 200 feet by 150. Employees enjoy music piped in at intervals.

Workmen in rubber boots mixed the curds again with hot water and kneaded the taffy-like blobs into their traditional shapes. Then they popped them into tanks of ice-cold brine, first step in the curing process.

A cheese such as provolone may cure for four to five weeks. Romano is rubbed with salt to develop flavor and rind and to extract still more moisture. Seven or eight months it will cure on the shelf, its mold scraped off every month, before being finally sealed in wax and sent off to eager gourmets.

Through one chill loft after another I roamed where the great cheeses hung like golden lanterns or lay aging in racks. Down the silent rows passed a cheese scraper, his sole function all the frigid day to trim the faint blue-green mold from the aromatic wheels and globes and cylinders and bricks.

Scenic Year-round Vacationland

Wisconsinites, whether cheese makers or dairymen or brewmasters or bankers, are notoriously hard working. But they know how to live, too. Their lakes and streams are not reserved just for an annual two-weeks vacation. Winter and summer they take to the woods and the water at the drop of an old felt hat (with colorful trout flies stuck in the band).

On week ends the highways leading out of major cities are headed with cars, station wagons, and trailers topped by canoes and outboard dinghies. The men at the wheel have happily exchanged white collars and neckties for lumberjacks and sweat shirts.

They have plenty of camping sites from which to choose.

"We've got more lakes up here than we can sort out," J. H. H. Alexander of the Wisconsin Conservation Department told me one day as we were putting our fishing tackle together. "About 9,000 of them. Good deal of overlap on the names: The lumberjacks named many of 'em for their gals in town, and they seem to have known pretty much the same lot of gals."

I rode through central Wisconsin in August, to the lonely, lake-dotted terrain around Hayward in search of a typical Badger objective: a musky.

The muskellunge is Wisconsin's top prize for anglers, a steel-muscled, chunky, belligerent member of the pike family, the acknowledged heavyweight scrapper in the North American fresh-water division. The

world's record specimen, a 69-pound 11-ounce monster, was boated after a 45-minute struggle in Chippewa Lake, near Hayward.

But not by me.

At Ross's Teal Lake Lodge my son and I flailed the water to a fine foam with all-manner of impressive lures. We left Wisconsin's stock of muskies quite undented.

The Great Lakes gave Wisconsin its major highways of commerce, but along the western border flows another: the Mississippi. Blue and hazy, laced with marshes and islands, the majestic river looks as virginal as when the birchbark canoes of the first voyageurs glided along between its wooded palisades. Tracing the stream down from La Crosse to Prairie du Chien, I was rather startled to see an occasional modern dredge or a tug pushing a brace of barges; a bateau of singing Canucks would have seemed less incongruous.

Prairie du Chien's main street contains little trace today of the boisterous life it once led as a major fur-trading post. No painted Indians jostle buckskinned frontiersmen, flatboatmen in calico shirts and earrings, or officers in scarlet and gold. But off on a quiet road near the river still stands the Villa Louis—"Le Chateau Brillante"—still among the region's grandest mansions.

Col. Hercules Dousman, the villa's builder, evidently made a good thing out of business with the redskins and the white trappers. His son's highbred horses raced on a track surfaced with cork imported from England. Guests fished in stocked ponds or played pool on a table inlaid with ivory.

Restored to the heights of decorative fancy reached in the 1880's, the villa now abounds in such Victorian genus as fans hand-painted on chicken skins, prim china dogs, wire bird cages of incredible elaboration, "French cas- ket" bath tubs, melodeons, tufted sofas.

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Flying Fishermen Land on Mendota → and Pull Perch from Holes in the Ice

The lake's apparently inexhaustible supply of fish draws sportsmen summer and winter. Many of the usual winter crowd walk out from Madison. Others fly in from neighboring States. Nearly all spend chilling hours sitting on sleds, stools, or boxes. A few carry stoves and tents onto the ice.

This party used a heavy ice pick to chop through 18 frozen inches. Their 70-foot lines are baited with salmon eggs, perch eyes, or larvae. Floats of cork at the surface give warning of a bite. The Ceana flew in from Eau Claire.





Motorboats Tow a Footloose Island Across Kettle Moraine Lake, Near Fond du Lac

A buoyant mass of vegetation, this three-acre bog broke loose from shore last May, took sail in the wind, and piled up against the resort beach in the background. Hauled away, it blew back. Residents plan to cart it off by truck. Other floating islands continue to form in Wisconsin. Sedges, spreading across the water, lay foundations for shrubs and trees, whose roots intertwine. Solid mats rot and sink, eventually clogging lakes.

Down the road, at Mineral Point, I turned my car into Shake Rag Street and pulled up at the Pendarvis House (page 176). Built by Cornish miners in the 1830's, this cottage seems to grow right out of the limestone slope from which it was quarried. Its buff walls, 18 inches thick, possess a rugged Old World dignity, a well-bred sense of proportion, and an air of being here to stay—indefinitely.

In a flagged courtyard I was greeted by a tall, scholarly, soft-spoken gentleman whose grandmother had left Cornwall in the old days to settle here in Mineral Point.

"Robert Neal's my name. Do come in. I expect you want some Cornish pasty? And saffron cake? Frankly, wild horses couldn't drag me into eating that cake; I don't like the medicinal flavor. But some do. And I

think you'll enjoy our wild-plum tart with scalded cream..."

I did. The pasty, a robust meat pie with onions and potatoes inside, proved very filling. I even liked the saffron cake.

Well replenished and well seasoned, I drove on to Little Norway, near Mt. Horeb. In this pastoral replica of a Norwegian pioneer farmstead, set in a pleasant glen, I found many of the cherished possessions which Norway's emigrants brought to Wisconsin or made there: six-legged rockers, solid-wheeled buckboards (whose axles must have squealed like pigs caught under a fence), great two-handled flagons, wondrously carved spoons, very oddly abbreviated built-in beds.

Resident host at Little Norway is a rugged man in picturesque garb who calls himself Sticky. "From Latvia I come," he told me. "But Scandinavian I am by occupation, yes." In summer, Sticky obligingly answers the questions of visitors, wise and otherwise. But in winter he retires to one of the snug cabins of Little Norway and writes poetry.

From Sticky I might have heard many a tall tale, and certainly Wisconsin literature is studded with them, from the exploits of Paul Bunyan to the annual newsworthy fibs of the Burlington Liars' Club. But the facts of Wisconsin's natural endowment are quite as fantastic as any fiction.

Lake Mendota, Anglers' Dream

Take Lake Mendota. It's an attractive view at any time, especially from the Rigadoon Room of the Edgewater Hotel. But what lies below the shining surface is fabulous in its own right. For Mendota seems to be an inexhaustible fish store. The creel limit used to be 25 fish to a person; now it has been removed altogether.

With the capital city of Madison crowding its shores, Mendota is clotted with boats in summer and with bundled figures ice fishing in winter. Yet the university's scientists say the fishermen have made scarcely a dent in the perch population and won't in the foreseeable future—not because the fish aren't hungry and gullible (they are) but because conditions for their reproduction and nurture are nearly ideal.

I walked out on the lake in early March. The ice was still a good 18 inches thick, and hundreds of townsmen in parkas and the baggy "surplus" trousers of high-altitude hikers were crouched over fishing holes.

I stopped beside one grizzled fisherman who was sitting on an orange crate and staring at his cork bobber. Beside him lay three fat perch and a sprinkling of the salmon eggs he was using for bait.

"Some fellows prefer perch eyes or Mayfly nymphs," he volunteered. "Me, I like these eggs, here, or else goldenrod 'galls'; they're a sort of white grub we collect in the marshes."

"How's the catch this spring?"

"Oh, I guess we average about four perch an hour. Maybe fifteen a day."

We both looked up as a small plane swooped low over the western end of the lake and bounced lightly down on slender skis. A man and two children climbed out.

"Know that guy," said my friend. "Flies here from Illinois. Matter of fact, about three-quarters of the people who fish Mendota come from out of town. Sometimes there are three thousand of us out on the lake."

Iceboats Roar Like Jet Planes

Later, trudging back to shore, I met a disconsolate university sophomore standing beside her stalled iceboat. It was an old-fashioned, rather clumsy-looking craft, with jib and mainsail mounted on a heavy backbone and a steering rudder fixed to the stern.

"I feel like a helpless woman with a flat tire," she said. "The runners are stuck."

With much puffing and heaving, I helped her free the big blades from a slushy patch. She shouted for me to hop aboard, the wind caught our close-hauled sail, and off we skimmed.

Riding an iceboat in a stiff breeze is no more dangerous or uncomfortable than driving a truck 90 miles an hour down a steep wet hill, with the wheels loose, no brakes, and pieces of the windshield flying back into one's face. Exhilarating... In no time at all, we had whipped past the fishermen—a mere blur of huddled figures—and were careening down a long clear stretch of ice, taking pressure heaves and occasional snow hummocks in our stride.

That was my first jaunt. Next day, at a regatta held at Oshkosh on Lake Winnebago, I discovered that on my pioneering experience I had scarcely moved out of low gear. These new racing craft, slim fuselages sleekly varnished and single 75-square-foot sails stepped rakishly amidships, weigh a mere 300 pounds or so and travel like greased



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↑ **Faster than the Wind
They Sail in, Iceboats
Skim Lake Winnebago**

In the 19th century iceboats achieved the greatest speeds then reached by man. Along the Hudson River they raced and outran trains pushing full-throttle along tracks parallel to the frozen course.

Wisconsinites revolutionized the sport by attaching the rudder to the bow and mounting a streamlined cockpit atop straight-set runners (right). In 1953 a Wisconsin boat of this type reportedly hit 150 miles an hour in a brief spurt.

All sailboats go fastest across the wind. A vacuum of air currents in the lee of the sail sucks the craft forward as the wind hits the canvas. Given a 40-mile wind, iceboats can attain 100-mile speeds.

Page 185, upper: A boat heels around a tree marker.

**Racing Boats Take Off →
from Lakeside Oshkosh**

Their sails trimmed flat, these skippers compete in the Amy Heinz Memorial Trophy Race on Winnebago. Most owners build boats for \$700 to \$800. Any one of these Skeeters would bring up to \$1,700.

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comets. When one of them zipped down from the windward mark of the course in front of me, ice flying in a fine spray from its razor-sharp bow runner, it gave off a low, awesome roar like a jet plane on the horizon.

The official speed record for an iceboat, 144 miles an hour, was made in New Jersey in 1907. But Chuck Rahr of Oshkosh told me that in 1953 a Wisconsin boat reached 150.

I talked with Rahr shortly after he won the Amy Heinz Memorial Trophy in his *Smoke II*. Blood streamed from his right cheek. He brushed it impatiently away with his gloved hand.

"Ice chips," he said. "Stripped all the paint off the leading edge of my runner plank. That's the trouble with this sport: You spend half the year repairing the damage you've done in three months' sailing."

"Have any bad moments?" someone asked.

"Not this time. But last week at Lake Geneva my brother sheared off another guy's steering runner on a turn, and his whole boat rolled over four times. Didn't kill him, oddly enough."

Milwaukee Keeps Its German Flavor

My 5,000-mile ramble through Wisconsin began in Milwaukee and ended there, too. This is fitting enough, for Milwaukee is not only the State's largest city but perhaps its most characteristic.

Mahn-a-waukee Seepe, the Indians called it: the gathering place by the river. A crude, brawling frontier town, Milwaukee rocketed from boom to bust and back again before it settled down into a city of solid but convivial burghers.

Milwaukee is no longer the Deutsche Athen of the Midwest. Citizens of German origin remain the largest group, but Polish-Americans and a score of other nationalities contribute their own flavor.

Yet some of the old pattern remains. Milwaukeeans still leap soberly over leather horses in three athletic *Turnvereine*. Neighborhood taverns resound with rafter-shaking singing of *Lieder*.

Old cronies meet in the parlor of an evening for endless card games of *Schafskopf*, or sheephead, while the children in the kitchen may be tuning up for a family concert of chamber music.

Very much a part of this tradition is Milwaukee's young mayor, 44-year-old Frank Zeidler. I found his house sandwiched into

a block of modest old-fashioned homes with dark porches, dormer windows, and a scattering of tricycles. Zeidler met me there one evening in his shirt sleeves and ushered me into a small living room crowded with books, a piano, a pump organ, five daughters, one son, and a wife.

In snatches of conversation between songs, I learned that Frank, who has studied at Marquette and Chicago Universities, still takes correspondence courses. In fact, he has piled up some 26 credits since he became mayor of the Nation's twelfth largest city, in political science, public administration, analytic geometry, and the like.

To get to work, Frank either rides the bus or gets a lift from a friend of his, a detective sergeant.

Like any Milwaukeean, Frank is proud of the city's graft-free record. "Milwaukee amazes even me," he said. "Since the voters took control of the police force out of politics, years ago, a policeman is in trouble if he takes as much as an apple for a handout. And if an assessor gets a ham at Christmas—and it becomes known—he will be called on it."

Milwaukee has certainly acquired an extraordinary civic reputation. It won the Interchamber Health Conservation Contest so often that, in 1937, it was ruled out of the competition in its class in order to let some other city have a chance at the prize.

Four times it has won national traffic-safety awards. In its population group it has the lowest homicide and traffic-death rates. It is noted for its low fire insurance rates and its crime prevention record.

Wisconsin Goes Baseball-mad

As if that weren't enough, it also has the Milwaukee Braves.

It would be a grievous mistake, never made in Wisconsin, to assume that the Braves are just another baseball team. They are the darlings of the whole State, the slightly daffy symbol of Wisconsin's desire to place itself large and unmistakably upon the map of the Union.

Milwaukee had not had a big-league team since 1901. Then in 1953 the franchise of the Braves, who had been doing poorly as Boston's National League entry, was shifted to Milwaukee.

What happened? Mere pandemonium.

With two brass bands, a cavalcade of horsemen in war paint, and a battalion of pretty



Steins Uplifted, Milwaukeeans Start a Songfest in a Holbräu

Democracy-loving refugees from autocratic German rule settled here in the mid-1800's. Despite infusions of many other nationalities, the city retains its Rhineland flavor, especially in food, drink, and song.

girls in Indian bonnets leading the way, 60,000 Milwaukeeans paraded this hapless team to a big hotel, draped leis of pork sausages around the manager's neck, and showered his players with gifts ranging from trout flies to \$1,000 Government bonds.

This adoration proved no fair-weather friendship. The ticket turnstiles kept clicking like castanets in the new Milwaukee County Stadium—built for \$5,000,000 and rented to the Braves for \$1,000 a year (page 150). Attendance for 1953 set a National League record: 1,826,397 paid admissions—nearly seven times as many customers as had bothered to appear the previous year in Boston.

To repay the fans' love, the Braves performed prodigies of batting, pitching, base running, and fielding. By the end of the 1953 season they had surged into second

place. They finished third in 1954, and second again in 1955. And in 1956 they came within a hair's breadth of World Series glory, losing out in a close race with the Brooklyn Dodgers for the National League pennant.

"Wait till next year!" say Milwaukeeans.

Whence all this fervor? Mayor Zeidler puts it this way: "We have long felt we were capable people, but because of our peculiar geography, tucked away as we are behind Lake Michigan, our voice has not been heard in the land. This is a means of letting people know we exist."

Odd, that Wisconsin should feel such a need. When I left Milwaukee, the flags of a dozen countries flew in the lake breeze from ocean-going freighters discharging cargo.

Wisconsin doesn't have to flourish a ball bat to attract the world's attention. The world is coming to Wisconsin.



The U. S. Coast and Geodetic Survey, 150 Years Old, Ranges High,
Wide, and Deep in Search of Facts to Aid Navigators

BY STUART E. JONES

Editorial Staff, National Geographic Magazine

With Illustrations by National Geographic Photographer J. Baylor Roberts

AS a long-time user of nautical charts in my small-boat wanderings on Chesapeake Bay, I have often wondered how these large sheets of printed paper manage to convey so much vital information—the wealth of facts, figures, and symbols that provide mariners with veritable road maps of United States sea approaches.

How, for example, do the chart makers know the depths of coastal waters well enough to state them exactly in feet or fathoms? How do they know that certain areas of sea bottom are “foul with logs,” or—to use the chart abbreviations—“hrd Cl” (hard clay), “Oz” (ooze), or “Co Hd” (coral head).

Who performs the job of locating such shore-line landmarks as villages, windmills, cupolas, chimneys, gables, and oil tanks, and indicating them with neat symbols on the charts?

And those wreck-strewn shoals off the Carolinas, the submerged rocks of New England and Alaska—who pinpoints these hazards with such precision, so that seafarers, noting them on charts, may take warning?

I knew, of course, that the responsible bureau was the United States Coast and Geodetic Survey, under the Department of

Commerce. Since its earliest years the National Geographic Society, in its production of world-area maps, has worked closely with Coast and Geodetic. Rear Adm. Leo Otis Colbert, who headed the bureau from 1938 to 1950, was the sixth director of the Survey to become a life member of The Society's Board of Trustees.

Mapping by Land, Sea, and Air

The present director, Rear Adm. H. Arnold Karo (opposite page), explained to me that the bureau's primary task is surveying and charting coastal waters of the United States, its territories and possessions, an area comprising more than 2,500,000 square miles.

“But that's not all we do,” Admiral Karo added. “We work on land, too. And that brings me to the word ‘geodetic’ in our bureau's title—I'd better explain it.

“It pertains to the study of the size and shape of the earth, what scientists call the geoid. A geodetic survey, then, is one that takes account of the curvature of the earth. A large part of the Survey's job is surveying or measuring the national domain—providing a framework of geodetic control as a base for all our mapping, and also for engineering construction.”

The Survey, the Admiral explained, also helps aviation by preparing aeronautical charts of the United States, charts that show radio ranges, beacons, obstructions, approach systems, and other data essential to flying safety.

To do all this, the Survey employs about 2,000 men and women—hydrographers, geodesists, cartographers, engineers, geophysicists, oceanographers, mathematicians, and the like. It operates a fleet of six large vessels and many smaller ones.

“The results of all this effort are made available to the public and to other Government agencies in the form of charts, maps, and technical publications,” Admiral Karo pointed out. “All the Survey's activities, of

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← 20,000 Surveys, the Work of 123 Years, Cram the Vault at Bureau Headquarters

Coast and Geodetic Survey engineers chart the United States and its possessions by land, sea, and air. Fieldmen collect data on the rise and fall of tides. Other technicians study earthquakes and the earth's magnetism. About 185 of the Survey's 2,000 employees hold commissions and wear uniforms similar to those of the United States Navy.

Here Rear Adm. H. Arnold Karo, USC&GS (left), director of the Survey, discusses revisions on a Narragansett Bay chart with Harold R. Edmonston, chief of the Nautical Chart Branch.

Red tubes contain topographic surveys; dark ones hold hydrographic sheets.





← *Pathfinder* Churns Past Shishaldin Volcano, Aleutian Landmark

Nautical charts serve the ship's navigator as road maps of the sea. They reveal the water's depth, safe channels, submerged hills, shoals, and wrecks.

To chart nearly 100,000 miles of tidal shoreline and inshore waters, the Survey maintains a fleet of seventeen ships, including six major seagoing vessels.

One hundred officers and men aboard the 230-foot, diesel-powered *Pathfinder* spent the summer of 1956 in the Bering Sea making depth recordings for nautical charts.

Here the vessel speeds toward King Cove on the Pacific side of the Alaska Peninsula to pick up fresh food supplies from Seattle, Washington. Shishaldin Volcano, rising 9,387 feet above Unimak Island, is one of the few almost perfect cones.

← Page 190, lower: The Survey ship *Pioneer* charts water depths and bottom contours along the approaches to San Francisco's Golden Gate. Here in the plotting room below deck, the crewman at right checks the vessel's position on a Shoran instrument. † Lt. Comdr. H. S. Cole, *Pioneer's* electronics officer, examines the fathometer's graph of an odd pinnacle formation on the ocean floor off San Francisco.

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course, are important to our national defense. Today, just as it was when Thomas Jefferson founded it 150 years ago this February, the Coast and Geodetic Survey is a pioneer and a trail blazer."

After guiding me on a tour of the Survey's three floors and basement in the Commerce Department building in Washington, D. C., Admiral Karo suggested that I take a look at some of its field operations.

"For a start," he said, "I recommend Alaska. There our Air Photo Mission is mapping the Alaska Peninsula and Aleutian Islands, in cooperation with two ships that are making a hydrographic survey of inshore waters in the Bering Sea."

To Alaska for Aerial Photomapping

A few days later I stepped out of a Northwest Airlines plane at Anchorage and was greeted by National Geographic staff photographer Joseph Baylor Roberts. Having just flown across the continent, I looked forward to a night's rest before proceeding to the Air Photo Mission's base at Cold Bay, 600 miles westward, near the tip of the Alaska Peninsula (map, opposite page).

Joe had other ideas.

"Let's go," he said, grabbing my bag and hustling me toward a taxicab. "I've already canceled your hotel reservation. The mission's B-17 is fueled up and waiting at Elmendorf Air Force Base. We're going on to Cold Bay—right now, while there's still daylight."

Thirty minutes later I was airborne again, this time jammed among sharp-cornered boxes of photographic gear in the waist of a con-

verted World War II Flying Fortress. About three hours later I was on the ground at Cold Bay. Few places have been so aptly named.

Here, on a bleak, treeless neck of land between the Pacific Ocean and the Bering Sea, in an area noted for some of the world's foulest weather, I found the men of the Air Photo Mission living and working under conditions that would discourage all but the most stout-hearted.

Several thousand World War II veterans remember Cold Bay as the desolate place where, alternately, they cringed under the whiplash of the wind or groped about in a smother of fog in the days when this was an Air Force heavy-bomber base.*

Cold Bay's concrete runway, in the shadow of 6,700-foot Frosty Peak, serves today as an occasional refueling stop for airliners on the great-circle route to the Orient. DC-3's of an Alaskan airline call regularly. Airline and Air Photo Mission personnel, plus small units of the Civil Aeronautics Administration and Weather Bureau, make up the population of about 50, including a few CAA wives.

"We'd like it fine," one wife told me, "if it weren't for the bears that come prowling around the garbage cans at night."

Dozens of rusted quonset huts, wind-wracked relics of wartime, still stud the hills and nestle in the hollows around the airstrip. In one relatively sound quonset, formerly the

* See, in the NATIONAL GEOGRAPHIC MAGAZINE: "Strategic Alaska Looks Ahead," by Ernest H. Gracning, and "Bizarre Battleground—the Lonely Aleutians," by Lonelle Davison, both September, 1942; and "Our Air Frontier in Alaska," by Maj. Gen. H. H. Arnold, October, 1940.



base chapel, the Air Photo Mission—volunteers all—had set up housekeeping for the April-to-October season of photography.

"It's like living in a submarine adrift in a sea of mud," said Lt. Alfred C. Holmes, the photographic navigator.

Nevertheless, morale was high in the narrow tunnel of corrugated iron that 10 men called home. Food, flown from Anchorage and cooked by two-man teams in a turn-and-turnabout arrangement, was excellent. A radio set and a sizable library of paperbacks helped. There were endless games of chess, cribbage, and gin rummy, an occasional movie at the CAA quarters, and frequent sorties to near-by lakes and tarns, where big Dolly Varden trout struck savagely at lures.

The Coast and Geodetic Survey has no aircraft of its own. The Air Photo Mission is a joint operation with the Coast Guard, which supplies the aircraft, pilots, and flight crew, while the photographers and photographic navigator are from the Coast and Geodetic Survey. The pilot, Lt. Comdr. W. N. Durham, with the assistance of the copilot, Lt. Comdr. Keith Lowe, was responsible for all flight activities, and Lieutenant Holmes, a commissioned officer of the Survey, was in charge of the photography.

Plane Grounded 11 out of 12 Days

At five-thirty every morning Lieutenant Holmes left his cot, pulled on trousers, boots, and parka, and hurried through the chill Alaskan darkness to the Weather Bureau shack a few hundred yards away. There he studied the latest reports and forecasts, to

determine if the day's conditions would permit photography anywhere within range of the B-17.

In this kind of photography, the mission could operate only when there was a maximum of "two-tenths cloud cover"—that is, a clear day with not more than a few scattered clouds.

Alaska Peninsula and Aleutian weather being mostly atrocious, Holmes more often than not could go right back to bed without disturbing his fellows. On about one morning

Sailing Chart No. 9000 Guides Mariners in Aleutian Waters

Compiled from many sources, the Coast and Geodetic chart reproduced on these pages shows offshore soundings, reported shoals, outer buoys, principal lights, and visible landmarks. Recent surveys have revised many depth and elevation figures.





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↑ Photographers Aim a 9-Lens Camera Earthward from 21,000 Feet Above the Aleutians

Invented and developed by the Coast and Geodetic Survey, the 750-pound camera simultaneously exposes nine separate images on a single strip of film. Assembled images produce a picture of needle-point sharpness. Here Edwin Hawbecker and Bennett Sparks focus the goliath through a B-17's open bay. At this height each exposure covers an area of 270 square miles. Here the men work in a temperature of 20° below zero.

↓ Photographer Hawbecker must service the camera after each flight. Film for the multi-eyed monster measures nearly two feet in width and 200 feet in length. (See pages 200-201 for 9-lens photograph.)



in twelve he would burst into the hut with a jubilant cry: "Let's go, men! Out of those sacks! We're going flying!"

It usually took some time for his jubilation to penetrate the sacks.

Even this, however, did not guarantee a take-off. Commander Durham had to pass upon the weather outlook. He, responsible for the safety of a crew and a four-engine airplane worth several hundred thousand dollars of taxpayers' money, must make the final decision. Since Holmes, too, was an experienced pilot and navigator, Durham seldom questioned his judgment.

Rare Day Sends Photo Crew Aloft

One of the rare flyable days came along during our brief stay with the mission. Soon after a hurried breakfast the B-17, with Roberts and me aboard as observers, was off the ground and spiraling into a sky that was virtually cloudless.

The day was especially remarkable in promising that Cold Bay itself and the immediate surroundings could be photographed—something the Survey had been unable to do in several Alaska seasons. Cold Bay was the center of the mission's general working area, extending from Port Heiden on the peninsula westward to Amlia Island in the Andreanof group of the Aleutians.

At 12,000 feet all hands went on oxygen. Off to the west, rising 9,387 feet above Unimak Island, we could see the graceful snow-covered cone of Shishaldin, highest of the Aleutian volcanoes. Shishaldin is known locally as "Smoking Moses," but on this day its pipe had gone out (page 191). Pavlof Volcano, to the eastward, was doing better: a long plume of white smoke issued from its crater, 8,215 feet above sea level.*

In the waist compartment photographers Bennett Sparks and Edwin Hawbecker slid back a plywood hatch cover, admitting a hurricane of freezing wind and sound and exposing an awesome gulf of nothingness between the airplane's belly and the earth. Then the Coast and Geodetic Survey's unique nine-lens camera, suspended on cables and elastic shock cord, was carefully winched into operating position over the hatch (opposite).

Air blast whistled through openings around the nine-eyed monster, quickly driving the waist-compartment temperature down to 20° below zero.

Now we were at 21,000 feet, our correct

altitude for photomapping. Carrying an oxygen bottle, I crawled forward where there was heat. On the flight deck, pilot and copilot relaxed in their seats but kept sharp eyes on the dials that told of altitude, air speed, cylinder-head temperature, manifold pressure, and the like.

"Holmes is flying her now," explained Commander Durham, lifting his oxygen mask for a moment. "Our job is to get this airborne camera platform into position and then take her home again. Navigator and photographers do the rest."

In the Plexiglas-enclosed nose, Holmes used a Norden bombsight to control the airplane's course, just as a bombardier does on the run over a wartime target. Peering through an eyepiece, Holmes occasionally corrected for drift, or "crabbing," as he checked the plane's position. Finally satisfied, he pressed his intercom microphone switch and said casually:

"You may start the camera."

Sparks, receiving the command in the waist, pushed a button that started an intervalometer, a device that tripped the camera's nine shutters simultaneously at two-minute intervals. Each exposure produced a 24-by-24-inch negative that would be blown up into a print three feet square. At 21,000 feet, each picture would show a 270-square-mile patch of earth on a scale of 1:30,000.

For seven hours, with the camera clicking away busily and pausing only for a change of film, we flew long, ruler-straight, parallel lines back and forth across the Alaska Peninsula. Once, for good measure, we flew beyond the peninsula's southern coast and photographed the Sandman Reefs, a jagged cluster of rocks forming a hazard to shipping bound to and from Unimak Pass, a strait that connects the Bering Sea with the Pacific Ocean.

Pea-soup Fog Ends Flight

Late in the afternoon, thick fog began rolling in from the Bering Sea. I switched on my earphones and heard the intercom system come alive with a crackle of conversation.

"If we could run one more line," Holmes told Durham, "we'd have this area just about wrapped up."

"Yes," replied the pilot, "but look at that fog! At this rate, it looks as if Cold Bay will be socked in before you can say Shishaldin.

* See "Exploring Aleutian Volcanoes," by G. D. Robinson, NATIONAL GEOGRAPHIC MAGAZINE, October, 1948.





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♣ Sea Lions Climb High on a Bering Rookery

Hundreds of peculiar rock formations lurk perilously close to the surface along the Alaskan coasts. Survey ships that recently charted these waters found them dotted with the hulks of wrecked vessels.

Sealion Rock, a volcanic outcropping, breaks the Bering's surface two miles north of Amak Island. Thousands of Steller sea lions congregate here in summer. Their hot bodies often steam in the icy sea.

Eumetopius jubata is largest of all sea lions. A full-grown bull weighs up to a ton. Long hairs on its bulgy neck vaguely suggest a lion's mane.

After breeding, the herds move to warmer waters off California. Pups, born on land, must be taught to swim.

◀ Page 196, lower: When *Pathfinder's* launch sent a crew to erect a shore signal, sea lions bellowed at the intruders.

♣ Tide Gauge Records the Bering Sea's Rise and Fall

A cylinder atop the four-inch pipe revolves continually, charting the water's vertical movement inch by inch, minute by minute. Lt. Comdr. William E. Randall of the *Pathfinder* changes the roll on Amak Island.



And if that happens, we won't have enough fuel to get to an alternate field."

"In that case," said Holmes, "we're in perfect agreement. Let's head back to the barn."

As the fog billowed in rapidly from the northeast, advancing steadily upon Cold Bay airstrip, Durham maneuvered the big ship in a fast spiral descent that set my eardrums to popping and whistling.

We removed oxygen masks, and Sparks joined me in staring glumly through a waist window at the thickening soup.

"At times like this," he remarked, "a man is liable to think real hairy thoughts."

Turning in a wide circle west of the field, Durham found what he was looking for—a clear opening at the end of the runway, just ahead of the oncoming fog bank. The B-17 touched down smoothly, and by the time we rolled to a stop we were enveloped in damp, gray opacity.

Monster Camera Uses 200-foot Films

Later I watched Sparks and Hawbecker remove a roll of exposed film from the camera and prepare it for shipment to Survey headquarters. The roll, about two feet long and containing 200 feet of film, looked like a monstrously swollen version of one taken from an ordinary Brownie, even to the slotted openings at the ends.

"Someday, just for a gag," said Sparks, "I'd like to walk into a drugstore with one of these and ask them to develop and print it for me."

In preparation for the next mission, the men then set about checking and cleaning the camera, a task that consumes from three to six hours after every photomapping flight. While they worked and talked, I learned something about this extraordinary instrument, only one of its kind in the world.

"What this thing really amounts to," said Sparks, "is nine cameras operating in perfect synchronization on a single film—nine shutters, nine diaphragms, nine sets of lenses and mirrors, nine of just about everything. And if one of the nine cameras fails, you've had it—no picture."

This giant camera was designed in 1933 by Capt. O. S. Reading, photogrammetrist of the Coast and Geodetic Survey. The objective: to obtain the greatest possible coverage per photograph at the large scales required for detailed mapping. The pictures must show clearly the coastlines and alongshore features

such as rocks, piers, roads, buildings, drainage, and contour of ground. Fairchild Camera and Instrument Corporation spent two years building the machine at its plant on Long Island, New York.

One of the camera's lenses is set in the middle, with eight more arranged in an octagonal pattern around it, rather like a flower with eight petals. All nine lenses aim in the same direction—straight down—but only the central lens shoots a vertical picture. In front of each of the others a small stainless-steel mirror deflects the field of vision, so that as the plane flies they photograph what lies ahead of it, behind it, and off to the right and left.

Since these eight oblique exposures are really mirror images, of course, they come out reversed when the film is developed—left is right, and front is back. A special printing machine straightens them out again, and the nine exposures fit together into a single picture as neatly as a jigsaw puzzle (page 200).

From this print, by means of special instruments, cartographers transfer photographic details to charts and maps.

Plumbing the Depths of Bering Sea

Having covered airborne operations, Joe and I now transferred to the Survey's "navy." In response to a radio message, Capt. John Bowie of the Survey ship *Pathfinder* sent a launch to pick us up at a rocky beach near Cold Bay.

Pathfinder was running a hydrographic survey of inadequately charted Bering Sea waters in the area between the peninsula and small, uninhabited Amak Island. Farther west, near Adak, the sister ship *Explorer* was engaged in similar work. From the findings of these two vessels, plus those of the Air Photo Mission, would come the raw material for detailed, up-to-date charts and maps of an important part of our big, burgeoning Territory in the Far North.*

Pathfinder's chief operation was depth finding, a job once performed by heaving a lead weight attached to a line marked off in feet or fathoms.

Today depths are sounded by the fathometer, an instrument which sends a sound signal to the bottom of the sea and measures the time in which it bounces back to the ship's

* See, in the NATIONAL GEOGRAPHIC MAGAZINE: "Alaska's Warmer Side," by Elsie May Bell Grosvenor, and "Alaska, the Big Land," by W. Robert Moore, both June, 1956.



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↑ **Trailer Cabins Let Surveyors Keep on the Move Yet Live at Home**

Beginning at the sea and working inland, leveling parties have established a network of elevations across the Nation. Mobile housing proves ideal for the fast-moving survey teams. This unit camps near San Bernardino in southern California.

↓ **Trans-U.S. Pilots Check Their Course on an Air Navigational Chart**

Coast and Geodetic Survey charts tell airmen which routes to fly, danger areas to avoid, and airfields to use. Here Seattle-bound Capt. Richard O'Neil (left) and copilot Robert Weigel of Northwest Airlines prepare for take-off at Washington National Airport.



Airborne Nine-lens Camera Blankets New York Harbor

Only one of its kind, Coast and Geodetic's nine-lens camera gives map makers the biggest possible picture in the widest detail. The nine lenses take separate pictures simultaneously on one strip of film. Only the center lens shoots a vertical picture. Eight others, looking into deflecting mirrors, photograph ahead, behind, and to the sides (pages 194, 195).

→ Developed and joined by special rectifying equipment, the nine pictures show an area 16 times larger than that covered by the ordinary camera. This exposure, made from 8,250 feet, embraced 45 square miles before sections were trimmed on right and bottom margins.

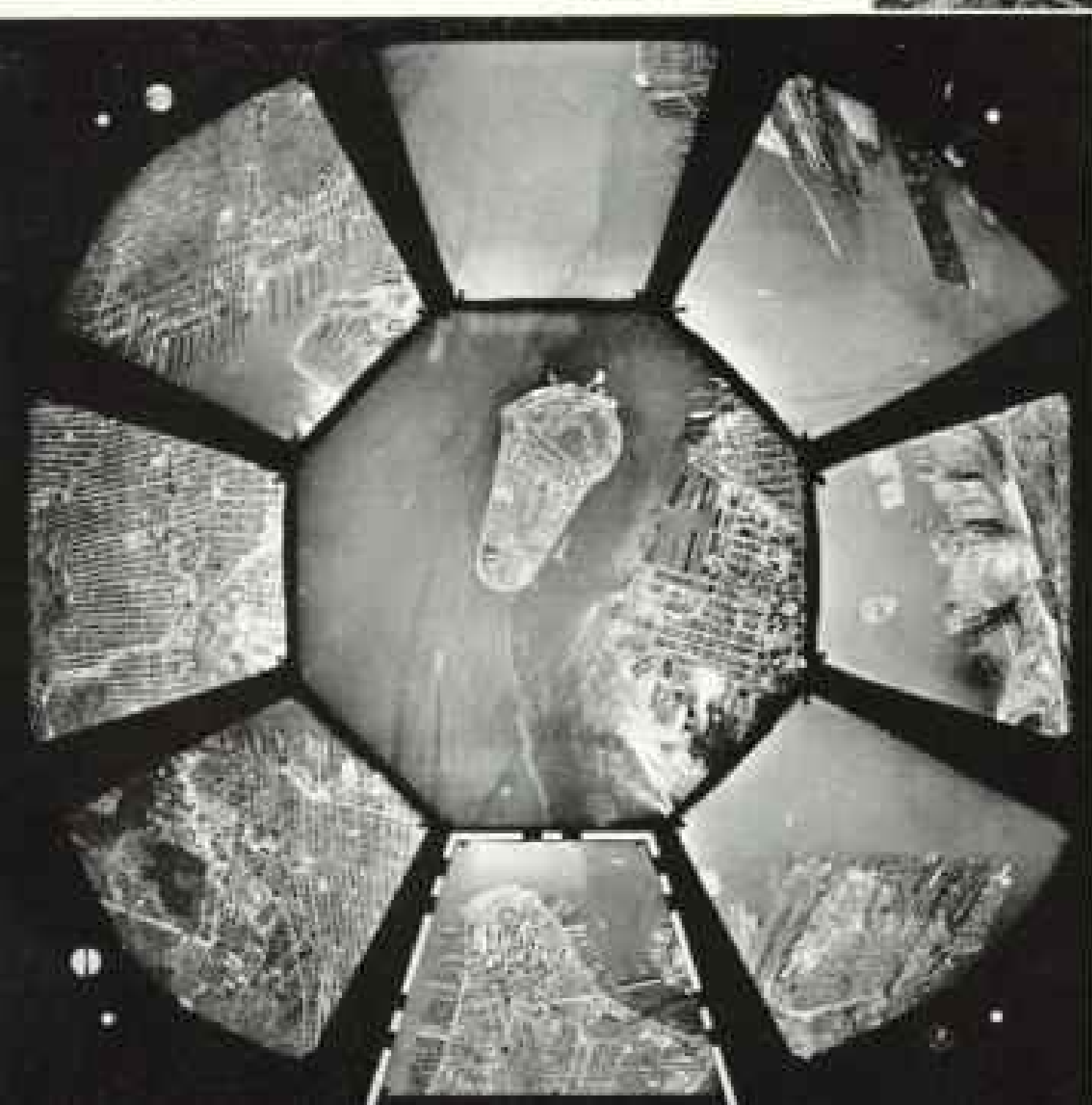
Governors Island, headquarters of the First Army, dominates the central panel. To the left, twin rectangles identify Ellis Island. Smaller Liberty Island reveals the statue's star-shaped base. Ships streak the harbor like water striders.

Battery Park, at the tip of Manhattan Island, gives way to the financial district's skyscrapers. West Side Drive, an elevated expressway, parallels the Hudson River.

Brooklyn, Manhattan, and Williamsburg Bridges span the East River. The New York Naval Shipyard in Brooklyn is blacked out for security purposes. Reflected sunlight beside the lower docks dances like frothing surf.

Jersey City and Hoboken fill the west shore. New white ribbon of concrete belongs to the New Jersey Turnpike.

↓ Before they are projected into a single print, the nine prints suggest a flower with eight petals. Segment outlined in white matches its counterpart in the composite.







keel. The fathometer automatically provides a reading of the depth. With this equipment, accurate soundings can be obtained in a second or two in water as much as a mile deep.

The fathometer's partner is a newer electronic miracle—Shoran, or short-range aid to navigation, which enables a vessel to establish its position day or night, in clear weather or fog. Under this system, a ship equipped with a Shoran instrument becomes the apex of an imaginary triangle with respect to two shore stations at known locations. The shore stations reflect radar-type signals, or pulses, over distances of 50 to 70 miles. Two sides of the triangle are measured by the Shoran method, which enables the navigator to find his precise latitude and longitude in a matter of seconds.

At 8 a.m. every day *Pathfinder*
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← Triangulation Observers Set Up a Station in Yosemite Valley

Triangulation—extending a series of imaginary triangles over a broad area with pin-point accuracy—establishes the exact latitude and longitude of fixed points for mapping. Working from stations one to 50 miles apart, crews determine their positions with theodolites.

This party sets up instruments atop Smith Peak in California's Hetch Hetchy watershed. The tent protects the delicate Wild T-3 theodolite from sunlight.

→ In flat or forested regions, geodetic technicians take triangulation readings from soaring steel towers. A five-man crew in Yosemite Valley erected this 77-foot structure in 3½ hours. Inner tower supports the theodolite alone; observers on the outer platform can move without affecting the instrument.

← Level Party Sinks a Bench Mark

Small bronze tablets record elevations at thousands of key points in the United States. Surveyors usually place the disks beside highways and railroads. Leveling parties in wilderness areas must penetrate remote canyons and scale rugged peaks.

Bench marks rest firmly in bedrock or concrete, with only the surface visible. Here the surveyor at left inscribes the elevation figure on a new marker in Cajon Pass, California. His companion drills a pothole.







← Departing Airliners
Roar Above Surveyors
on La Guardia Field

New York shares a common problem with many American cities: new buildings crowd its airport. Each additional structure offers another hazard.

To minimize this danger, obstruction-plan parties of the Coast and Geodetic Survey chart the profiles of more than 300 municipal airports at frequent intervals. Approach and landing charts based on the surveys point out the obstructions.

Here a field crew runs a line of levels to determine runway elevations. Later the party will measure the height of obstructions around the field. Using such data, the Civil Aeronautics Administration sets the load limit for outgoing air traffic.

Manhattan Island's Empire State and Chrysler towers pierce the horizon.

← Page 204, lower: A level party measures elevations at Newark Airport. High-intensity approach lights guide pilots in landing.

↕ Surveyor Henry Bozzo sights through an alidade to obtain the position and height of an obstruction near La Guardia Airport.

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Illustrations by John E. Fiorino,
National Geographic Staff

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lowered its four 30-foot diesel launches, each equipped with Shoran and fathometer and manned by an officer, coxswain, deck hand, and operators of the electronic gear. As the launches cruised back and forth over their assigned stretches of the sea, the officers in charge, bending over survey sheets in the cabins, plotted depth figures and position coordinates called out by the men at the instruments.

We went along one cold, rainy day in a launch skippered by Lt. Comdr. William E. Randall. Besides routine depth finding, our mission was to inspect a tide gauge and to install survey controls on Amak Island (page 197). Such controls may be cloth banners on wooden supports, or splashes of whitewash on rocks; they serve as auxiliaries to Shoran by providing the launches with visual bearings for position fixes.

These jobs accomplished, Randall proposed entertainment.

"Want to see some trained seals?" he asked.

We said we did, and the coxswain steered for Sealion Rock, a jagged volcanic outcropping two miles north of Amak.

A few hundred yards from the rock, we could hear the bellowing of its inhabitants, a vast herd of sea lions. As we drew closer to the rookery, we saw thousands of thick-necked, writhing creatures. Each ponderous bull guarded a harem of ten to twenty cows. The cows, in turn, watched over month-old pups. The powerful odor of the animals was borne to us on the wind.

These were Steller sea lions (*Eumetopias jubata*), larger relatives of the California variety that sometimes perform as "trained seals" in circuses and vaudeville shows (page 196). Found in most Alaskan waters, they are regarded as ruthless destroyers of fish. Coast and Geodetic Survey men join fishermen in looking upon them as nuisances.

Sea Lions Imperil Survey Parties

"Very often when we go ashore to set up controls," said Randall, "we have to pick our way through crowds of sea lions—not the safest job in the world considering that the footing is slippery and that the bulls weigh as much as 2,000 pounds.

"During the breeding season, about June, we give them a wide berth, because then a bull will charge a man without hesitation. The cows and pups usually flop into the water when men approach. But they all have pretty nasty-looking teeth."

Of recent years the U. S. Fish and Wildlife Service's Branch of Alaska Fisheries has been studying sea lions with the dual objective of reducing their numbers and putting them to commercial use. Tests proved the hides to be useless—too soft and spongy for tanning; still under study is the idea of manufacturing pet foods from sea-lion flesh.

Bottom Snapper Samples Ocean Floor

Back aboard *Pathfinder* we found Captain Bowie and a petty officer taking a sample of the Bering Sea floor. This was done with a bottom snapper, a heavy metal cylinder armed with spoon-shaped jaws. Plummeting downward at the end of a cable, the snapper automatically closes its jaws upon striking bottom and takes a bite of whatever material lies there (page 208).

This time it swallowed a lump of the black volcanic sand often found in the Bering Sea. The type of material and the position at which it was found were duly recorded for later transfer to charts. Knowledge of bottom characteristics, as provided by charts, helps mariners find good holding ground for anchors.

After long hours of bobbing about in the launches, *Pathfinder's* hydrographic officers spent more hours in the ship's drafting room, compiling and checking figures that would go to headquarters. After that it was every man for himself in the war against boredom generated by months at sea.

The first night I walked into the senior officers' lounge, I found Lt. Comdr. John Boyer industriously plying a pair of knitting needles, with a ball of yarn beside him and a square of brown wool steadily growing larger in his lap.

"A man has to do *something* to kill time around here," he said with a sheepish grin.

"Making a sweater, perhaps?" I suggested.

"No," he replied. "As a matter of fact, it's going to be a dress for my wife."

From rooms opening off the lounge came the sounds of other hobbyists at work. One officer tapped away at leather-tooling projects. Another worked in wood with power tools. A third operated a "ham" radio station and chatted nightly with brother hams thousands of miles distant. Bill Randall busied himself with an Ektachrome color-film processing kit, while the executive officer, Comdr. John C. Mathisson, whiled away his spare hours at both woodworking and silk-screen printing.



↑ **Surveyors Measure Shallows by Rod in San Francisco Bay**

A hydrographic party's launch cruises back and forth in the channel leading to Redwood City harbor. Every few yards a crewman plunges the pole to the bottom and reads the depth. His companion determines the position by taking a sextant fix on shore signals.

↓ **In Deep Water the Fathometer Takes Measurements Automatically**

An electric impulse shoots to the bottom and bounces back. By timing the echo, the fathometer (foreground) measures the depth and records it on a graph. Two men with sextants take fixes on shore. A recorder (seated) logs angles and time at 15-second intervals.





Pathfinder's Skipper Examines Volcanic Sand Dredged from the Depths of Bering Sea
Bottom samples enable hydrographers to describe the sea floor on sailing charts. Capt. John Bowie (right) and Chief Quartermaster Emilio Loya empty this clamshell snapper.

An overnight run westward to Unimak Island, through Unimak Pass, and eastward in the Pacific brought *Pathfinder* to the salmon-cannery village of King Cove to meet a ship bringing supplies of fresh food from Seattle. Joe and I left the Survey vessel there, rode a mail boat back to Cold Bay, and then flew to Anchorage.

Wire-dragging Maine's Rocky Coast

A week later and 3,500 miles distant, I watched other Coast and Geodetic Survey men at work in surroundings far different from those of Alaska. This was a wire-drag party, based at Southwest Harbor on Maine's beautiful Mount Desert Island.

Wire drag is the Survey's method of ensuring that all submarine obstructions, pinnacle rocks, boulders, and ledges have been found, and that the least depths over them have been determined. Such surveying always follows sounding in rocky regions, where electronic depth finding often leaves gaps.

The Maine party, headed by Comdr. John C. Ellerbe, put to sea daily in the 66-foot

launches *Hilgard* and *Wainwright*. Each vessel towed one end of a long cable maintained at a selected depth by buoys and weights.

When the wire caught on an underwater obstruction, the towing vessels were stopped and crewmen went to the spot in a skiff. The obstruction's depth was determined by lowering a lead line. Location of the obstruction was established by sextant sights on three fixed control points on shore.

Cruising in *Hilgard* from Mount Desert Island toward Isle au Haut, I noticed many lobster-trap buoys. Didn't the drag often catch the traps and pull them out of position? If so, didn't lobstermen get angry?

"The answer to that," said Commander Ellerbe, "is that we don't drag in areas where lobstering is in progress. Early in the summer I called a meeting of lobstermen at Southwest Harbor, explained our plan, and asked them to cooperate by removing their traps.

"To lessen the inconvenience, we divided our working area—about 100 square miles—into a number of smaller ones, so that only

small groups of lobstermen had to cease work for a few days at a time. The men have given us one hundred percent cooperation. They're our friends."

As if to prove the point, a passing friend hailed us, came alongside in his boat, and presented us with half a dozen fine lobsters.

"Though the lobstermen know this bottom as the average man knows his back yard," Ellerbe said, "there's always a chance the drag will reveal a hitherto unknown shoal or ledge—the kind of place where lobsters abound. The lobstermen know this and cooperate accordingly. As for seiners, it is helpful to them when the drag establishes areas to be flat and free of pinnacles."

Mechanical Brain Predicts Tides

Back in Washington, D. C., I revisited headquarters to observe some of the methods by which the Survey's experts process material sent in by field units.

In the basement, roaring batteries of color presses turn out finished nautical and aeronautical charts to be sold by Survey district offices and authorized agents throughout the Nation. The charts are kept up to date by a special crew, mostly deaf persons hired under a Survey policy of giving jobs, where possible, to the handicapped. With eraser and rubber stamp, they incorporate information received after the sheets went to press.

In a room by itself I found the Survey's tide-predicting machine, which digests and computes tide-gauge readings obtained by hydrographic parties. Results go into *Tide Tables*, one of the bureau's most widely read publications.

At first glance the tide-predicting machine, about the size of a grand piano, suggested something put together by a small boy equipped with a mammoth Erector set and only a foggy notion of what he intended to build. Closer inspection revealed a superb precision instrument—an intricate arrangement of gleaming brass gears, camshafts, pulleys, weights, and counterweights.

When an operator twirls the controls, all these finely machined parts go into action, calmly and without haste. End result is the appearance of figures on three dials facing the operator. Mathematicians translate the dial readings into daily tide predictions for any given locality. On paper unrolling slowly across the control console, two pens plot curves that serve as a record of tide ranges.

Most people, upon confronting this splendidly complicated gadget, assume immediately that it's electronic. So did I.

"No, indeed," said my guide. "This is strictly a mechanical brain. There isn't a single vacuum tube, or a transistor, or even a foot of electrical wiring, anywhere in it. Furthermore, it's more fun to watch than the so-called electronic brains. Here you can actually see the wheels going round, rather than just a lot of wires and flashing lights.

"The important thing is that it works, and has been working since 1910. Given the necessary data, the operator could set his controls and crank out a prediction of, for example, low tide at the southern tip of Madagascar on July 23, 2057. Normally, however, we predict tides only two years in advance."

Another tower of efficiency, and of complexity, was the Division of Photogrammetry's Zeiss stereoplanigraph. Stated in the simplest terms, this device makes it possible for an operator to look at stereoscopic pairs of aerial photographs and see them as single three-dimensional pictures. Mountains seem to bulge up realistically, valleys to slope, houses to rise solidly from street fronts.

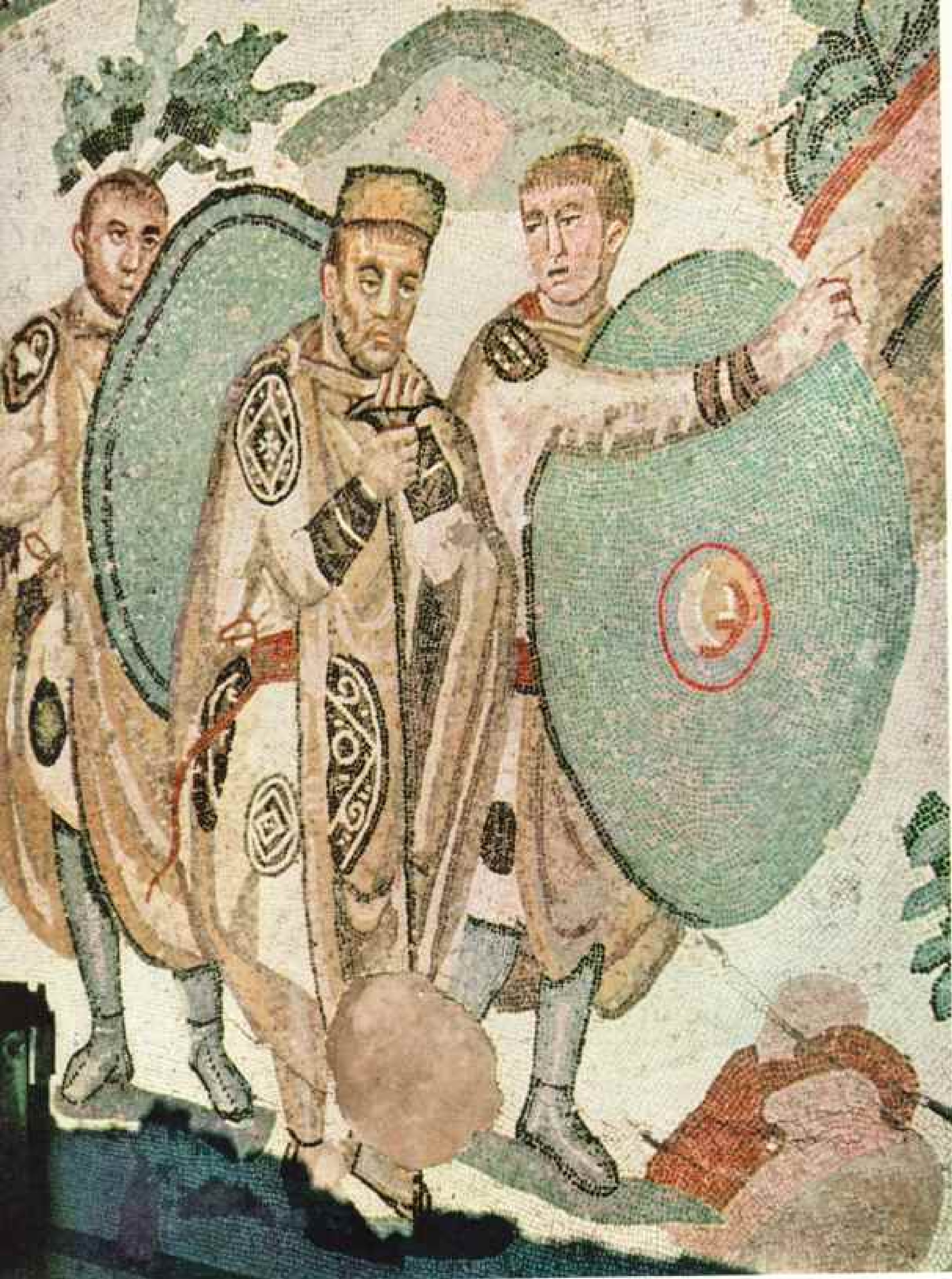
3-D Viewer Traces Contour Lines

Working hand and foot controls as he views the image through a "3-D" binocular finder, the stereoplanigraph operator traces contours by moving a dot of light between hills, around buildings, and along shorelines.

The dot, preset at any given elevation—say 500 feet above sea level—will appear to "walk" on land at this level. Moved to lower land, such as the seashore, it will seem to float above it; across land higher than 500 feet it divides into two dots. Thus by keeping his dot "walking" the operator automatically traces a 500-foot contour.

As the beam of light courses over the image, its movements are transmitted instantaneously, by means of a variable-speed gear, to a pencil point on a near-by plotting table, where measurements are compiled for later use on nautical and aeronautical charts.

As I ended my study of the Coast and Geodetic Survey, it seemed to me that its whole attitude was best summed up in the title of a boys' book about the bureau written by Rear Adm. Robert F. A. Studds (Ret.), a former director. The title, a soft-spoken command which tells a helmsman to maintain the present course, is *Steady As You Go*.



Guarded by Shield Bearers, a Roman Emperor Endures in Mosaic at His Sicilian Villa

Archeologists believe the mansion near Piazza Armerina was built by Marcus Aurelius Valerius Maximianus, a general who reigned between A.D. 286 and 305. This likeness, part of 38,000 square feet of mosaic floors, resembles known portraits of Maximian. Guard at left wears ivy-leaf shoulder patch of the emperor's Herculii Legion.

Roman Life in 1,600-year-old Color Pictures

Archeologists Uncover Brilliant Mosaics in an Ancient Villa in Sicily,
Preserved for Centuries by an Avalanche

BY GINO VINICIO GENTILI

Inspector, Department of Antiquities and Fine Arts for Eastern Sicily

With Illustrations from Photographs by Duncan Edwards

IN the heart of Sicily, in a landscape that is green, restful, and fresh with water, there has come to life in recent years an ancient treasure of mosaic floors, astonishing in the coloring of their lifelike figures and the vastness of their surface.

These dramatic picture stories in stone bring to vivid life the times of Imperial Rome, seen through the eyes of its own contemporary artists. They portray with infinite detail an amazing variety of subjects: the courtly life of noblemen, African big-game hunts, an outdoor barbecue, religious customs, feats of Hercules, bathing scenes, even a bevy of female athletes lightly clad in costumes like modern Bikini bathing suits.

A Dramatic Art Gallery in Stone

As an archeologist, I have been entrusted since 1950 with supervising the excavation of these treasures. The site lies in mountainous terrain near the town of Piazza Armerina 55 miles northwest of Syracuse.

Here, some 1,600 years ago, a Roman of almost unlimited wealth erected a palatial and ornate villa, marvelously decorated in color and design. An army of artists, craftsmen, and laborers must have worked on it.

Today the ceilings, most of the walls, columns, and statuary have crumbled away. But the mosaic floors remain, almost unbelievably well-preserved through the centuries, a brilliant art gallery alive with human figures, gods and heroes, animals, fishes, and striking geometric patterns. No other single group of floor mosaics uncovered anywhere matches them in scope and complexity.

Who built the palace? We may never be absolutely sure, but there is impressive evidence that it belonged to a Roman emperor, Marcus Aurelius Valerius Maximianus.

While he reigned, the empire still held sway over most of the western world—northern Africa, Europe, Britain, and the Near East. He died A.D. 310; at the end of that century the Roman Empire began its long decline.

A well-known Norwegian archeologist, H. P. L'Orange, has suggested that the Piazza Armerina ruins might be the villa to which Maximian retired after he left public life. I think rather it was simply his summer home, a place for country ease, for hunting and field sports. In those days this part of Sicily would have been a quiet, remote, and wooded area abounding in game.

There were diggings at the site as early as 1812, but extensive excavation did not begin until 1929. This led to the first major discovery: a huge, masterfully executed mosaic depicting the story of the mythological Greek hero Hercules. This mosaic, roughly 60 by 80 feet, covered the floor of what was once a single large room.

After World War II the Italian Government made funds available for further excavation and restoration under my supervision. Since 1950 we have carefully removed tons of earth; section by section we have uncovered the vast structure, about 38,000 square feet of floor pavements, plus parts of walls, columns, statuary, and other objects.

Obviously, the villa was designed by a master architect with a well-organized plan. A private road led into it from a highway to the south. Aqueducts carried ample water for drinking, baths, and toilets flushed by a continuously flowing stream.

Palace Built on Split Level

As the diagram on page 214 shows, the rooms themselves fall into four great complexes. First, at the front of the villa—the bottom of the drawing—stand the monumental entrance, the *atrium* (rather like an enormous vestibule), and the typical sumptuous Roman baths, hot and cold.

The second group centers around the *peristyle*, a large courtyard some 40 yards long and 30 yards wide. Here columns supported a roof around the four sides; the center, graced by a fountain, was open to the sky.

(Continued on page 216)





Roman Nobleman Burns Incense to Diana for a Successful Hunt

Three men who became emperor are believed to appear in this mosaic.

The man feeding the sacred fire has been identified as Constantius Chlorus, who governed Rome A.D. 305-306. An image of Diana, bow in hand, stands on a pillar behind the altar.

Dismounted horseman at left resembles portraits of Constantius's son, Constantine I, who became Rome's first Christian emperor and founder of Constantinople. Here, before his conversion, he appears as a pagan.

A third patrician (right), wearing the Herculean ivy leaf, is thought to be Maximian's son Maxentius, who seized imperial power but lost it.

← Page 212, lower: A hunting dog harasses the altar-bound sacrifice shown in part above. Artisans depicted the boar with eye downcast at its tormentor.

Mounted Hunter Stabs a Frightened Hare

The rider strikes with a two-pronged hunting spear. Hunters jabbed with the weapon or held it steady against charging beasts. Stylized shadows look like curved walking sticks.

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FRANCE

Rome

Roman Imperial Villa near Piazza Armerina, Sicily

Piazza Armerina • Sicily

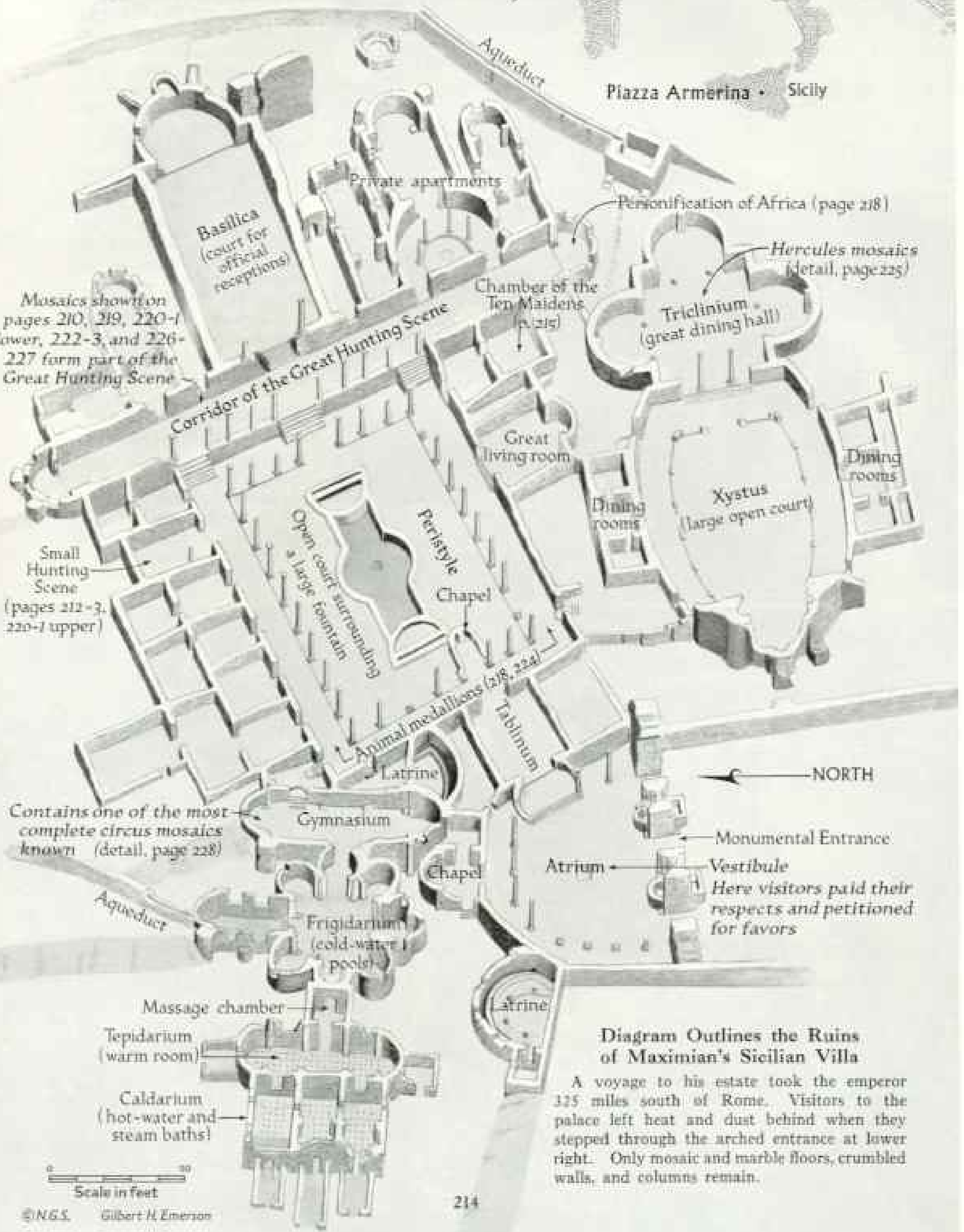
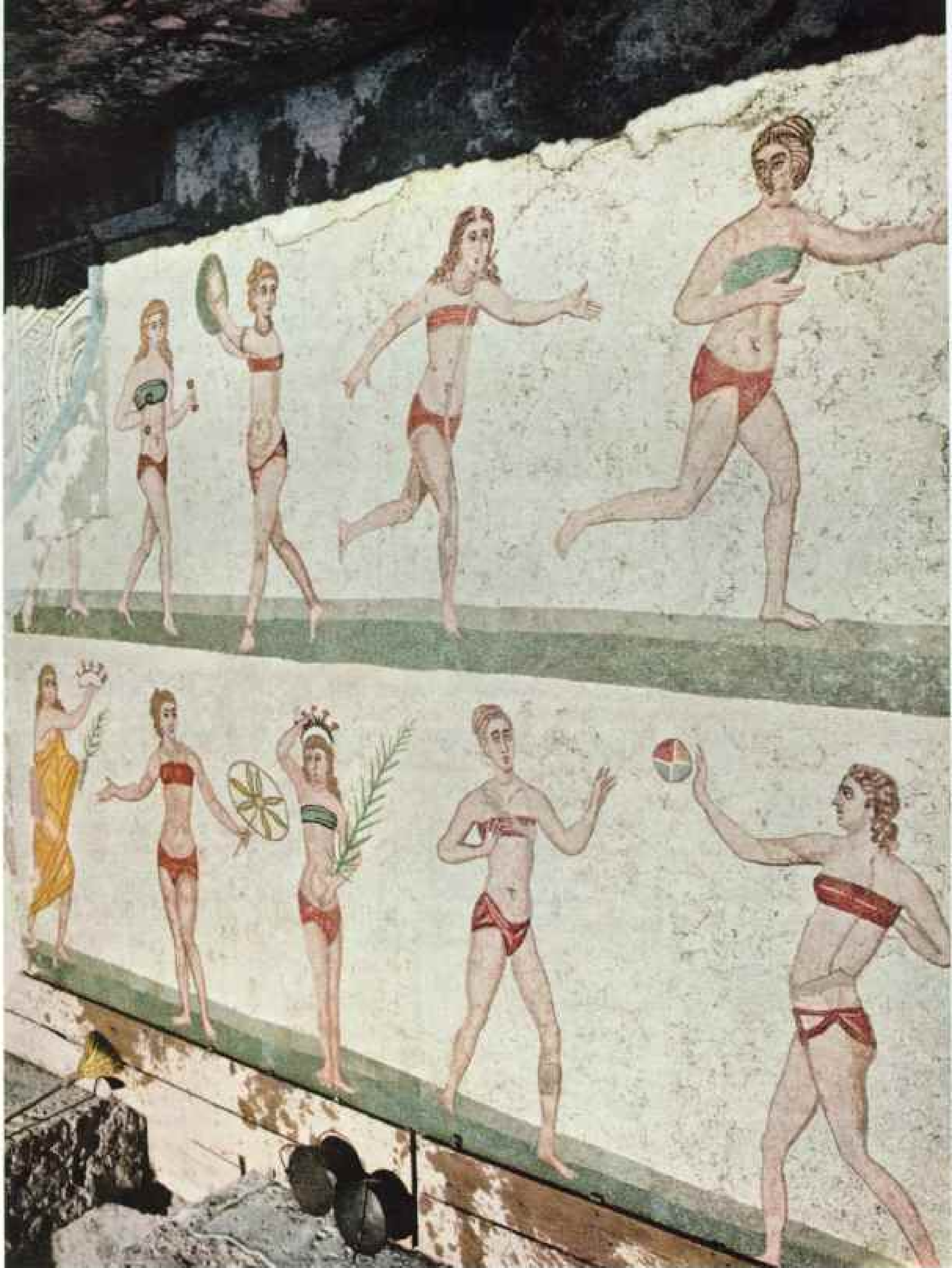


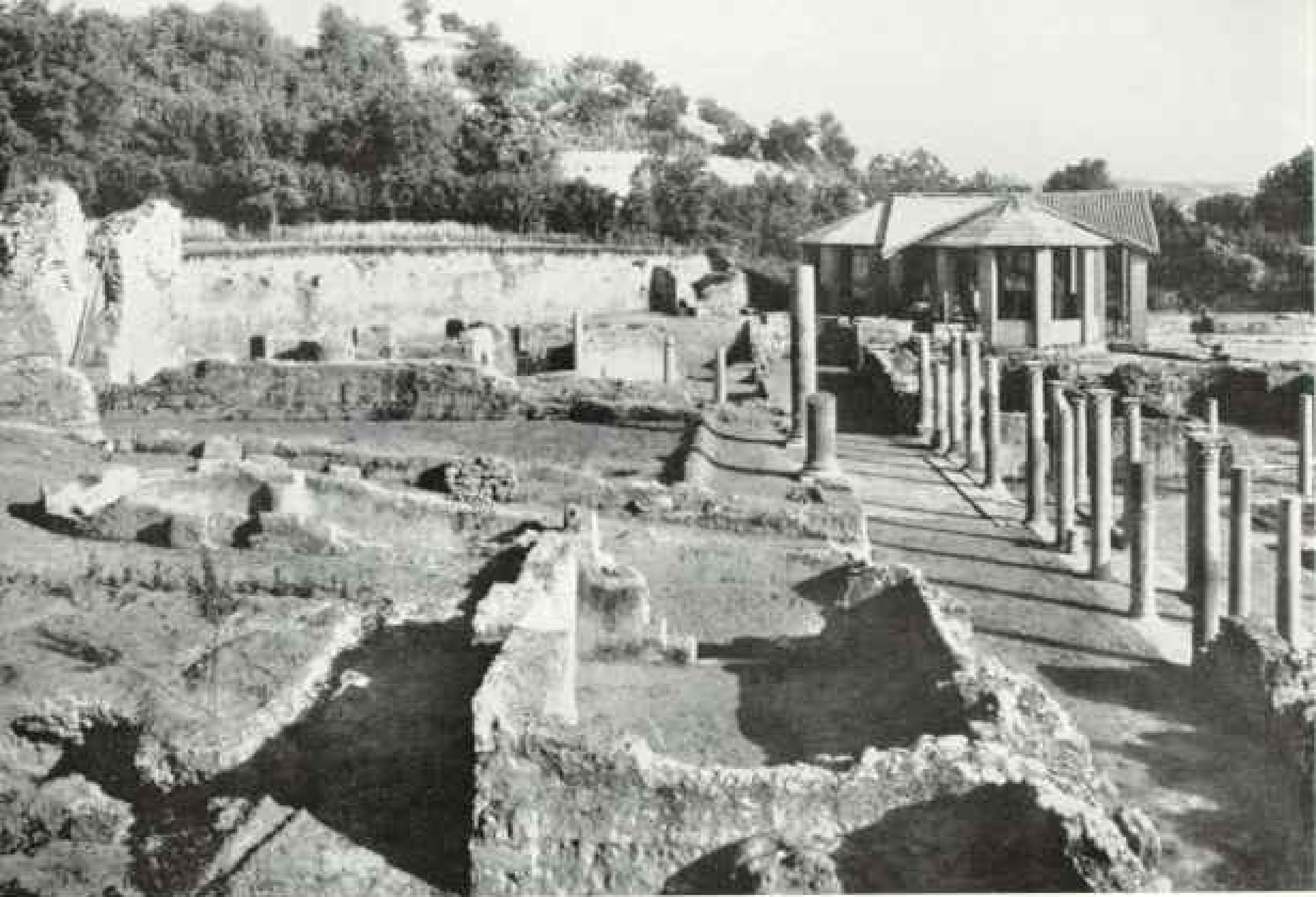
Diagram Outlines the Ruins of Maximian's Sicilian Villa

A voyage to his estate took the emperor 125 miles south of Rome. Visitors to the palace left heat and dust behind when they stepped through the arched entrance at lower right. Only mosaic and marble floors, crumbled walls, and columns remain.



Vivid Stones Portray the Athletic Prowess of Roman Women in Bikinilike Garb

Girl at upper left exercises with dumbbells; her neighbor poises a discus. Two runners complete the top panel. A judge in golden robe (lower left) bestows crown and palm branch on a winner, who carries a wheel. Another contestant lifts her crown. Two others toss a ball. Archeologists believe a successor to Maximian contributed this mosaic to Piazza Armerina. Peeling uncovered part of an earlier work, the starred mosaic at upper left.



Excavated Ruins at Piazza Armerina Attest the Grandeur of Imperial Rome

A giant landslide and centuries of decay failed to erase the plan of Maximian's villa. This view from the north looks down the colonnaded corridor of the Great Hunting Scene (diagram, page 214). Aqueduct wall stretches at left. Chamber of the Small Hunting Scene lies in right foreground. Protective sand covers the mosaics, and modern tile shelters the triclinium (background).

Living rooms flanked the peristyle on two sides. The whole group lay slightly uphill from the atrium, rather like a modern split-level house.

South of the peristyle, on a still higher terrace, stood the third group, a sizable open court, a great dining hall in the shape of a clover leaf, and a nest of smaller dining rooms. This is the site of the first excavations, where the mosaics illustrating the exploits of Hercules were found.

Sumptuous Private Apartments

The fourth complex lay east of the peristyle (near the top of the chart), centering around a *basilica*—a formal hall with a curved wall, or apse, at one end where the emperor's throne once stood. The most luxurious of private apartments lay to the right of the basilica.

In front of the basilica, running the width of the villa, was a tremendous corridor some 5 yards wide and 73 yards long.

Covering the floors of the palace were the mosaics, magnificent multicolored works of art made of innumerable tiny segments of

stone or glass paste painstakingly set in mortar. Since most of the pieces are square, they are called *tesserae*, from the Latin word meaning dice. Except for the great basilica, which is paved with marble, all the floors in the villa are covered with mosaic, and many are almost intact.

The art of mosaic was already old when these floors were laid. Almost 1,000 years earlier the Greeks designed figures of colored pebbles to decorate their floors. The Romans themselves had used mosaics for centuries, combining the beauty of a handsome rug with the durability of stone (page 224).

For the artisans who built the villa, however skilled they were, this must have been a stupendous job. A fast workman could probably lay somewhat less than two square feet a day of figured mosaic.

I believe it likely, however, that the whole project was completed in a relatively short time—perhaps three or four years—which means that whole squads of craftsmen would have worked on many rooms simultaneously. They cut the stones by hand, mixed and smoothed mortar, and laid tesserae piece by



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✦ **The Author, Using a Scale Model, Points to the Villa's Colonnaded Courtyard**

Corridor of the Great Hunting Scene, shown above, runs down the far side of this plan at the National Museum of Syracuse, Sicily. Crowded walls in foreground represent gymnasium, cold-water pools, and steam bath. Arches of the monumental entrance rise at right. Legs on the wall reconstruct Greek statuary.

Lutz Martini, National Geographic Staff





**Africa Personified
Bears an Elephant's
Tusk as Her Scepter**

Stylized crosslines representing wrinkled skin give the elephant at left the look of a child's quilted toy. The Asian tigress on African soil is another artistic fancy. Strips of colored cloth hanging on the branch in background signify a sacred tree. Flames of a phoenix nest rise at left.

Scholars identified idealized Africa from Piazza Armerina hunting scenes laid in her realm. ← War with Carthage introduced African lions and other beasts to Rome some five centuries before Maximian built his Sicilian villa. Successive emperors shipped entire menageries from Africa and Asia to die in *venationes* (mock hunts). Lions, prized for ferocity, were almost exterminated in North Africa.

This courtyard panel shows the emperor's Herculean ivy leaf at opposite corners.



piece, using pincers to place precisely the right colored squares in exactly the right spaces. Then they leveled and polished the finished floor.

The subject matter of the pictures was often chosen to suit the room they decorated. For example, the *tablinum*, the entrance hallway to the house, portrays a respectful group welcoming the lord on his arrival.

Bathing Habits, Styles Revealed

A similarly apt choice of subjects appears in the baths, which actually included not only hot and cold pools but a gymnasium and steam room as well. On the floor of the vestibule leading from the peristyle to the baths is portrayed the lady of the household, the *domina*, taking her two young children to bathe. Two maids follow, carrying bathing gear and clean clothing neatly folded.

These figures not only throw light on bathing customs of the times but on such things as children's shoe styles—sandals with black straps—and ladies' hairdos: combed back and piled on top of the head, leaving the ears uncovered. Oddly enough, one of the children is shown with one triangular eye.

Mosaics in other parts of the baths show, appropriately, bathers in various stages of dressing and undressing, and a stocky, athletic young man getting a rubdown from a slave. On the floor of the *frigidarium*, or cold baths, pleasant aquatic scenes lend atmosphere. Four small boats, each carrying two cherubic fishermen, float on the rippling surface of a sea alive with fish. Around the boats a throng of mythical marine creatures form a garland—sea nymphs, Tritons, and others.

The *palaestra*, or gymnasium, of the baths has a spectacular mosaic depicting the Circus

Maximus, Rome's great arena (page 228).

The dominant decorating themes throughout Maximian's country estate are, quite properly, outdoor sports, hunting, and animals. These reflect not only the interests of the owner but also the use he made of the villa. I suspect that his visits there were normally from August to October, after the worst of the summer's heat and before winter made travel difficult.

Perhaps the most striking of the athletic scenes, to modern eyes at least, decorates the floor of a room off the peristyle, a room I have named the Chamber of the Ten Maidens (page 215). These ten young women wear very brief two-piece costumes brightly colored in red and green. They perform gymnastics—running, jumping, discus-throwing, ball playing, and other games—on the lawn.

Of all the villa's mosaics this one has attracted the most attention in the popular press, for obvious reasons. Yet it probably was not a part of the original villa floor at all but was added a century or so later. The faces and bodies of the girls are drawn in a

Fable in Mosaic: Winged Beast Cages Hunter

This single episode, in which trapper becomes the trapped, startles visitors and puzzles scholars. It occurs in the Great Hunting Scene. Half lion, half eagle, mythology's fanciful hybrid is called a griffin.

Lulu Martin, National Geographic Staff





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✦ **An Elephant en Route to Please a Roman Mob Loses a Quayside Tug of War**

Piazza Armerina's Great Hunting Scene covers a corridor about 5 yards wide and 66 long. Its episodes depict the chase, capture, and transport of wild animals. Keepers here chain-haul their prize up a gangplank.





← Mounted Beaters Drive Stamping Stags into a Net

The author believes African craftsmen designed and laid the Piazza Armerina mosaics in three or four years. Other estimates run as high as 30 to 80 years.

The Small Hunting Scene (left) depicts sportsmen pursuing game through the countryside near the villa. The Great Hunting Scene (below, both pages) shows an expedition to supply mock hunts in Rome's Colosseum.

↓ Hunters Drag a Rhino from an African Swamp

Roman circus crowds rated this ton of fury high on their list of favorite animals. Imperial expeditions sought the rhinoceros in the Sudan and Ethiopia. Laws permitted the hunters to requisition food and lodging in any Roman province.

Two overseers superintend this job. A hippopotamus (above) stands belly-deep in the marsh. Loss of tesserae, or mosaic stones, obscures the head.

© National Geographic Society





Crewman Wrestles an Indignant Bird onto the Gangway

Thousands of tiny stones went into this detail from the facing page.

style which did not come into popularity until the fourth and fifth centuries. Also, we can see that this mosaic overlies an earlier geometric pattern of squares and stars.

Animals and hunting scenes occur everywhere, but nowhere on such a grand scale as in the spectacular Corridor of the Great Hunting Scene (pages 220-223 and 226-227). Here, unrolled before us as if on a gigantic scroll 66 yards long, is an almost photographic record of one of the most astonishing aspects of ancient Roman life.

The Roman populace had a passion for animals, the larger and fiercer the better, whether

simply on display in cages or pitted in the arena against each other or against men. *Venationes*, or mock hunts, became a major diversion of Roman life. They must have been similar to the bull-fights still held in some countries, except that lions, tigers, leopards, rhinoceroses, and even elephants replaced the bulls.

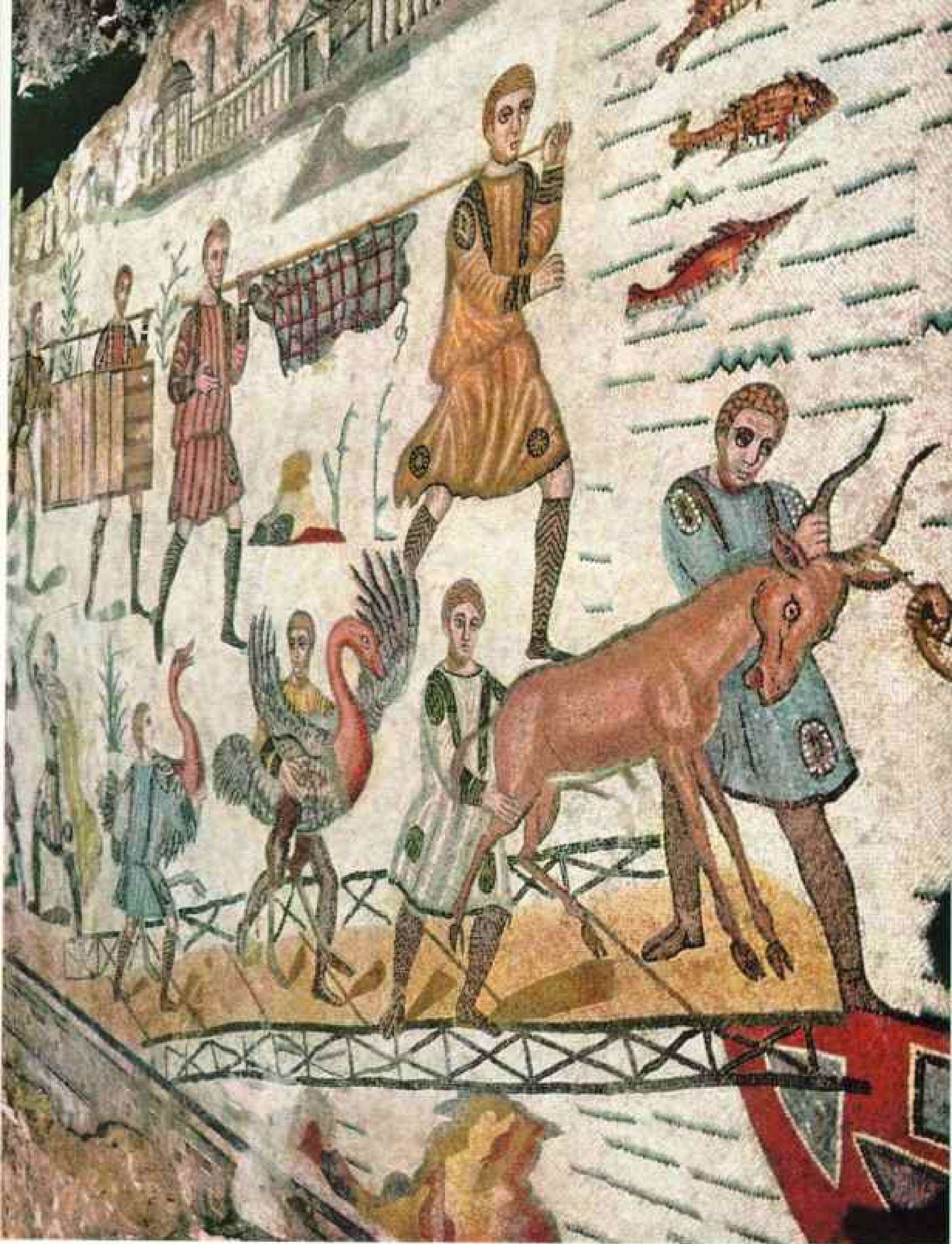
To satisfy public demand for these pagan spectacles, Roman emperors and nobles went to astounding lengths. At the opening of the Colosseum, A.D. 80, for example, historians record that 5,000 animals were killed in 100 days of mock hunts.

Procuring animals for the shows became a major problem for the government and a particular burden to provincial Roman officials in Africa and Asia Minor. Soldiers, professional hunters, native guides, and beaters took part in elaborate hunts, driving the animals into nets and pits. The beasts were carried by ox-cart to the Mediterranean, transferred to ships, and eventually sailed up the Tiber to Rome. A tragically large proportion died en route.

The whole process is portrayed in a symphony of color on the floor of the great corridor. The work was obviously done by artists who knew the subject firsthand; my own belief is that these floors were laid by craftsmen specially imported from Africa. Indeed, the Emperor Maximian himself may have seen big-game hunts while campaigning in Africa.

Along this enormous mosaic lions, tigers, leopards, and panthers stalk through a landscape of rivers, hills, marshlands, and pine, oak, and palm forests. Hunters follow them armed with spears, shields, and lassos; some are mounted, some afoot. Captive animals

(Continued on page 229)



Struggling and Kicking, Ostrich, Crane, and Antelope Board Ship

Many animals died on the voyage between Africa and Italy. Lighters carried the survivors up the Tiber to Rome, where they were shown at dockside. Entering the Colosseum, they might fight one another or be hunted in settings modeled on their habitat. These wild passengers are hustled up a gangplank. Trussed boar and a crated catch follow. A provincial villa looks down on the roundup. Fish swim in stylized waves.



Stone by Stone, Priceless Roman Mosaics Regain Their Ancient Glory

Primitive man foreshadowed the mosaic when he arranged pebbles on the floor of his cave. Ancient Sumerians expanded the technique, cementing bright stones to a base. Egyptians by 1000 B.C. were fashioning mosaics in the form of glass jewelry. Roman mosaicists, especially in the Christian era, transformed a pastime into an art with their stone or glass painting.

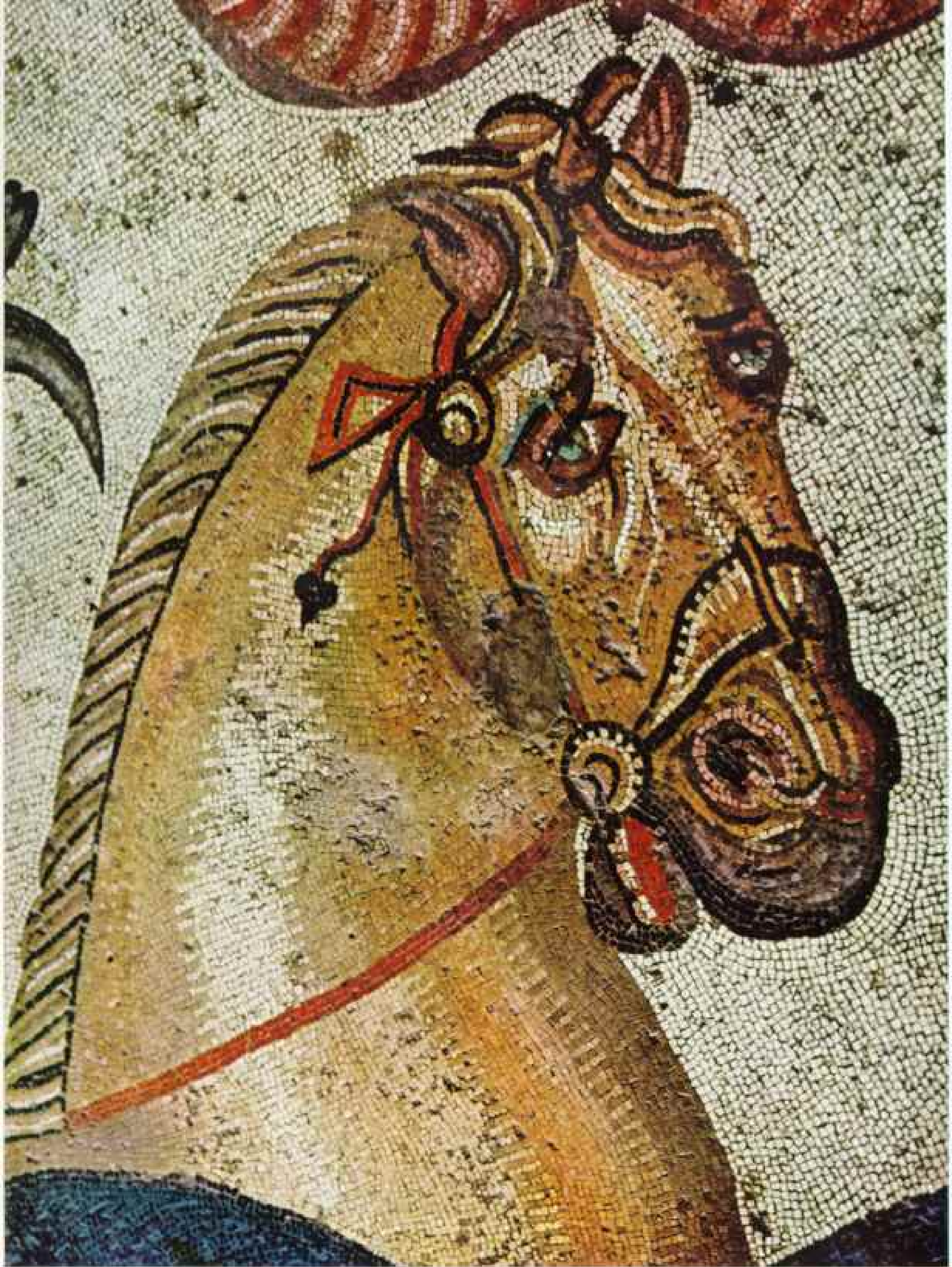
Evidence suggests gangs of artisans labored side by side over the tessellated pavements at Piazza Armerina. Stones of various colors came from Africa and Sicily.

Craftsmen laid a rough base of mortar, added several coats of lime, and traced designs on the surface. Hew-

ing cubes of stone one-third inch thick, they tapped them lightly into the pattern.

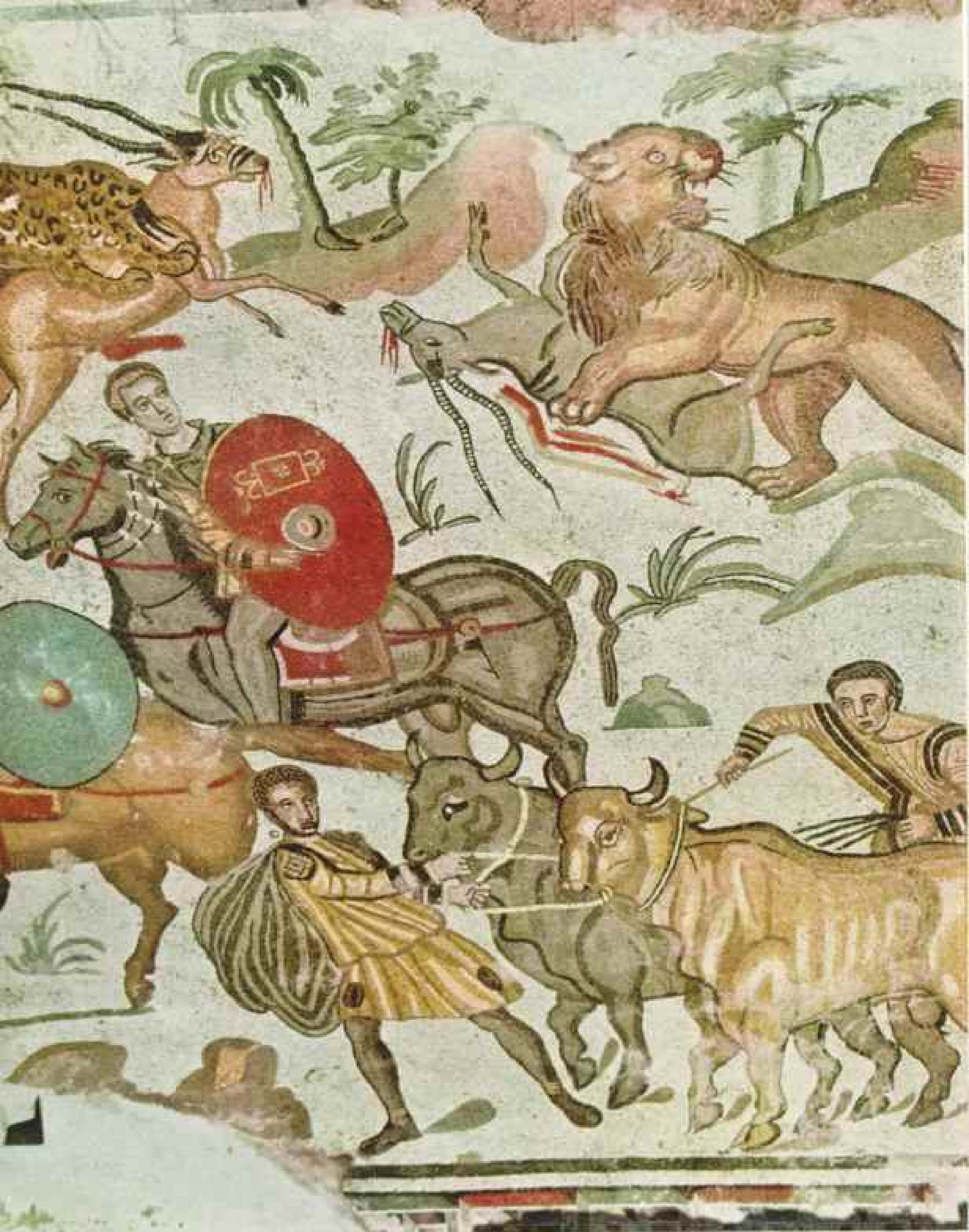
Duplicating traditional methods, this man replaces missing pieces with stone taken from the villa's ruins. He watered the foreground to bring out colors and aid the matching of stones.

Only a craftsman can repair stone carpets like the masterpiece opposite. The horse's red ribbon and tongue, the dark bridle, the highlighted neck, and the needle-point reflection in the eye call, not for a paintbrush, but for naturally colored stones, all painstakingly fitted like pieces of a jigsaw puzzle.



Riderless Horse's Liquid Eyes Seem to Mourn the Master Shot by Hercules's Arrow

Maximilianus Hercullus recorded feats of his namesake on the tessellated floor. In his eighth labor, Hercules captured man-eating horses of the Bistones in Thrace; he repelled the defending countrymen. Serpent-haired Hydra (its belly undulating above) and Cretan Bull (horn, left) opposed the hero in his second and seventh labors.



Guards on Horseback Convoy Oxen Past Leopard and Lion at Their Kills

Wild animals of more than 50 kinds predominate in the mosaics of Piazza Armerina, suggesting that the owner was passionately fond of the chase. Though they used vivid colors, Maximian's artisans did not sacrifice form. Details in this episode of the Great Hunting Scene indicate that its designers knew their subjects firsthand.

Here blood gushes from the nostrils of an addax bearing a spotted executioner on its back. The lion turns from its kill and snarls at intruders. A Roman teamster and his Moorish assistant urge their yoked brutes to greater speed. Contemporary artists portrayed drivers, hunters, and others in exact dress of the times.



Spearmen Launches an Attack on the Lion as Cart with Cage Rumbles By

Imperial hunting expeditions, planned as thoroughly as any campaign by the legions, kept circuses and amphitheaters filled with wild animals. Augustus, Rome's first emperor, claimed 3,500 lions and leopards destroyed during his rule. Pompey showed 600 lions at one time. Trajan's reign set a record; 11,000 animals were said to have died to celebrate a single victory.

Aiming his spear at the lion, the hunter at upper right demonstrates that self-preservation often compelled men to kill rather than capture valuable beasts. Ironbound wooden crate with handle (left) served as both trap and cage.



Trumpeter and Magistrate at the Circus Hail the Winner of a Chariot Race

The herald blows his official tuba beside a course marker, and the magistrate holds palm branch and purse for the winner. One of the driver's four chariot horses enters at right. White strip below is the finish line.

are shown being dragged with ropes and chains up flimsy-looking gangplanks to waiting boats.

Perhaps the most curious figure in the whole corridor, however, is a winged lion, a mythical griffin, crouched in the middle of the hunt and holding in its claws a barred cage. From between the bars peers the woebegone countenance of a man (page 219).

The other main category of subjects chosen by Piazza Armerina's master architect for his mosaics is pagan mythology. (There is no trace of Christian influence to be seen anywhere.)

Pagan gods, goddesses, and heroes, in fact, are scattered liberally even through scenes that deal realistically with Roman daily life. Diana, goddess of the chase, looks down over Roman hunters. Jove, Hercules, and others survey the chariot race in the Circus mosaic. Orpheus and Arion, both mythological musicians, charm with their lyres respectively the beasts of the forest and the monsters of the sea on floors in two of the smaller living rooms.

By far the dominant mythological figure in the villa, however, is Hercules, and the large mosaics which portray him are, in my opinion, Piazza Armerina's masterpieces.

Diners Gazed on Exploits of Hercules

These cover most of the floor in the great dining hall, or *triclinium*. This chamber normally held three couches on which diners reclined while they ate. The custom was for three men to share a couch, making a total of nine around the table.

In this vast dining hall mosaic art achieves an unsurpassed grandeur. In the center, in heroic-sized figures, are shown the monsters that Hercules, half god and half mortal, had to overcome in his legendary labors.

These tasks were an earthly penance imposed on Hercules by his master, King Eurystheus, before he could achieve immortality. They included strangling a lion with his bare hands, killing a many-headed monster, the Hydra, and eventually invading the underworld, Hades itself.

Other parts of the mosaic show Hercules, victorious in all his labors, in a frightful struggle with death, which he could not conquer. Finally, crowned with laurel, he takes his place among the gods on Mount Olympus.

The emphasis on the Herculean legend in the villa is important. It has a direct con-

nection with the Emperor Maximian and the history and politics of his reign.

Actually, Maximian was only a co-ruler, appointed by the Emperor Diocletian to help overhaul and run the unwieldy Roman Empire. Under this plan, Maximian ran the western half of the empire, Diocletian the east.

Diocletian, to add to his prestige, claimed to be under the direct protection and guidance of Jove, the chief Roman god, and decreed that Maximian enjoy similar patronage from Hercules. Maximian duly changed his name to Maximianus Herculeus, and adopted Herculean symbols, even to the shoulder patches of his soldiers (page 210).

It is not surprising, therefore, to find in Maximian's palace this series of magnificent mosaics portraying the story of his patron. And the climactic scene of them all, to me, is still another, in the eastern alcove of the great dining hall.

Massacre May Symbolize Roman Victories

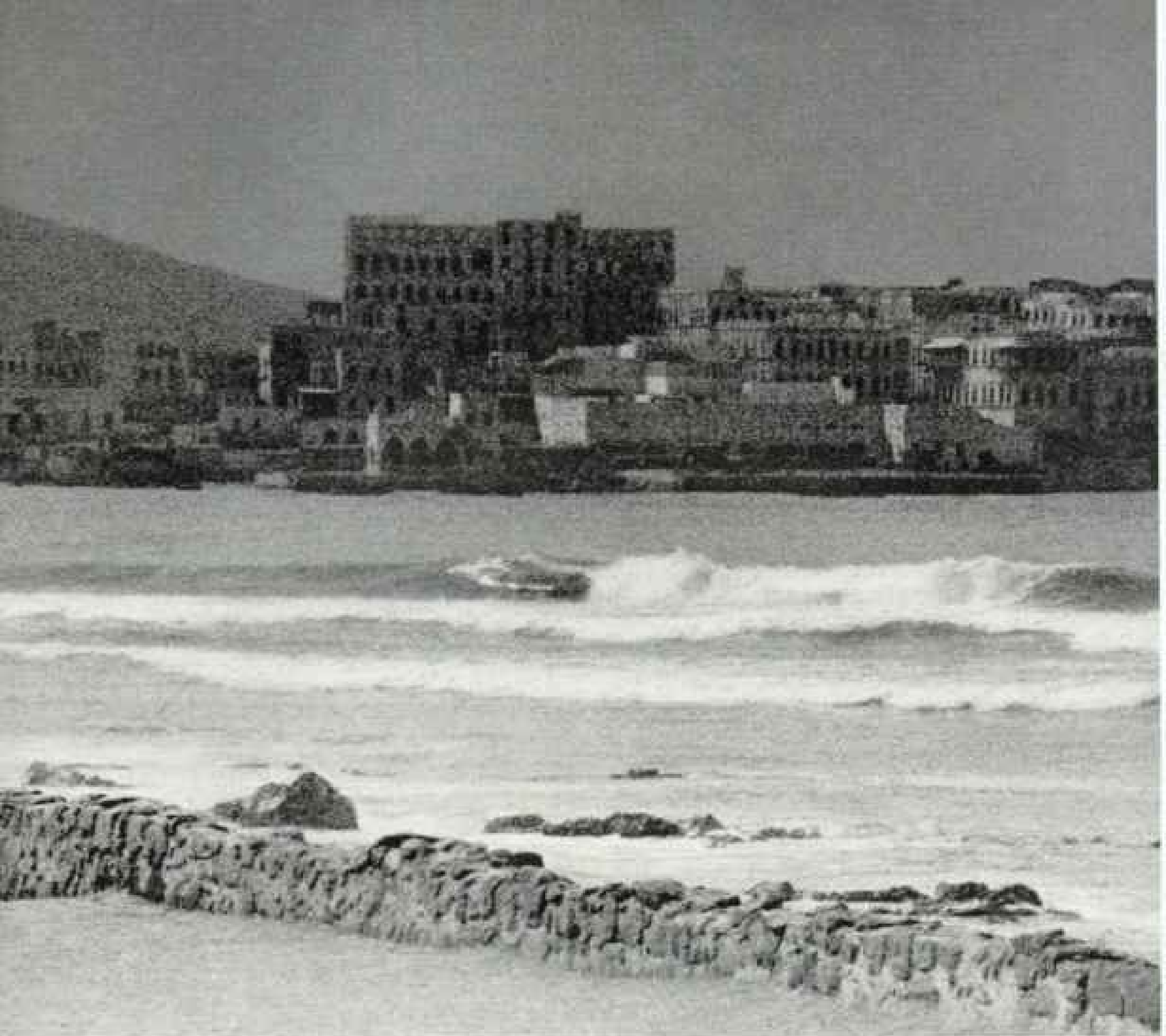
This is the Massacre by Hercules. Here, in a creation worthy of the hand of a Michelangelo, Hercules has come to the aid of Jove to slay with poisoned arrows five rebellious giants who threaten the god's throne on Mount Olympus itself. Just so had the faithful Maximian come to the aid of the Emperor Diocletian, perhaps only shortly before this mosaic was made, to quell rebellions in Britain, Europe, and Africa.

After Maximian's death the villa continued to be used for hundreds of years, by whom we do not know. We find evidence of periodic alterations and reconstruction lasting into the sixth and seventh centuries.

The beginning of the end probably came after A.D. 800, when Moslem Arabs arrived in Sicily and the site was temporarily abandoned. The Normans, who followed the Arabs some two centuries later, reoccupied it and built a town around the site.

Then, after the Normans, came the disaster to which we undoubtedly owe the preservation of the mosaic floors. A series of floods, caused by reckless overcutting of the forest on near-by mountains, buried the whole structure under tons of earth.

It is this earth which we have now so laboriously removed. Our next task is clear: To provide a protective covering over our priceless treasures, so that these ancient mosaics will continue to be preserved for future generations to see.



Along the Storied Incense Roads of Aden

BY HERMANN F. EILTS

United States Consul at Aden, 1951-1953

With Photographs by Brian Brake, Magnum

WHEN strife in Egypt blocked the Suez Canal last fall, the reverberations were felt in every oil-hungry capital of western Europe. But perhaps no single bystander in this bitter quarrel sensed more keenly the pressure of an economic knife at its vitals than little Aden, the sultry British Crown Colony dominating the southern mouth of the Red Sea.

For the lifeblood of this remote outpost is the water-borne traffic that pulses back and forth along the canal's great international artery. Not a ship bound between the

Mediterranean and the Indian Ocean but must pass Aden, and a goodly share of them drop anchor. They leave that free port the richer for their fees, whether for oil or coal or warehousing or simply the tax-free purchases of their passengers.

To the 250,000 passengers who debark each year, this parched and clamorous port doubtless seems the end of the earth. But to us who have lived in Aden it bears another face.

We remember its dry and sunny winters, when tennis and swimming can be enjoyed by day but a jacket is desirable at night. We



Tall, Vacant-eyed Dwellings of Arabian Merchants Overhang Mukalla's Crashing Surf

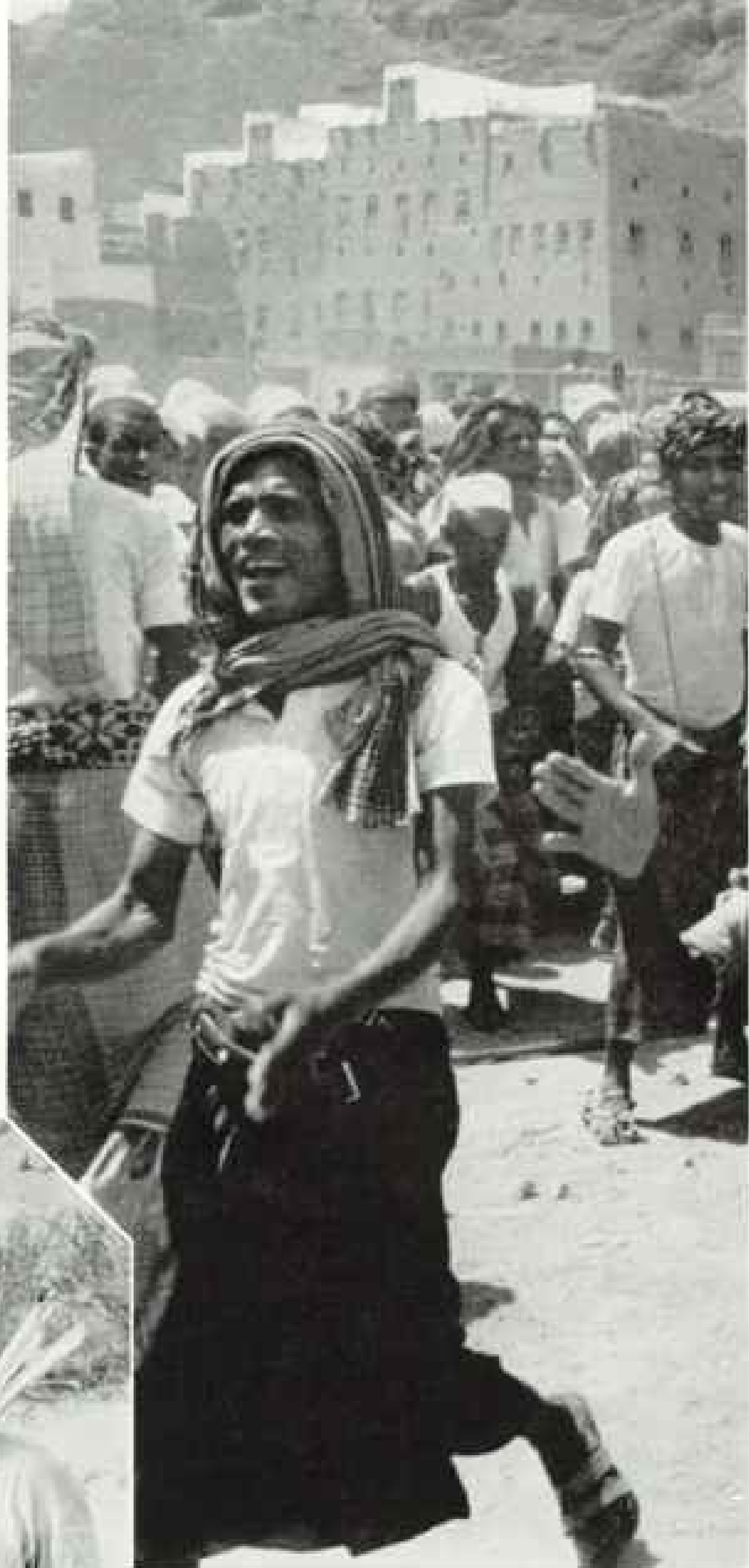
remember camel races, the clacking windmills drawing sea water into the salt pans, the bustle of the harbor. We remember a colorful, buoyant community, and a host of friends.

When the British occupied Aden in 1839, it was a mere nest of adobe houses huddled under jagged shark's-tooth hills, with barely 500 inhabitants. Today it holds some 4,400 Europeans and 134,000 Adenese, a modern oil refinery with a daily capacity of 100,000 barrels, and substantial trading firms. Should the canal ever be permanently blocked or bypassed, however, Aden would suffer. In a few years it could well return to its former status as a quiet trading port.*

Air Age Gave Aden New Importance

To a large degree, then, Aden's importance depends on the Suez Canal. Today Great Britain senses more poignantly than ever the Colony's value. For the air age has given Aden and the shallow inland arc of its Protectorate a new strategic dimension: In time of war it would loom as an essential way station on the Royal Air Force's routes from Africa to Asia (maps, pages 234-235).

* See "Rock of Aden," by H. G. C. Swayne, *NATIONAL GEOGRAPHIC MAGAZINE*, December, 1935.



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↑ Stuttering Drums Delight Festive Throngs in Al Hauta

Merrymakers celebrating the anniversary of a *sayyid*, or Moslem holy man, gyrate beneath the latticed windows of a mud house. Bystanders break into screams at the end of each dance.

Al Hauta lies in the Hadhramaut, chief of the wadis, or dry watercourses, churning southern Arabia's high plateau.

← Strawstack Hats Crown Women in the Hadhramaut

Male headgear leans to turbans and headcloths. Women veil less of themselves than many of their Arab sisters.

© National Geographic Society



Already the RAF maintains a base for jet fighters and bombers at Khormaksar and a station up the coast at Riyan. As for the hinterland, its patchwork of sultanates and sheikdoms is being drawn more tightly together. Successive British governors have presided over them with a light rein; but now trouble to the north is underlining the indispensability of peace in Aden's back yard and the advantage—if it is possible—of locating there new sources of petroleum.

As a representative of the United States, I had free and easy access to the Colony's strange and ever-haunting hinterland. This great area is divided into the Western and Eastern Protectorates. The Western, wilder

and more impoverished, embraces some 18 treaty sultanates and sheikdoms; the Eastern holds seven treaty states. Some 450,000 tribesmen inhabit the wadis of the west, while the east supports perhaps 350,000.

Uneasy Frontier Separates Aden and Yemen

This is a vast area. The tepid whitecaps of the Indian Ocean slap against its barren shore, from the fishing village of Turba to the gaunt harbor houses of Mukalla and Shihr. Westward stretches the uneasy frontier of Yemen; northward, the sands of the Empty Quarter; and toward the east, the dusty Oman.

Through this ancient country once plodded caravans bound for King Solomon's court,



for Egypt, or for Rome, bearing the exotic freight of India and China, the frankincense and myrrh of the Hadhramaut. In time, sea routes, capped by the Suez Canal, doomed this traffic. But the old tracks across mesa and wadi remain, the skeleton of today's primitive road grid, and recently I have journeyed by jeep along more than one.

"Indigo Warriors" Halt Jeep

To traverse Aden's desolate, starkly beautiful hinterland by such trails is to enter a world seemingly frozen in time, impervious to the fruits as well as the fevers of progress. And yet...

I was driving down the sandy road from Mahfidh to Mudia one searing afternoon, separated from my guards, when suddenly two half-naked tribesmen appeared out of nowhere. Waving their rifles, they signaled me to stop.

Aulaqi warriors, they were the drab yet haughty legatees of a venerable culture—the Ma'in, moon worshipers who once held sway over all this region and waxed fat on the fees of the great caravans. Their torsos gleamed like gun metal from the mixture of indigo dye and animal fat with which they greased themselves, partly for adornment, partly as a skin lubricant. A rag bound up their lank locks; ragged *jutas*, or sarongs, drooped from their waists. In each man's belt was stuck the inevitable curved and heavy-hilted knife.

One warrior put his hand on the jeep door.

I rapped his knuckles lightly with my cane.

He jumped back, surprised, and angrily demanded why I had done that.

"The jeep is not yours," I said. "If you need food or water, you are welcome to it."

He sucked his knuckles a moment.

"*Min ente?* Who are you?"

"The American consul from Aden."

"Ah, Sahib, we are but poor and hungry Bedouin, and worn are our feet. We travel to Mudia, where, it is said, men have come seeking workers from among the tribes. In a car it would be quicker."

I gave the pair a lift and thought no more about it until, some five weeks later, I was visiting the oil refinery at Little Aden. A young worker stepped up to me and said:

"Don't you remember me, Sahib? I am the man to whom you gave a ride."

Tribesman Becomes Oil Technician

I stared at him. He stood smiling at me in clean overalls, his hair clipped, his flesh filled out with nourishing food. I checked with his supervisor. The Aulaqi apprentice was coming along fine, he said. An eager fellow, he would soon make a good technician.

Change, then, does come to the Protectorate. Not wholesale, as yet, but fitfully—sparks struck from the anvil of Aden Colony, where the changing impact of Western ways on an older civilization resounds most sharply.

When one leaves the Europeanized confines of the Colony and crosses into the Protector-



Aden and Its Protectorate Flank the Suez Run

Visitors to Aden, a British Crown Colony, rarely venture out into the Protectorate, some 117,000 square miles of tableland and desert sharing the vaguest of borders with Yemen, Oman, and Saudi Arabia.

Almost roadless and waterless—and so far oil-less—the Protectorate yields a meager living. Nomads seeking scrub for camels and farmers scratching the sands of wadis realize only dimly that ancient silk and spice caravans passed their way.

Only sizable port between Suez and Bombay, Aden lives by refueling and dhow traffic.

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ate, one encounters not just a different world but a far older one. In the decades before my coming, the blood feud had ravaged all this land, and no stranger moved unarmed or without a guard. Even as I write, fighting has again broken out here and there.

In short, I lived in southern Arabia between 1951 and 1953 when peace, first established in the Protectorate's eastern sector by the remarkable Harold Ingrams, was filtering into the more primitive western portions as well.

A British political officer, Ingrams traveled from wadi to wadi, often with his equally remarkable wife Doreen, cajoling, arguing, pleading, occasionally threatening the local sheiks and tribesmen. Backed by the influential Sultans of Quaiti and by statesmen like Abu Bakr Al Kaf of the Hadhramaut, he began little by little to succeed.

Britain Keeps the Peace

In time, peace spread westward as well. A mere handful of British administrators, guided until most recently by the then Governor of Aden, Sir Tom Hickinbotham, have persuaded tribe after tribe to halt its sanguine feuds, allow the caravan routes to be opened to peaceful trade, and accept advice and counsel from the government of Aden. Active encouragement, too, is being given to public health, education, and agriculture.

An occasional clash has occurred, of course, and once I nearly blundered into a dawn attack by Haushabi raiders on a Lahej fortress. But on the whole I was able, as few before me and few since, to journey safely throughout this remote and fascinating realm.

I used to pass often through Lahej and came to know very well its sultan, Sir Ali Abdul Karim. Few rulers of the Protectorate possess so vigorous and versatile a personality, fewer still an intelligence so nimble.

It was in Ali's capital that I was offered a lion. The origin of this offer tells a bit about the country. The lion, a fine dark-

maned beast, had been given by the Emperor of Ethiopia to Ali's half brother, Fadhil Abdul Karim, when the latter was sultan. Ill and with various charges against him, Fadhil left the country, taking with him, I was told, his harem, his bagpipe band, and a share of the treasury.

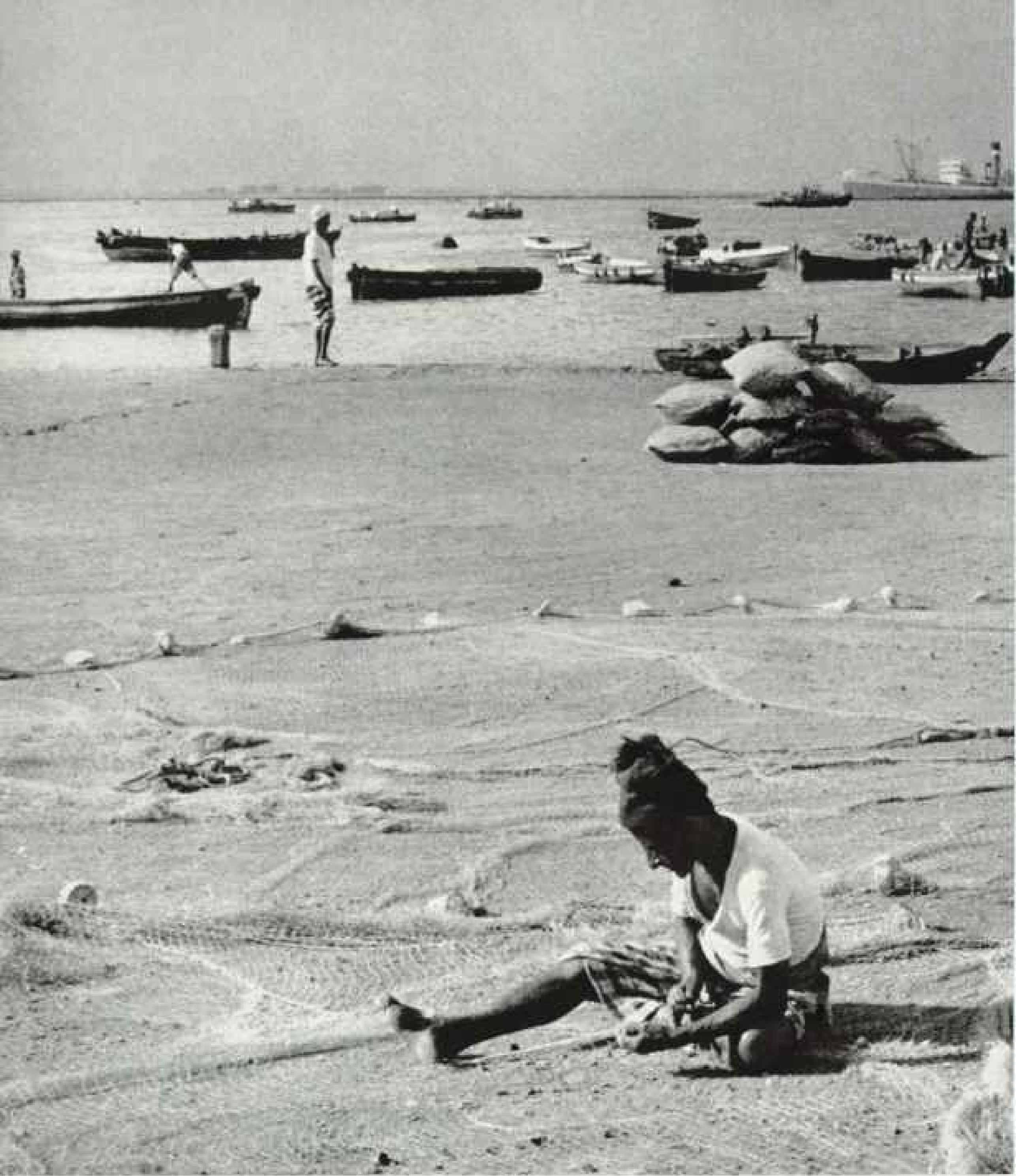
Lion Eats Hole in Sultan's Exchequer

This left Lahej with a lion but scant funds for its upkeep. Within a month or two, indeed, the lion had eaten a sizable hole in the exchequer. In a desperate effort to balance the budget, British Adviser Arthur Watts asked me, among others, to adopt the animal.

Reluctantly I declined. Scores of rats used to plague the run-down dwelling we then occupied in Aden, and it was tempting to import a lion to police them. But the cure might perhaps have proved just a trifle drastic.

Though I took many short side trips into the interior, my principal sortie encompassed what the British used to call the Great Circuit—a 1,500-mile journey from Aden up





Adenese Arabs Spread Nets Ashore for Mending. Fishing Sambuks Crowd the Sands
Aden is a free port. Its bazaars offer visitors the world's goods duty free at much less than the accustomed price. A quarter of a million passengers stop each year while their ships take on oil or coal.

to Yeshbum, northwestward to Beihan Qasb, across to the Wadi Hadhramaut, south to Mukalla, and back down the coast to the Colony.

On this venture I was accompanied by my wife Helen and our friend Mrs. Dorothy Griffiths, whose husband managed a British firm in Aden. We set out from the Colony one

winter morning in a jeep and a station wagon, driving along the beach at low tide to the fishing village of Shuqra, capital of the Fadhli Sultanate, and then striking inland.

As we climbed the winding track of the Arqub Pass, we seemed to have stumbled upon the dead landscape of some burned-out star. Under our feet the earth, gritty and metallic,



British Cruiser *Kenya*, Bunkering off Shore, Drinks Oil from Submarine Pipes

Lighters and launches dot the water, ready to serve vessels entering the dockless harbor. The port thrives like a filling station on a busy corner. A new plant refines up to 100,000 barrels of Kuwait crude oil daily.

lay armored with worn layers of lava, and all around us rose in russet desolation great frozen mounds of slag and the saw-edged lips of old volcanoes. The sun beat down in brassy waves, and our cars crawled through the silent rock-strewn waste like beetles lost among the clinkers of some giant's ash heap.

Once we had mounted the mesa, some 3,000

feet high, we turned toward Mudia. Far to our left, misty in the quivering heat of the horizon, stood the great granite wall of the Qaur ed 'Audilla, with the market village of Lodar at its base. Up on this 7,000-foot plateau, reached only by zigzag trails that would give vertigo to a goat, stretched a country of grain and vegetables, fruit trees and



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↑ Desert Patrol Slips By the Silent Walls of Ataq

Lawlessness stalked the Aden country until the 1950's, when British influence calmed most of the tribes.

Even today far-flung forts and encampments like Ataq's must be vigilant to keep the peace. In remote places tribes of surprising ferocity still attempt to settle old scores by raid and ambush.

A Ruttled Track Cuts → Through "Murder Valley"

This brown and melancholy wasteland seems lifeless; yet should a traveler stop, nomads would almost surely appear from nowhere within minutes.

Armored cars and jeep-like Landrovers whip up dust as the patrol convoy leaves the Wadi Yeshbum and approaches a gravel plain known as the Jau Khudail.

A solitary fort squats atop the dark hump at right. Such retreats, common throughout the Protectorate, were essential in the violent days when the valley earned its "Murder" nickname.





pastureland, swept by cool winds. But our route ran eastward across a tawny plain studded with camel's-thorn and desert scrub.

Approaching the land of the indigo warriors, we were urged to accept government guards. Hostile tribesmen, we were warned, had recently been attacking isolated trucks.

However, we drove the dangerous sector without incident and, some eight hours later, entered the Wadi Yeshbum at Habban, the merchant town of the Wahidi Sultanate.

All Quiet in "Murder Valley"

This long canyon, known until recently as "Murder Valley," once echoed with the rattle of rifle fire; ambush and assassination were everyday affairs. In some villages we could still see trenches running from houses to wells, so that the women might draw water in reasonable safety; and long lines of withered palm stumps showed where bitter men in senseless reprisals had killed the date tree roots with doses of kerosene.

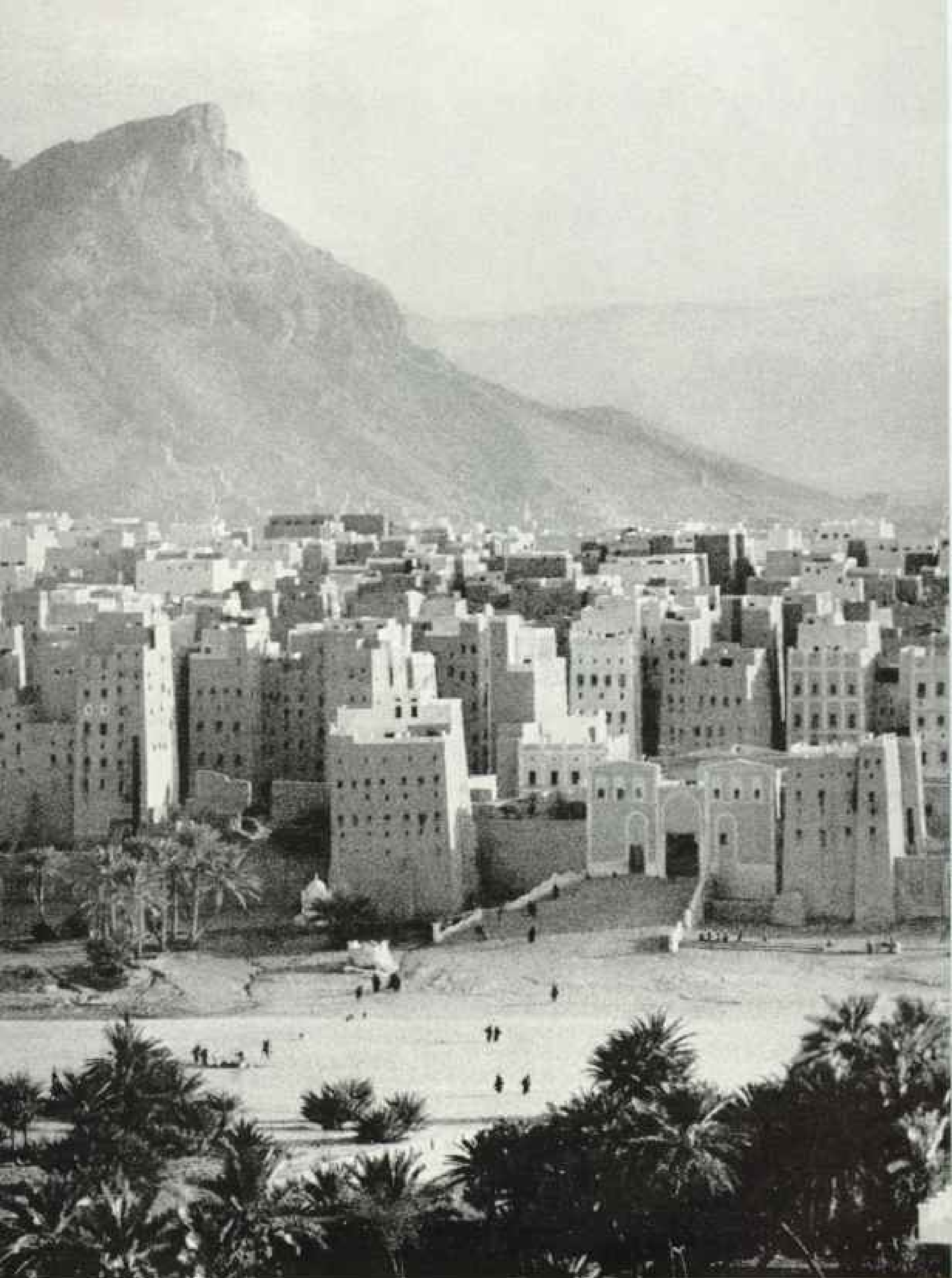
But now, little more than a year after a motor track had opened the wadi, the villages slept in reasonable security. New palms had been planted. Small black-clad children dozed beneath the *'illb* trees; goats grazed near by.





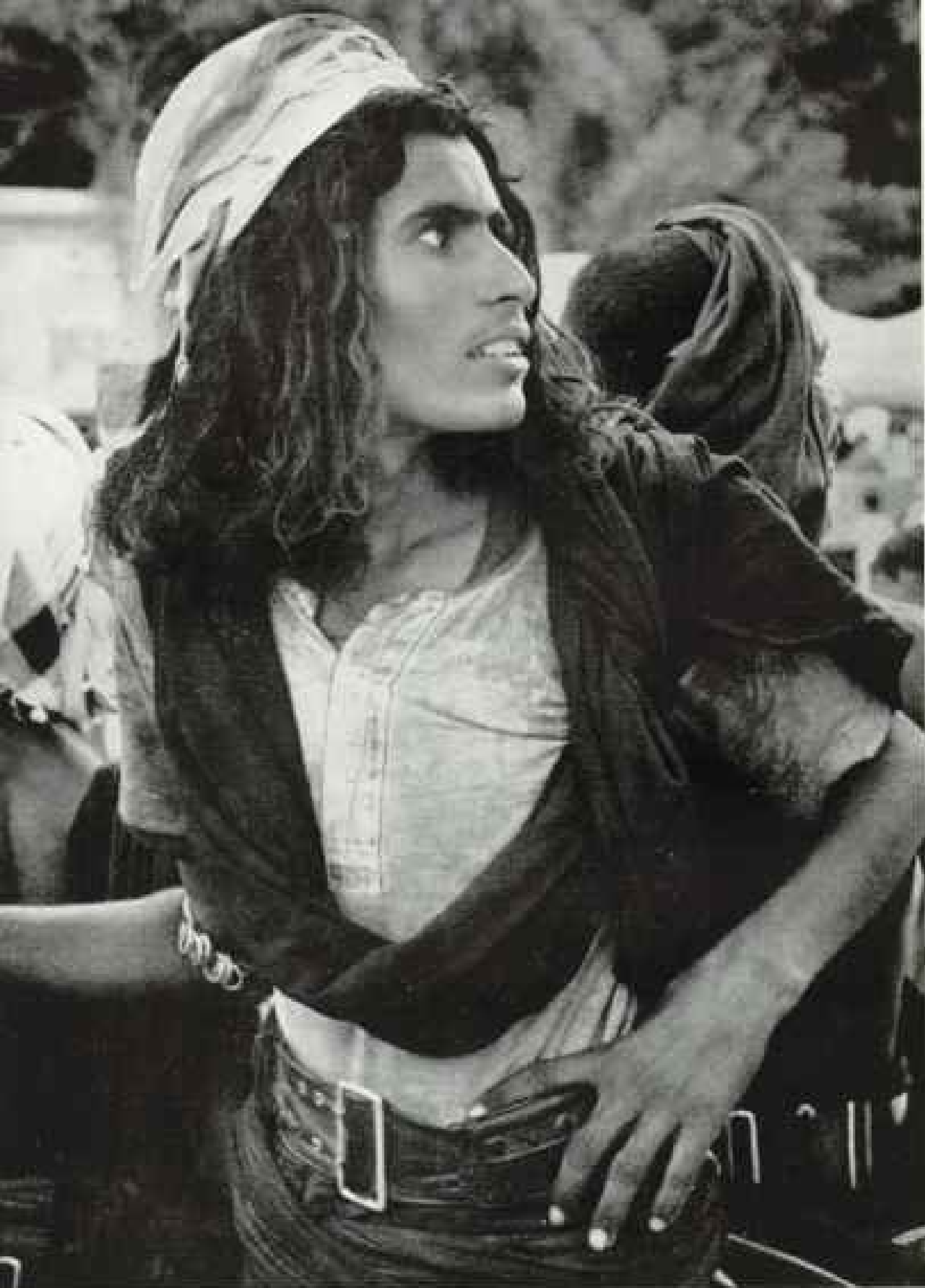
Shibam, City of Whitewashed Mud, Shimmers Like a Mirage in the Wadi Hadhramaut

Suitable land is scarce. To make maximum use of a low mound between escarpment and river bed, Shibam thrusts walls 70 and 80 feet high. Lower walls, six feet thick, are windowless for defense. Elevators are lacking.



Skyscrapers Jam Together as Tightly as Manhattan's Riverfront Apartments

Black-robed women walk out from the city gate to the well on the sands and to date groves lining the wadi for miles in either direction. Spring rains occasionally turn the highway into a river.



Long Hair Frames the Face of a Bedouin Camel driver

Layers of clothing protect the desert dweller during furnace days in the Empty Quarter or icebox nights on the 6,000-foot plateau. The shawl covers mouth and nose on dusty roads. This nomad, in Saim's bazaar, shows the features of an Arab. African strains are also prevalent.

Ascending to the Jau Khudaif, we drove in a wide arc northwestward to Beihan Qash. We arrived at night and, as we approached the village compound, a fusillade of rifle shots greeted us.

Naturally enough, we ducked. But the barrage was no more than a jovial salute from Sharif Husain and his retinue.

In futa and turban, bearded like a prophet yet with a twinkle in his eye, Husain came forward. With him was his son Amir Salih, for whom he had acted as regent until the past year.

"*Ahlan wa sahlan*," they declared. "This is your people and your land."

"God increase your wealth," I replied. "We have come a long way."

Graciously Husain led us to his offices, where we refreshed ourselves with coffee seasoned with cardamom, and thence to his sleeping quarters, located in a tower.

Moving out to make room for us, he put me, as consul, on the topmost floor of honor. On the next level he placed a British officer who had ridden in with us and, on the floor just above the storerooms, my wife and Mrs. Griffiths. The social stratification was distinct and explicit.

That night we rejoined the sharif for a state dinner. Spread out on mats were great baskets of chicken and eggs, lamb and rice, pickled fruits and vegetables. From time to time Husain would thoughtfully select a choice morsel from the common platter and pass it to me. Afterward, a servant brought rose water to pour over our hands.

Next day I noted several involuntary guests of the sharif—gaunt and tattered prisoners hobbling about the public square

in chains. They were, I suspected, hostages from other tribes; for the practice is still rife in all southern Arabia of securing a neighbor's goodwill and cooperation by holding his son or cousin or uncle as collateral.

Another medieval custom which, fortunately, occurs now much less often than it used to, is the trial by fire. To determine whether or not a suspect is telling the truth, the interrogator applies a red-hot iron to his tongue. If the iron leaves a scar, the man is a liar. The trial by food (*lukhmat al khamuq*) is similar: The victim must swallow a piece of hard dry bread. If he chokes or coughs, the truth is not in him.

That this is a hard land, living by a hard code, I needed little reminder. If I had, Mubarak Abdullah, captain of the government guards of Beihan, would have supplied it. A handsome man with the profile of an Egyptian Pharaoh, Mubarak is an Aulqi, known throughout the Protectorate. Years ago he urged some travelers to visit his tribe, assuring them of hospitality. Instead, one guest was murdered.

Mubarak's "face was blackened." So, quietly, over the space of a few years, he had in turn killed the responsible members of his own family. Now he seemed much more cheerful. An excellent police officer, he was heartily in favor of peace and found fault with the British only in their not intervening as strongly as he wished in tribal affairs.

With him, next day, I climbed the steep slopes of Jabal Raidan, hearing on the way the tale that somewhere beneath these rocks is buried the treasure of the ancient kingdom of Himyar.

It might well have been a substantial sum. For the Himyarites, building their dominion about the time of Christ on the ruins of the empires of the Ma'in, of Sheba, of Ausan and Qataban, were the last of the great societies of southern Arabia. They ruled from central Yemen, but fragments of their tombs and fortresses and palaces lie under the drifted sands from one end of the Protectorate to another.

Alas, their treasure—if indeed they left any at Jabal Raidan—is still there. We, at any rate, found nary a copper.

I enjoyed our stay in Husain's rough capital of adobe houses and fortlike buildings. His was a shrewd and lively mind.

Indeed, with his short-wave radio, he was often better informed on events in Europe and America than I.

But we could not stay. An invitation had come from Sheik Abdullah Bahri of the Balharith, who was camped some five miles up the wadi. As we approached the black camel's-hair tents huddled on the sands beneath some 'ilb trees, the Balharith tumbled out to greet us, rifles barking a noisy welcome.

After as elaborate a luncheon as the tribe could afford (their flocks were few), we repaired to another tent while the servants and women devoured the leftovers. Here on rough

Deadly Dagger Rides in a U-shaped Scabbard

This Mukalla boatman uses his weapon for eating more than for defense. When unscrewed, the tip of the curving sheath reveals a container for kohl, used for darkening the eyelids. Carnelian amulet on his throat encases holy writings to ensure the blessings of Allah.



homespun rugs, leaning back against camel saddles, we sipped our coffee and talked gravely of Protectorate affairs.

At one point the sheik suggested that my wife and Mrs. Griffiths might care to visit his wives. They agreed enthusiastically. We had had a few glimpses of his women as they popped their heads over the kitchen curtain from time to time to steal a look at us and giggle. But it would certainly be more rewarding to talk with them in their own quarters.

Harem Life Remains Restricted

The tent in which the ladies were received was tiny and crowded with a dozen women all talking at once. As is the custom among the Balharith, seminomadic still, they were not veiled, though their ever-present headcloths drooped low over their faces. More active and indispensable to the life of the camp than their city cousins, these women have consequently a greater freedom.

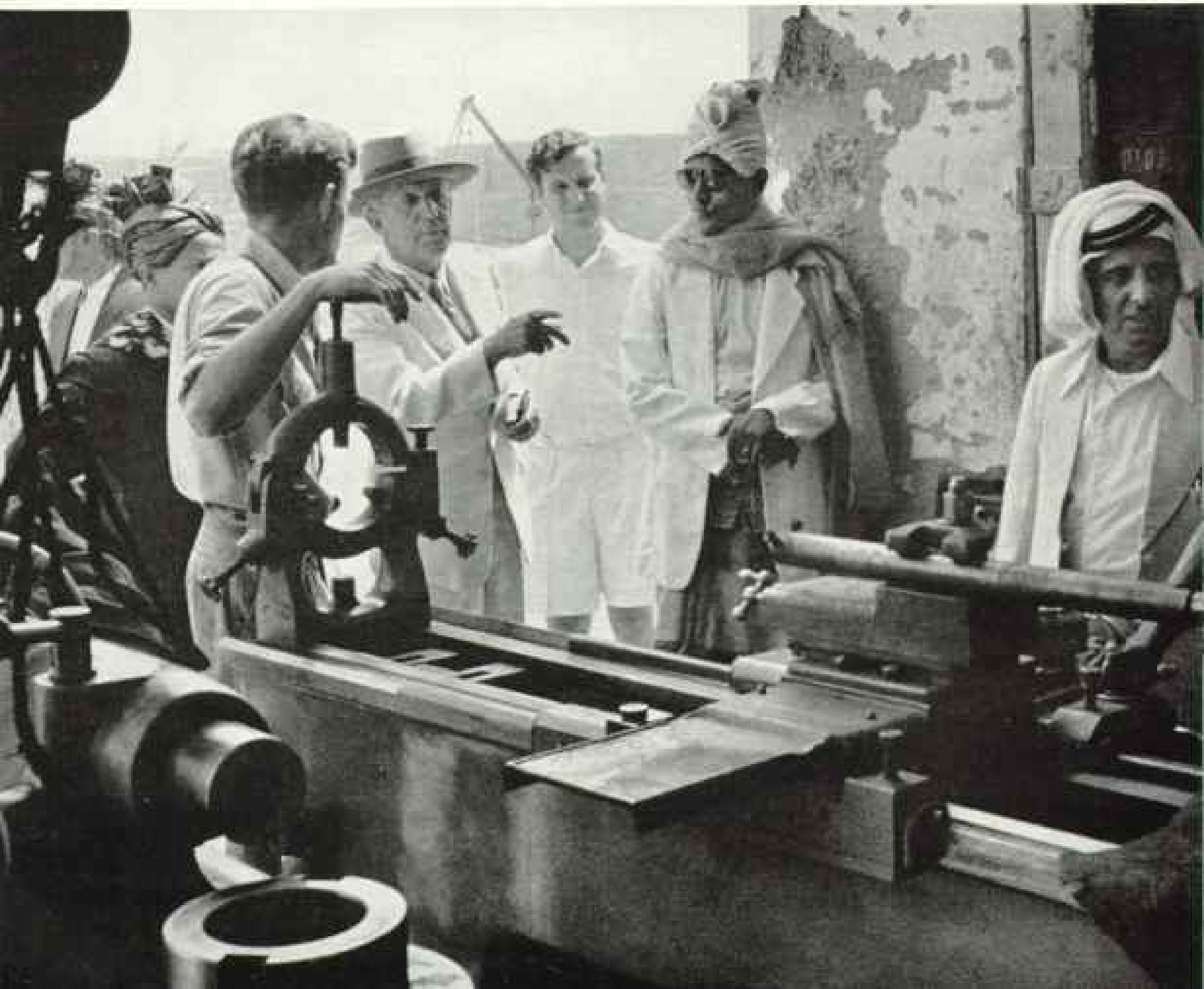
But not much. The world of the harem re-

mains restricted, intellectually stifling. Among the well to do, time hangs heavy on the ladies' hands. They kill it with gossip, drinking endless cups of tea, changing their clothes, and adorning themselves—with no place to go.

Their less-well-off sisters must work long and hard. They draw the water, tend the flocks, collect the fuel, prepare the food, and, in general, age early.

All this is not to imply that Sheik Abdullah's women were unhappy. Pretty, sparkling-eyed, and jolly, they crowded around Helen and Mrs. Griffiths with the curiosity of children, but no envy. Once the ice was broken, they unabashedly pinched and poked the two Westerners and showered them with questions. How old were they? Did they have children? If not, why not?

Mrs. Griffiths they approved; she had a pleasing plumpness. But they commiserated with Helen over her slim proportions and warned her solemnly that she would lose her husband if she did not soon become much



fatter. All had married early. At 13 and 14 years of age a girl is considered quite eligible in the Protectorate.

Children under three around the camp tended to be heard but not seen. They must be kept safe from the "evil eye" of any strangers. We were told, too, that women and small children dared not sleep alone, for fear of jinni—demons of the wilderness. Our own observations led us to believe a jinni would have a hard time squeezing edgewise into an Arab household.

Still more curious to me was another superstition we encountered; it involved nail cutting. Like



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↑ Date Farmers Learn to Irrigate with Steel Pipes

Agriculture is largely confined to the dry riverbeds, where dams and wells provide trickles of water for millet fields and date palms. Wherever water is drawn for irrigation in the Hadhramaut, the chug of the gasoline engine increasingly replaces the clop-clop of camel and donkey feet. Using loans from the British Government, some 500 farmers have bought pumps on the installment plan.

This white-coated Hadhrami gets advice from an official. Like many from his wadi, he emigrated to the East Indies and saved enough to return and buy a few date trees. His sarong reflects Indonesian influence.

← Sultan Ali of Lahaj (dark glasses) visits the pump repair shop in Sa'im. Col. Hugh Boustead, British Adviser in the Eastern Protectorate, points out details. Ali's host, Sultan Husain of Kathiri, queries the lathe operator.





many Arabs elsewhere, Protectorate tribesmen believe that if a man does not bury his clipped nails, but leaves them strewn carelessly about, he will be forced on Resurrection Day to pick them up with his eyelashes!

The custom in regard to a child's first teeth struck me as quite charming. When a youngster pulls out a wobbly "milk" tooth, he doesn't put it under his pillow and hope that a good fairy will replace it with a dime. Instead, he tosses it at the sun and exclaims:

"O eye of the sun, take the tooth of the ass and give me the teeth of a gazelle!"

Abdullah's people lived substantially as their ancestors before them. We passed many of his tribesmen as we progressed down the Wadi Balharith, their camels laden with salt quarried from the mines of Ayyidin to the north. Some, whose goatskin water bags were empty after their long trek, we were happy to be able to help.

"I, the King of Qataban"

On our route eastward the next day, bound for the Hadhramaut with two of the sheik's brothers, we passed traces of a civilization far older than theirs. At Qohlan, for example, we crossed a field of ruins where a tall stone stele records the proud boast of a first-century B. C. ruler—"I, the King of Qataban, in my city of Qohlan"—and lists a long line of towns and principalities over which he ruled. American archeologists, among them Dr. William F. Albright, have excavated here.

The Arabs can no longer decipher this lost script, and the place names are no more than legendary to them. But they are dimly aware from the crumbled water works and massive foundations still found in the Protectorate that their land once held a much richer, more populous, and more powerful culture.

We passed on. Long, dry days in the gravelled desert were our portion, but at night we slept under a curtain of stars while the sand gave back to the sky its heat. Sometimes tribesmen appeared from nowhere to stand

Eyebrow Arches Garnish the Windows of the Kathiri Palace in Saion

Coated with lime, the sultan's home dazzles beholders in the midday sun. Walls show the pronounced slope that prevents collapse of the Hadhramaut's immense mud structures. Harem dwellers reach the topmost apartments by trudging up a flight of more than 100 steps.

Townpeople loiter in the public square on the chance that Sultan Husain may emerge and distribute gratuities.

just outside the glow of our campfire, and sometimes our drivers and Abdullah's brothers tilted back their heads and chanted Arab songs. Improvising words, they satirized us amiably in verse after verse.

South of the Ramlat Sabatain (the Sands of the Two Sabas) we rode, leaving on our right the storied site of Shabwa. Both the Yemeni and the British claim Shabwa, and, by mutual consent, each side stays clear of it. I had been asked by the British to avoid it and, of course, had agreed.

Yet I would have loved to walk Shabwa's dusty streets. For under its debris may well lie one of the great cities of the Queen of Sheba's realm, and it was through Shabwa, according to some, that the Magi journeyed on their way to Bethlehem. The frankincense they bore might have been harvested from the gum-resin trees of wadis not far from here; their myrrh might have come from the *Commiphora* shrubs of the Fadhli sector.

We followed our own star into the Wadi Hadhramaut. Its rugged palisades walled us in on either hand.

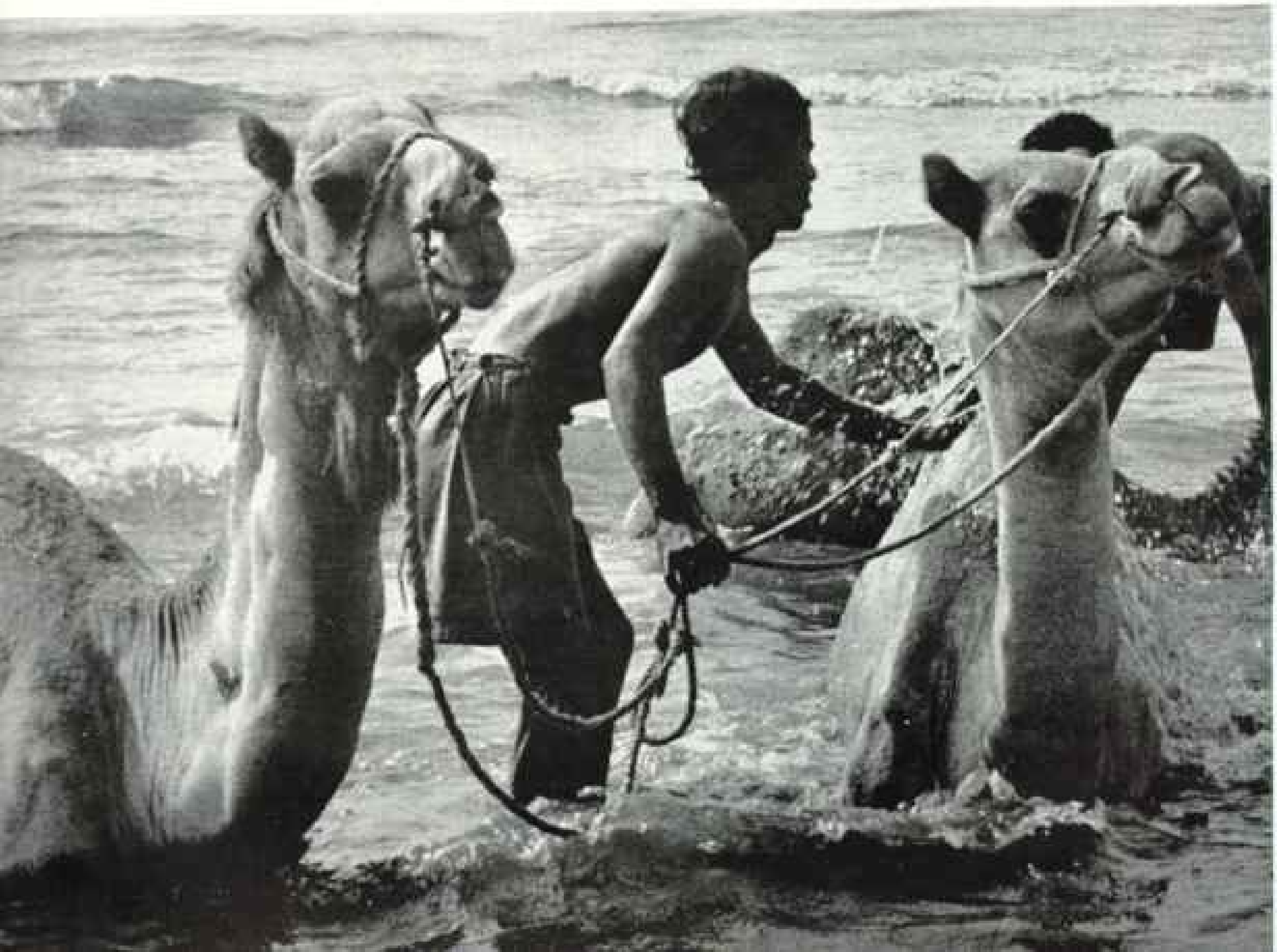
This long and celebrated valley is the jewel of the Protectorate. For generations its trad-

ers and its young men have quit it for adventures in Hyderabad, Indonesia, and the sea-ports of the East. But those who could afford it would come back in the end, bringing enough money to buy a few date palms, or build a gleaming whitewashed house with tall garden walls, or subsidize a mosque or library. Those who could not return would send remittances. The Hadhramaut was home, and even in the green luxuriance of Asia its image did not fade.

End of Feuds Brings Progress

The blood feud had set its grim mark on this wadi, too, and for many years commerce and agriculture had shriveled. But with peace the date groves were flourishing once more, and irrigation works, repaired and maintained by the village councils, were diverting water and precious silt to the fields. A government-sponsored scheme to allow Hadhrami farmers to obtain on easy terms pumps for lift irrigation promised to aid agricultural development still more (pages 244, 245).

Shibam, first of the large Hadhramaut cities that we entered, looks as if some titan had squeezed it together in his fist. Within



a closely encompassing wall bulge upward some 500 "skycrapers," many of them six stories, rising starkly against the rugged backdrop of the escarpment. Massive and windowless at their feet, they taper impressively toward balustraded penthouse roofs (page 240).

Shibam takes one's breath away. Here, at last, is no mere effort at adobe shelter. Here is architecture.

Saiun, a few miles farther up the wadi, is less formidable but perhaps more gracious. A garden city, its houses spread richly out among its palms and high-walled lanes. Dominating the town is the palace of Sultan Husain bin Ali of the Kathiri; it resembles an



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♣ Hadhrami Bedouin Legion Trains with British Lee-Enfields

British Advisers maintain authority over the Protectorate's sultans and sheiks by subsidies and a system of native troops. Best military group in the Eastern Protectorate is the 400-man legion. Officers (right) wear uniforms like those of Jordan's Arab Legion, whose men originally trained the Hadhramis. To save uniforms, privates drill bare to the waist.

◀ Military Camels Get a Salt Bath in the Gulf of Aden

Aden Protectorate Levies, commanded by RAF officers, help maintain order. These parade camels come from the levies' headquarters at Sheikh Othman, seven miles north of Aden.

elaborate wedding cake surmounted by four dazzling towers.

We were the guests of officers of the Desert Locust Survey unit in Saiun. These men are constantly on the move, tracking down reports of locust swarms and hoping to poison their breeding grounds before too late.

I had seen locusts in flight and knew what the men were up against. It is an awesome sight. By the millions the insects whir past, at perhaps 1,000 feet, in a long, dark cloud that literally blots out the sun.





The task of the survey unit is made no easier by the fact that many Arabs regard it as foolishness, or worse. They eat locusts—dried, ground into paste, or deep fried. "Allah has sent us this food. Why should you destroy it?" The desolation which locusts can bring means little to a tribesman tending a few goats on barren hillsides.*

City of the Prophet's Descendants

Tarim is the city of the Sayyids—descendants of Mohammed. One of the more handsome cities of the Hadhramaut, it boasts many imposing Indo-European buildings.

We visited a fine library given to a local mosque by the Al Kaf family of Sayyids; another gift to Tarim from the Al Kaf was a new hospital, nearly completed.

During the Moslem month of *Shaban*, the road from Tarim to Qabr Hud is usually busy with thousands of devout travelers on *ziyara*, or pilgrimage, to the tomb of the prophet Hud. Some come on camels and donkeys, some in cars, many more on foot. This year, however, differences with tribesmen caused the trek to be canceled.

One of the few wayfarers we did encounter was a wandering magician and his drummer boy. While the boy beat his tambourine, the old man performed several simple tricks for us, topped by one that I cannot easily explain. Taking a heavy four-foot spear, he inserted its steel tip in the socket of his eye and then balanced it upright for nearly a minute, his hands at his sides.

Such contemporary feats prepared us in part for the shrine at Qabr Hud. Here the prophet (the Biblical Eber) is said to have fled, pursued by enemies. His camel, exhausted, collapsed at the foot of a great rock. Hud was ready to despair, when the rock cracked open. He dashed into the gap, and the fissure closed behind him.

A white beehive dome now surmounts the

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

★ Squeezed Between Rock and Sea, Mukalla's Houses Can Only Go Up

As a port, Mukalla ranks a poor second to Aden, 300 miles west. Many dhows call here on the runs to Africa and India, but larger vessels stop only occasionally since they must anchor outside the shallow harbor. One tapering minaret breaks the rectilinear monotony of this expanse of gaunt stone houses.

rock. Entering, one can see a rift in the granite, some 10 feet long. Stuck to the rock and along the walls are thousands of threads and bits of string left by Moslem pilgrims as offerings. Outside lies an enormous boulder called the Naga, Hud's camel, petrified for all time. At the foot of the hill lies a ghost town, silent and empty, occupied only during the three days of the pilgrimage.

Two motor routes drop down from the Hadhramaut to the coast. We chose the picturesque West Road, which runs from Henin to Meshbed; thence to Hajarain and southwards past the mouth of the palm-green Wadi Duan (whose villagers, like cliff dwellers, build their many-storied houses on the steep slopes); up and over the harrowing Jahi Pass and across the *jol* to Mola Mattar; and finally down the long grade to Mukalla.

Few sights in the Protectorate are more awesome than the *jols*. Stony, dry, desolate, these high plateaus stretch almost without definition into the distance, their monotony broken only by the sharp-lipped gorges which split their surface from time to time.

For all its lifelessness, the *jol* is an exhilarating place to traverse. Here, at some 6,000 feet, we seemed to be wandering across the windy roof of the world. And when we came again to the descent beyond Mola Mattar, our excitement was no less.

Corkscrew Trail to Remote Mukalla

I am not referring to the view of the coast. That is spectacular, but it was not my immediate concern. I was more interested in keeping our cars from skidding over the edge of our rough-hewn, corkscrew trail and ricocheting downward from crag to crag.

We rattled into Mukalla safely enough that afternoon and headed for the home of our host, Col. Hugh Boustead, British Resident Adviser to the Eastern Protectorate. As we drove into his compound, a squad of Hadhrami Bedouin Legionnaires rushed out, fell in, and began smartly to dress the line.

Groaning to myself, I buttoned my khaki shirt and began to dismount. All through our trip, when word of our arrival had gone ahead, I had had, as a visiting consul, to review the local guard of eager tribesmen. Grimy and tired, I was about to come to attention—when Colonel Boustead dashed down the steps, immaculate, strode to the head of his troops, and took the salute.

A few seconds more and he would have

been treated to the sight of an American presiding over his favorite afternoon function.

An astute and very active administrator, Boustead is one of the most colorful figures in the Protectorate. A junior naval officer in World War I, he had found that service too dull, had deserted, joined the army, and fought in France. When, later, he was awarded the Military Cross for gallantry, an Admiralty pardon had had to be hurriedly sought before he could receive the medal.

Through Boustead I came to know the late Quaiti Sultan, Sir Salih bin Ghalib. Already well along in years, Salih was the picture of calm but tired dignity. His interests were many, and here in Mukalla, off the beaten track, he pursued them with quiet enjoyment. His writings numbered a score or more of published and unpublished books, ranging from learned treatises on Islamic law to textbooks

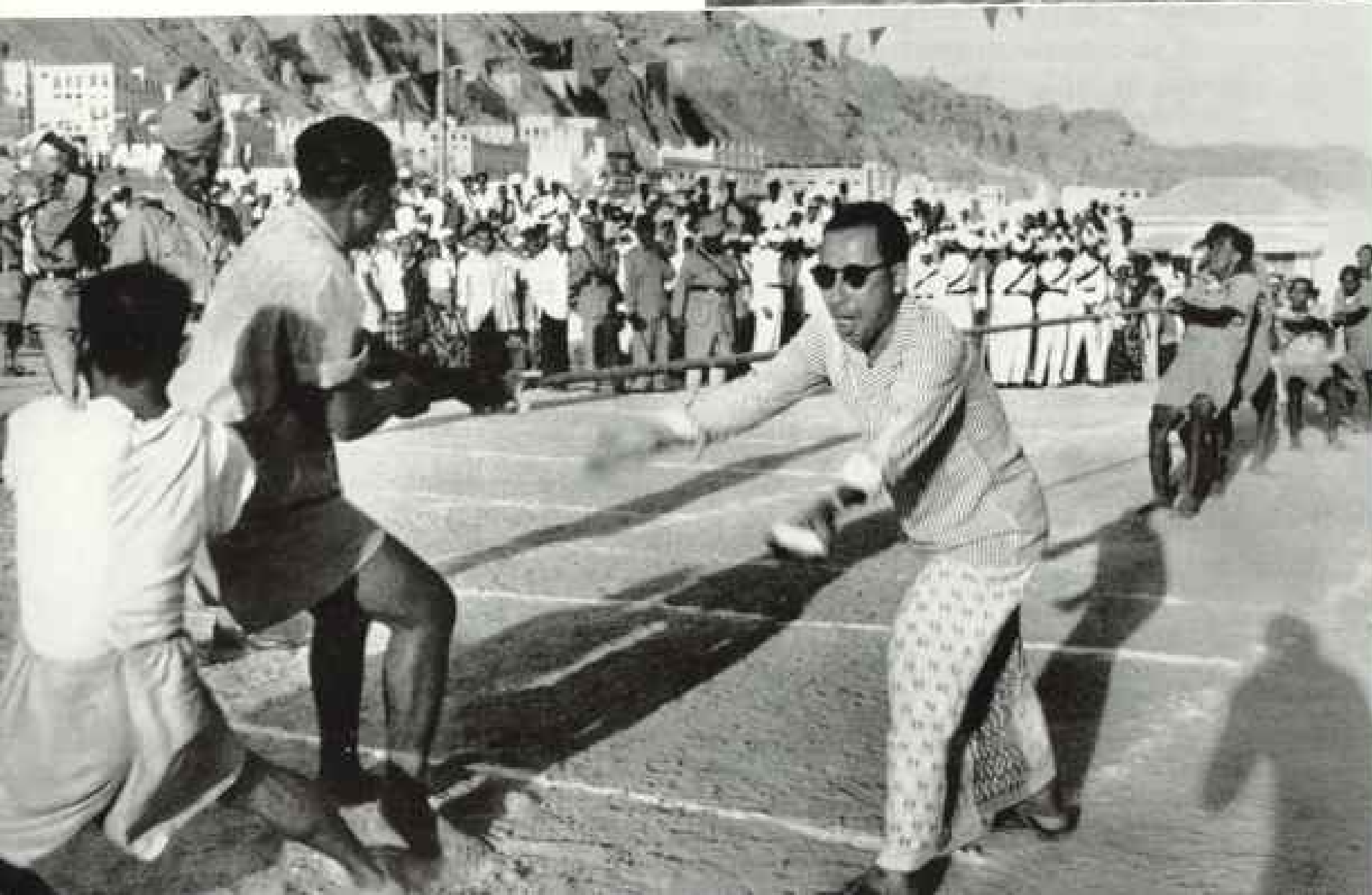
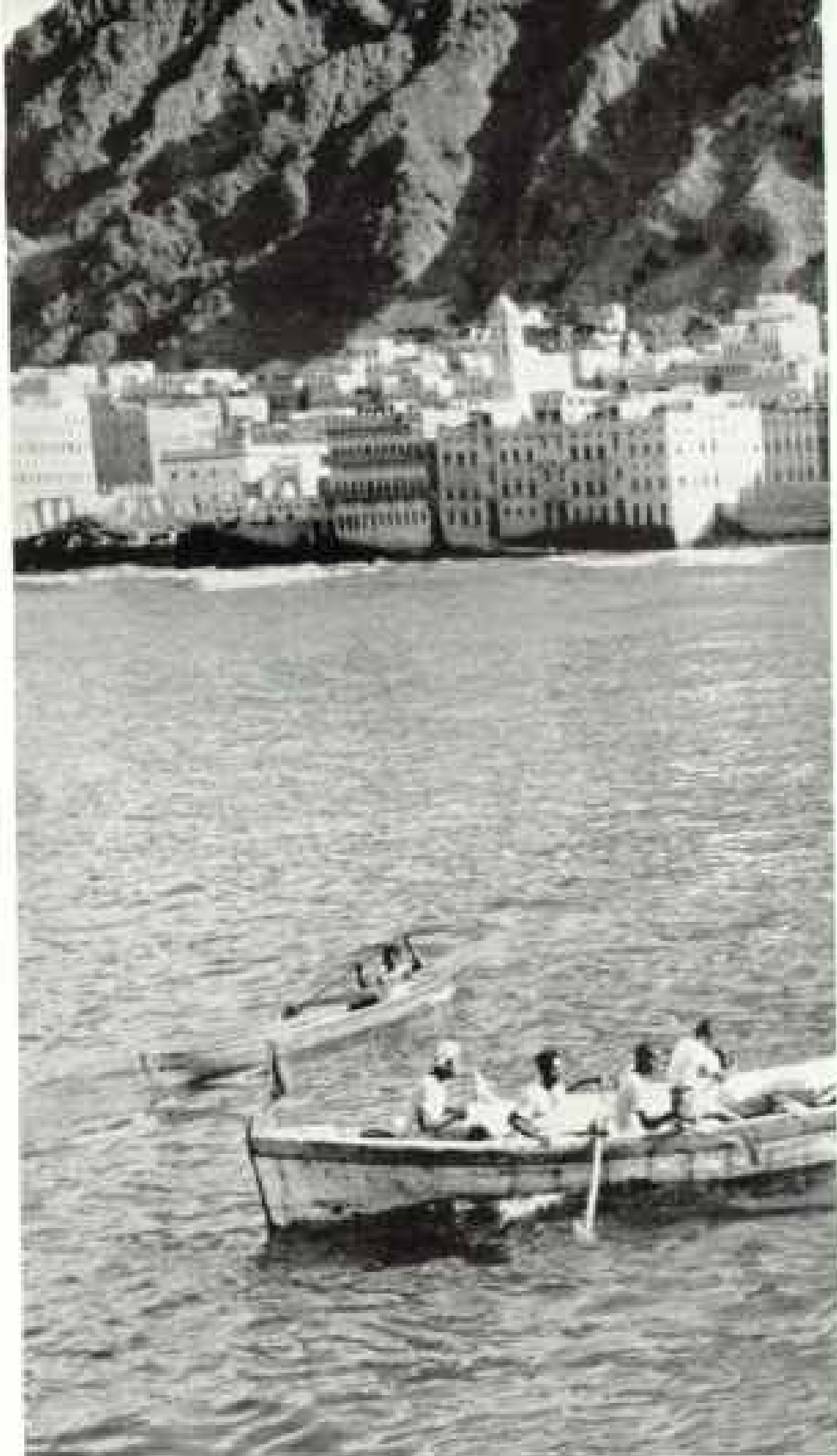
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Water Sports in Mukalla Harbor → Honor a New Sultan

Roughly 25,000 people live in Mukalla, capital of the Quaiti State, most important of the Protectorate's sultanates. Last summer they mourned the death of their sultan, then celebrated the accession of his son, Awadh bin Salih bin Ghalib.

Here Sultan Awadh (front row, facing camera), with members of his court and British officials, watches Arab and Somali boatmen line up for the Accession Day regatta.

↓ Celebrations continue with a tug of war in the palace courtyard.





in Arabic on higher mathematics. Until a few years ago he had been an ardent athlete.

Although the public showing of films is still forbidden in Mukalla, the sultan was his own cinema producer and delighted in projecting his highly moralistic films to select audiences of friends. I recall a delightful evening we spent with him, marred for me only by the belated discovery of a protruding spring on my side of the small throne sofa I shared with the sultan.

Through Boustead, too, I met Amir Awadh, the sultan's son (above), who has now ascended the Quaiti throne, and Qaddal Pasha, the sultan's Sudanese chief secretary. It was Qaddal who urged us to visit the Mukalla and Gheil Ba Wazir schools, of which, as

former education adviser, he was very proud.

We did. Mukalla provides an excellent school for Bedouin boys and also a girls' school—a real rarity in southern Arabia. Gheil Ba Wazir has a progression of schools ranging from elementary through secondary, complete with boarding departments. Connected with the latter schools is one of two Boy Scout troops in the Aden Protectorate.

The last leg homeward to Aden drew us along the dunes facing the Indian Ocean. At the tiny fishing villages of Haura and Irqa, each a treaty sheikdom in its own right, nets were spread on the sands for mending. Arab seamen from little coves like these bring back some 20,000 tons of fish each year; exports go largely to Ceylon via Aden (page 236).



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A Balcony Assemblage in Saiun Hears a Sultan Speak

Last summer Sir Ali Abdul Karim, Sultan of Lahej, made state visits to strengthen ties with brother sultans. Here he addresses dignitaries at the Kathiri palace. Harem women on distant parapets watch like ravens.

From Ahwar, the administrative center of the Lower Yafai Sultanate, we journeyed on past Shuqra, resisting the temptation to veer off toward Abyan. Here the British have helped launch a most encouraging project of growing cotton under irrigation. Production has shot up from less than 10,000 bales in 1953 to 27,000 in 1956, valued at \$6,500,000, and acreage under cultivation has almost quadrupled.

Hurrying against the turn of the tide, we made our way down the beach to the Col-

ony, dodging an occasional caravan of slack-mouthed camels lurching toward Aden's markets. As the jagged profile of Jabal Shamshan's extinct volcano loomed up behind the city, a plane circled twice and lumbered slowly down upon the tarmac.

I could guess its probable cargo—*gat*, the druglike plant which so many Adenese chew with stubborn addiction. It still comes down from Yemen and from the Western Protectorate by camel. But it is tastiest when the leaves are freshest; so now the airplane has been requisitioned to bring the Colony its daily supply, much of it from Ethiopia.

I thought it odd that the marvels of 20th-century transportation should be bent so feverishly to bring about a state of languor. For, while the plane's engines were still warm, some benign Arab gentleman would be reaching for his first leaves of the day, preparing to blot out the worries of the world and to slip into a light-headed, rose-tinted daze.

Yet, after all, I had just been journeying in a long circuit through a land itself still half asleep, destined to wake soon from the slumber of centuries, but today still somnolent. As a tribesman, holding in his hands a fragment from the ruins of Qohlan, once said to his Western friend:

"We Arabs live in an ancient house, and it has fallen on us. Now we lie helpless under the weight of its stones. You must tunnel down to us and open a door for us, so that we may pass out into the daylight and build our house anew."

Every Year This Medieval German Town Repays a 300-year-old Debt to Youngsters Who Saved It from Fire and Pillage

BY CHARLES BELDEN

With Photographs in Color by the Author

RED-HOT cannon balls soared over the ramparts of Dinkelsbühl, aimed to set fires and blow up the arsenal. Disease raged during the siege, and the war-weary councilors of this little free city in Franconia had just received wretched news. The troops they had counted on for relief would not come after all.

These fearful days during the Thirty Years' War of 1618-1648, when a handful of children miraculously averted the wrath of the conquering Swedes, come to life every July in the pageant pictured on pages 257 to 268.

A Child Touches a Conqueror's Heart

The children, so the legend goes, approached the Swedish commander in the market place just as he was about to accept the city's surrender. Infuriated by Dinkelsbühl's stubborn resistance, he was determined to let his troops loot and burn. But one tiny boy reminded him of his own son, who had recently died, and so touched his heart that he spared the city from pillage.

In remembrance of this happy event in 1632, Dinkelsbühl honors its little saviors at the festival of the *Kinderzeche*, or Children's Treat, in a setting that looks like movie scenery for a fairy tale. But during my recent visit to photograph Dinkelsbühl's reliving of the past, I discovered that this romantic backdrop is as authentic as it looks.

Spared by time, the walls and bastions of Dinkelsbühl still stand intact, encircling the town and surmounted by 18 medieval towers. Four additional towers, massive and square, fortify the town gates. Carved stone fountains and half-timbered houses as much as six stories high appear hardly altered in three centuries and more (page 266).

That so many venerable structures remain so well preserved struck me as remarkable enough. But what makes Dinkelsbühl especially noteworthy among medieval towns is that so little has been added through the years to overawe the past.

Even before crossing the moat to the towering Wörnitz Gate, I sensed that this

town in the fertile hills of what is now western Bavaria must have dropped off to sleep long ago into lasting tranquillity.

Near by the dark Wörnitz River reflected the walls. It moved slowly as the clouds, and the air was full of the smell of hay and the buzzing of bees.

This quiet present, I learned, stems from the bustle of a thousand years ago. Here, at the crossing of roads from Venice northward to what is now the Netherlands and from Strasbourg east to Vienna, the German King Henry I ordered many of Dinkelsbühl's early fortifications. He commanded that one man in every nine work on the walls, while the other eight should till his field as well as their own and store away a third of the harvest for troubled times.

More walls went up as the town expanded in the 12th and 13th centuries, offering protection to freedmen and runaway serfs alike.

Quarrelsome knights and rebellious peasants terrorized the countryside. But Dinkelsbühl, now proclaimed a free city subject only to the authority of the emperor, flourished behind its solid walls. Its citizens were to be tried nowhere else. Proud of its own courts



and constitution, Dinkelsbühl grew into a miniature republic, fostering crafts and trade.

By imperial decree, cloth made and measured in Dinkelsbühl was not to be measured again elsewhere—a highly prized privilege for its weavers and dyers. Tanners did well, too, and ambitious smiths bought iron in Styria to forge into scythes for sale as far away as Switzerland.

Grain and powder mills sprang up, and a mill to press oil from beech-tree seeds; also establishments to thicken cloth and make it warmer by moistening, heating, and pressing it. An unusual mill became part of the town wall as a fort in its own right. It burned in 1923 but was restored. Swans still glide in the moat that mirrors its walls.

Favorite Stopping Place of Emperors

Dinkelsbühl's prosperity mounted with the imperially granted right to hold annual markets and fairs and to collect custom fees. A further commercial boost was the power to punish anyone who bothered tradesmen headed for the fair. A town gate still shelters a picture of a severed hand with dripping blood, as a warning to itinerant evildoers.

The town's growing wealth was reflected in a new ring of walls and, within it, increasingly impressive buildings, notably St. George's Church. Its Romanesque west portal, dating from 1220, shows inscriptions left by crusaders. But most of the construction was done in the 15th century, resulting in one of southern Germany's most beautiful late Gothic churches.

Emperors liked to stop over in Dinkelsbühl, where they were always welcomed by the town councilors in the market square. They received useful presents as well. Thus Maximilian II and his wife came by on June 12, 1570, and collected, among other things, 14 tubs of pike, 14 tubs of carp, 28 bags of oats, and 21 pails of wine.*

The Town That Slept for Centuries

But 75 years later less gracious visitors brought Dinkelsbühl to the verge of ruin. Here is what happened in one bad year during the Thirty Years' War:

The French took the town in August, after seven days' bombardment. The Bavarians besieged the French in November and threw them out. Before the next harvest was in, the Swedes occupied the town. Then the Bavarians returned.

Dinkelsbühl suffered eight sieges and conquests altogether, and the plague alone killed nearly two-thirds of the town's inhabitants.

In a way Dinkelsbühl can thank the disasters of yesteryear for its prosperity today. Its wealth and commercial influence blown away by war, the town slumbered behind its walls. Industrialization passed it by, and Dinkelsbühl remained forgotten.

Then, late in the last century, artists discovered its rare charm. As one enthusiastic writer put it, Dinkelsbühl recalls the past as impressively as if it had sunk into a flood hundreds of years ago and only just emerged again exactly as it was before. The population today numbers 7,200. But more than 300,000 visitors come each year, and some 45,000 stay at least a night.

An American traveler in Dinkelsbühl some years ago ate *Bratwurst*—pork with spices, fried in a pan. Recently he detoured 80 miles from his route just to eat another Bratwurst there. Even better known are Dinkelsbühl's fried and boiled carp.

But the main attraction is, of course, the festival honoring the children who saved the town. Near-by Rothenburg, by the way, also puts on a pageant to celebrate its escape during the Thirty Years' War. To save his town, the mayor took a dare and downed nearly a gallon of wine in one draught.

Citizens Grow Beards for Festival Roles

Scores of Dinkelsbühlers take part in the week-long festival—dressed as town councilors and guards and Swedish officers and soldiers. Those whose roles call for luxuriant beards start growing them right after New Year's to be properly bewhiskered by July. The festival itself begins with a play representing the beleaguered town council deciding upon surrender. The climax comes in a town square just inside the Wörnitz Gate, when the Swedish commander spares the town for the children's sake (page 264).

"Always remember the debt of thanks you owe them," he says.

And throughout the festivities the children are indeed well remembered. They get more than applause. Each child gets a cornucopia filled with candy and cookies—along with three centuries of gratitude from their fairy-tale town.

* See, in the NATIONAL GEOGRAPHIC MAGAZINE, "Dinkelsbühl, Romantic Vision From the Past," December, 1931.



Little Colonel, Atop His Charger, Recites the Children's Plea That Saved Dinkelsbühl

Boys and girls, interceding with Swedish invaders, saved this Bavarian town from sack during the Thirty Years' War (1618-1648). Each summer Dinkelsbühl commemorates the event with the festival of *Kinderzeche* (Children's Treat). Resplendent in 18th-century uniform, this young officer leads the Boys Battalion (background).





"Swedish Invaders" Camp Within Sight of Beleaguered Dinkelsbühl

Sweden's standing army in the Thirty Years' War was the envy of a Europe largely dependent on mercenaries. King Gustavus Adolphus forbade his well-paid troops to pillage captured towns. The edict may have helped save Dinkelsbühl, which survived eight sieges during the course of the war.

Townsmen take the part of enemy soldiers in the Kinderzeche. Here they pitch tents in view of the town's old timbered houses.

Page 261, lower: Horn, halberd, and lantern identify the scarlet-clad town crier of Dinkelsbühl. He sings a different verse each hour to tell fellow citizens all is well.

Below: Colonel Sperrouth, the Swedish commander, rides grimly into the town after residents throw open the gates. Infantrymen in striped hose line his triumphal route to the town hall.

Next two pages: The children of Dinkelsbühl, led by a gatekeeper's daughter, march in procession. Legend says Lore, the young heroine, overheard the town council debating surrender. She proposed gathering the children together for an appeal to Sperrouth, whose small son had just died. Deeply impressed, the burgomasters agreed to her plan.

Every other year a new Lore leads the children in parade. They are followed by burgomasters, the Boys Band, and the Boys Battalion.

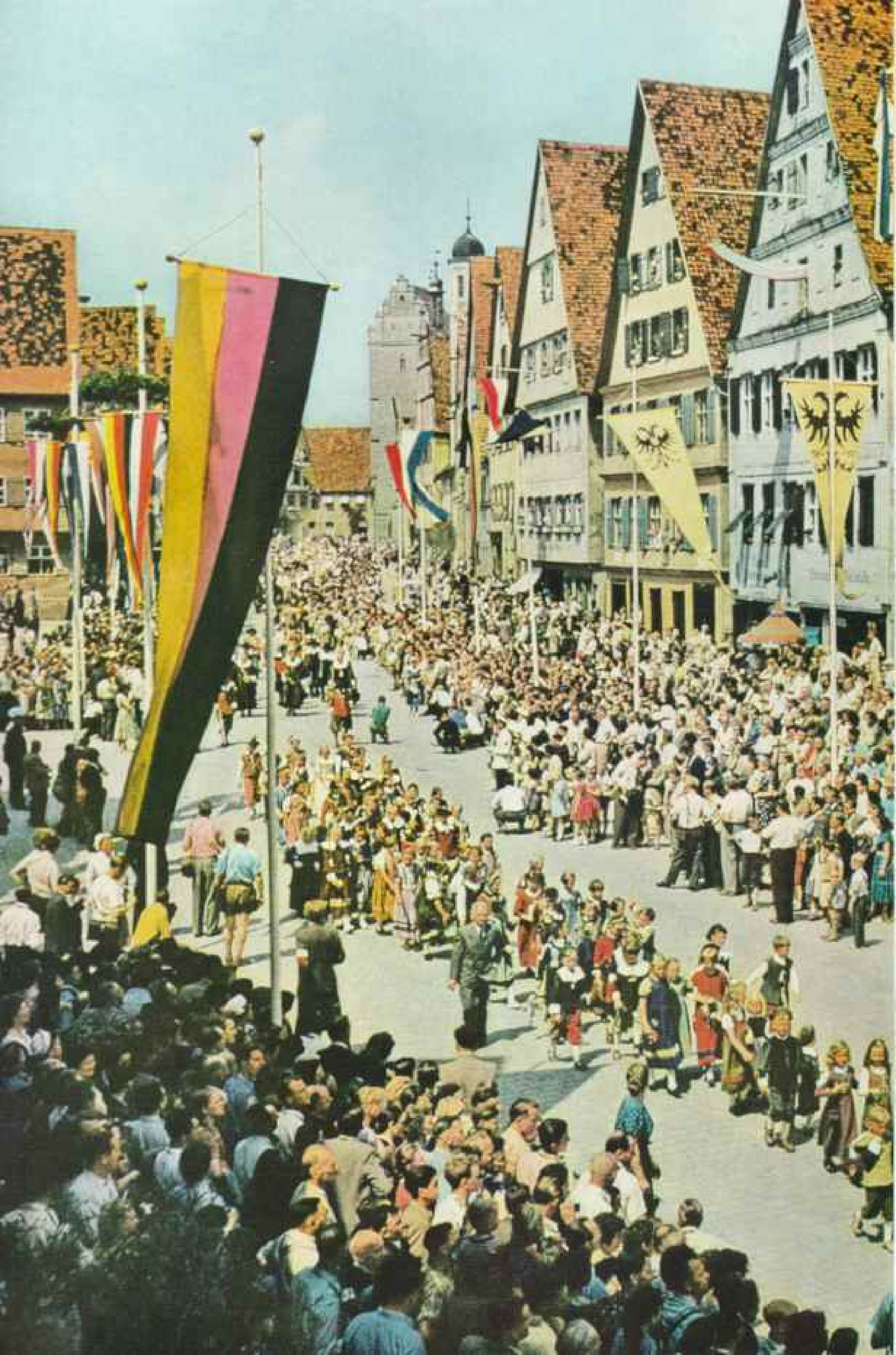
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Little Stümel (opposite below)

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© National Geographic Society

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↑ **Young Burghers Ask Mercy
"for Your Own Child's Sake"**

Kinderreue comes to a climax at the Wörnitz Gate as Sperreuth (astride his mount) spares the town. "Children are the rescuers of Dinkelsbühl," he tells citizens. "Always remember the debt of thanks you owe them." Church bells ring in celebration.

↓ **Solemn Burgomasters Yield Keys
to the Treasure Vaults**

Waiting for the Swedish colonel's entry into the town, mayor and councilmen stand in fur-trimmed robes and medals of office on the steps of the Rathaus (town hall). Guards are members of the town militia. Men in the back row wear burghers' berets.





Swordsmen Salute Each Other on Pedestals of Crossed Blades

These students perform the medieval sword dance, a favorite *Kinderzoché* event. Banner at right bears a double eagle, symbol of the old German empire. Law has robbed the duel of its sanguinary character.

↓ Six-story Deutsches Haus Has Stood Five Centuries

A Dinkelsbühl patrician built this home in 1444. Now a hotel, it overflows with guests at festival time.

Steep gables and half-timbered fronts are typical of the town's houses (opposite). Window frames display the ornate wood carvings of south Germany. Dinkelsbühl's official red and white banner hangs from the building at the left.



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↑ Tile Roofs Look Up to a Fairy-tale Tower

Farmers established Dinkelsbühl, one of Franconia's oldest towns, in the 6th or 7th century. Henry I of Germany fortified it in 928. The community became a free imperial city in the 13th century. Later a town council took form; it still exists.

Industrialization in the 19th century passed Dinkelsbühl by. The town preserves a medieval atmosphere.

Prosperous merchants erected these houses. They used the beams projecting at rooftops for hauling goods to attic store-rooms.

→Page 267, lower: Dancers take possession of the street during Kinderroche.

Gilded deer over doorway proclaims an inn.

© National Geographic Society





Costumes and Cone Say Festival Is Near

Kinderzuche began in the 15th or 16th century as a children's school pageant. The saving of Dinkelbühl was woven in after 1637.

Weeks of preparation go into the celebration, now held each July. Most of the 7,200 townspeople take a hand renovating costumes, training children, and decorating houses.

Youngsters in the Boys Band practice under the town bandmaster. The spit-and-polish Boys Battalion drills endlessly. Uniforms, once Swedish, now are 18th-century German.

Small workers here put finishing touches on a cornucopia. Girl at right sews uniforms for dolls representing the Boys Battalion.

← Blossom-crowned maids compare cones filled with candy and cookies.

Two Navy Meteorologists Reach Record Height with a Light Gasbag of Transparent Plastic and Survive a Fall of $14\frac{1}{3}$ Miles

By Lt. Comdrs. Malcolm D. Ross, USNR, and M. Lee Lewis, USN

When Commanders Ross and Lewis were preparing to invade the stratosphere, they found that the detailed reports of the record-breaking National Geographic Society-U. S. Army Air Corps flight of nearly 21 years before were still among the best sources of data on the upper atmosphere. In appreciation and in recognition of The Society's long and active interest in the stratosphere, they have contributed this narrative of their historic flight.—The Editor.

SLOWLY but with reassuring steadiness the pointer of our sensitive altimeter climbed past the 72,200-foot mark, continued its unhurried sweep to 72,400, and began a resolute assault upon still higher numerals on the dial.

Within our aluminum gondola, the *Strato-Lab*, high in the near-vacuum of the upper atmosphere above South Dakota, we gazed at the instrument and groped for suitable words. The world's record altitude for a manned balloon had just been topped.

Lee finally broke the silence.

"A lot of very fine people have passed this way," he murmured.

The tribute was a subtle one. Indeed, in the figurative sense, a great many people had passed our way—all the hundreds who had helped earlier balloonists achieve their goals and the hundreds more who had helped us.

New Vehicle for Stratosphere Explorers

In those next few fleeting minutes last November 8, our altimeter—confirmed by ground radar—registered 76,000 feet, thus surpassing the record of 72,395 feet, about $13\frac{1}{4}$ miles, established by Capts. Albert W. Stevens and Orvil A. Anderson in the *Explorer II*. Like them, we took off from the hill-sheltered Stratobowl, 12 miles southwest of Rapid City, South Dakota. Our own ascent very nearly coincided with the 21st anniversary of their flight, made November 11, 1935, under the joint sponsorship of the U. S. Army Air Corps and the National Geographic Society.*

But far more important than a record is the fact that the feasibility of penetrating the stratosphere with a light, relatively inexpensive man-carrying balloon of polyethylene plastic has now been demonstrated. This, we believe, marks a new era of exploration of the great frontier just a few miles above our heads—a region now being invaded

more and more by rocket planes and missiles, and soon by man-made satellites.†

For more than nine years light plastic balloons have been carrying a variety of instruments high into the stratosphere in the Navy scientific program known as Skyhook. Meanwhile, some of us decided that this gossamer-thin, transparent material had been developed to such a point that it could be trusted to carry human observers as well.

"Hope to Go Higher... Stay Longer"

Our flight to 76,000 feet proved that this confidence is justified—even though a malfunctioning automatic valve released a burst of gas when we reached our ceiling and brought us down a lot sooner (and faster!) than we had planned. This year we hope to go higher and stay longer.

During a portion of that $14\frac{1}{3}$ -mile plunge to earth, our gondola dropped at a rate of about 4,000 feet per minute, and we had little or no control over the balloon.

By dumping all our 300 pounds of ballast and by ruthlessly tossing overboard some 200 pounds of instruments and equipment, we slowed the descent enough to make a safe landing in a sandy basin 18 miles southwest of Kennedy, Nebraska.

* For full accounts of the *Explorer II* flight, see, in the NATIONAL GEOGRAPHIC MAGAZINE: "Man's Farthest Aloft," January, 1936, and "Scientific Results of the World-Record Stratosphere Flight," May, 1936, both by Capt. Albert W. Stevens. See also "National Geographic Society-U. S. Army Air Corps Stratosphere Flight of 1935 in the Balloon *Explorer II*" (Contributed Technical Papers, Stratosphere Series, No. 2), published in 1936 by National Geographic Society, Washington, D. C. For a brief assessment of scientific results, see "Twentieth Anniversary of the Epoch-making Stratosphere Flight by *Explorer II*," NATIONAL GEOGRAPHIC MAGAZINE, November, 1955.

† See, in the NATIONAL GEOGRAPHIC MAGAZINE: "Space Satellites, Tools of Earth Research," by Heinz Haber, April, 1956; and "Aviation Medicine on the Threshold of Space," by Allan C. Fisher, Jr., August, 1955.



Pressure-suited Balloonists Prepare for a Simulated Six-hour Flight into Space

Two weeks before their 76,000-foot ascent, the authors tested equipment at the General Mills laboratories, Minneapolis, Minnesota. Here the *Strato-Lab* gondola rests in an altitude chamber, called the Bean Pot, whose air pumps create reduced pressures like those of high altitudes. Lid at upper right will complete the seal. The aluminum shell is bedded in ice (not shown) to control temperature. For familiarization, authors Ross (left) and Lewis wear Air Force pressure suits, emergency garments designed to permit respiration and to keep body fluids from boiling upon sudden exposure to extremely low pressures. Capt. Norman Lee Barr, Navy flight surgeon, advises them. Project engineer Harold Froehlich (right) receives instruments from an open hatch.

Our stomach-sinking drop, while by no means a tea party, was not the wild, near-fatal misadventure one might imagine. The Office of Naval Research, sponsor of the flight, had provided well for every contingency. Above us, suspended between the gondola and the balloon, we carried a 64-foot cargo parachute (page 280). If the balloon had failed entirely, this large parachute would have opened to lower the gondola gently to earth. And if the big cargo chute had failed, we could still have bidden the gondola a hasty adieu and used our personnel chutes.

Nevertheless, as Lee said dryly in a radio comment to aircraft tracking our flight:

"This is an unusual experience, and we could have done without it!"

Flights to 100,000 Feet Planned

The ascent was our second in the Navy's Strato-Lab program for a series of manned flights to altitudes ranging as high as 100,000 feet, and perhaps higher. The purpose: studies in aeromedicine, meteorology, atmospheric physics, astronomy, and other fields.

On the first flight, last summer, we had gone to 40,000 feet in an open gondola, with oxygen masks, to study airplane vapor trails. On the second, with a sealed gondola, we hoped to photograph earth and sky from 75,000 feet. With the aid of binoculars and special light filters, we planned to observe sun and stars, as well as auroral particles and sodium distribution in the upper atmosphere.

Until the day of the manned satellite, a



Thomas J. Abernethy, National Geographic Staff

↑ Lewis Tries Breathing at 100,000 Feet

The Navy balloonists learned pressure breathing at Wright-Patterson Air Force Base, whose altitude chamber can duplicate conditions at 200,000 feet.

Here automatic valves force oxygen into Lewis's lungs, but he requires a voluntary effort to exhale. Air pressure distends the fingers of his gloves.

↓ Ross, tested at 100,000 feet, is seen through the control room's two-inch-thick glass.





balloon is by far the best means we have for making such studies in detail, using human observers. A gondola suspended from a bubble of gas provides a stable viewing platform that can hang at a given altitude for hours. Research rockets with automatic instruments, and even manned rocket aircraft, go higher, but they remain only brief minutes on the fringe of the great void.

Thus the purpose of the Navy's balloon program is strictly scientific; altitude records are incidental. Our 76,000-foot mark, while personally gratifying, was not certified as a world record. That would have involved prior arrangements with the National Aeronautic Association.

Medical Tests Made by Radio

Because of our abrupt descent, we could not carry out our scientific mission in the first attempt. But in one field, research in aviation medicine, our colleagues say that we were about 110 percent successful!

Why 110 percent? Because the emergency gave observers an unexpected bonus, an opportunity to record our reactions under stress.

Throughout the flight we bore on our bodies tiny electrodes that picked up pulse and respiratory rates, the sounds of our breathing and heart action, and even the electrical impulses of our hearts (page 274). This information was broadcast from the gondola and recorded at a ground station and in a laboratory aircraft circling far below. Within the plane Capt. Norman Lee Barr, Navy flight surgeon, recorded these telemetered responses. If the readings had indicated dangerous physiological changes, he would have immediately radioed a warning (page 281).

The information obtained is now under study by Navy medical experts.

The day of our flight was a cold one—only three degrees above zero at dawn, our take-off time. We had been routed out of our motel

beds at Rapid City for a steak breakfast at 1 a. m. From that moment on we were borne along in the brisk, minute-conscious program established by the Navy's operations officer, Comdr. Robert C. Cochran, and our principal contractor, General Mills, Inc., makers of the balloon.

Pull on long underwear... have electrodes attached... wriggle into pressure suits... The routine was familiar, even to the pre-flight "bloodletting." For days before and after the flight we submitted to the unpopular needle of Chief Hospitalman W. K. Border, who drew blood samples for analysis.

Getting into our suits, normally a difficult chore, proved easy. The Air Force had loaned us an expert on these tailor-made garments, Lt. Bruce Pinc. Once we had our feet in the pants, this muscular young giant seized the top of the suit carefully and, in turn, lifted us off the floor several times, so that we slid into the fabric like sausage into a skin.

Balloon Thinner than This Page

At the Stratobowl the balloon was a monstrous silver jellyfish straining at its leash. Ground crewmen had begun pouring into it the allotted 40,000 cubic feet of helium.

It heartened both of us to see, striding around the balloon, a tall, thin figure in a "man-from-Mars" pressure suit like ours—Charles B. Moore, our friend, instructor in the art of ballooning, and the *Strato-Lab's* alternate pilot. In 1949, while chief of balloon research for General Mills, Charlie had made the first manned flight with a plastic gasbag. If the polyethylene envelope had some imperfection, he would spot it.

It must seem to the reader that a balloonist pushes his luck rather far when he relies upon a plastic material thin enough to see through. Indeed, Navy polyethylene balloons are only two-thousandths of an inch thick—*thinner than the page these words are printed on!*

But that is the key to success, for it saves an enormous amount of weight, permitting smaller balloons to lift heavier payloads to greater altitudes.

For example, the rubberized-cotton envelope of *Explorer II*—a gigantic 192 feet in diameter when fully expanded—weighed 5,916 pounds with its various accessories. Our own balloon, only 128 feet in diameter, weighed a mere 595 pounds, including valves. In fact, *Explorer II's* ballast alone weighed more than our balloon and its load.

← Wind Tosses the Transparent Bag; Plastic Rips and a Balloon Dies

When this duplicate of the *Strato-Lab's* envelope was inflated at a mooring post near New Brighton, Minnesota, winds of 8 to 12 miles an hour tore the bag. To escape tricky ground-level gusts, the balloonists took their equipment to South Dakota's Stratobowl, a natural depression shielded by 500-foot hills (page 276).

In this view the plastic inflation tube extends across the bag like a drawstring. A small pilot balloon in the upper right indicates wind drift.

The gondola, housed in a small tent, had been strung up like a giant's kettle between four stout poles—the same poles that supported the *Explorer II* gondola. Still sound, they had remained in the bowl for 21 years.

And still sound, though a mellow 10 years old, was our own shiny *Strato-Lab*. Despite its newly minted appearance, the gondola had been built in 1946 for a proposed Navy-sponsored stratosphere flight to be made by the renowned balloonist Dr. Jean Piccard. That plan was abandoned, principally because of the limitations of plastic films then being investigated for balloon use.

For the *Strato-Lab's* equipment, modifications, and general spick-and-span appearance, we could thank both General Mills and another able contractor, Winzen Research, Inc., of Minneapolis, Minnesota.

Scale Checks Balloon's Free Lift

A coffee break . . . a final check on our pressure suits . . . the minutes slipped away. Suddenly it was time to go, and we crunched across a frozen field to the gondola, now suspended beneath the balloon, and clambered awkwardly inside.

To launch with sufficient rate of rise, thus overcoming drift that might dash the gondola against a hillside, we had to have a certain amount of free lift—excess of lift above the amount required merely to suspend the load.

This can be determined by the pull of the balloon against a scale.

With the aid of the two ranking General Mills engineers for Project Strato-Lab, Harold Froehlich and Dick Schwoebel, the weight was carefully checked against the free lift and adjusted. Then a pilot balloon was released to check wind drift.

"I lost it," Lee said from the upper hatch.

"It looked good to me," Charlie Moore belted. "Of course, if you're ready to chicken out, I'll go."

We both laughed. It was a little late to "chicken out," or lose one's nerve.

"Seriously, Lee," Charlie shouted, "it went straight up and was well above the rim when it cleared. We'll let another one up."

The second was reported equally successful.

"Good-o, Charlie," said Lee.

"Harold, are you ready?" Mal asked. Froehlich nodded from beneath the gondola.

"All set, Lee?"

"Ready, Mal."

"Let her go!"

We were airborne. The time: 6:19 a.m.

"Lee, how are we doing?" As yet, Mal could see nothing through the lower hatch.

"Fine. We're going straight up."

"Are we clear of the rim?"

"Not yet. We're about even with the trees. We're starting to rotate . . . I can't see the edge."

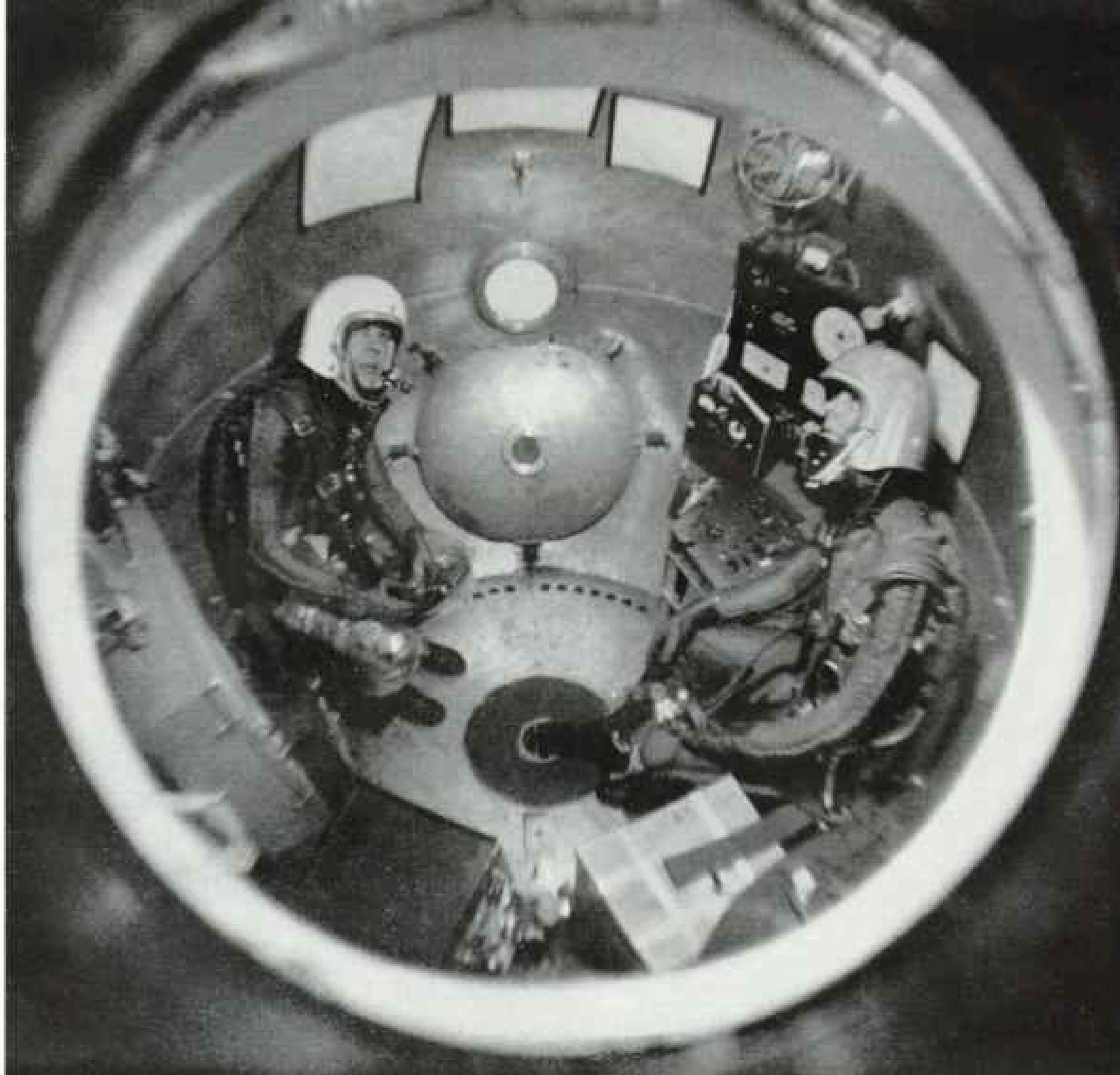


Navy Technician Wires a Pilot for Medical Examination by Radio

Each balloonist carried three electrodes attached to his body and a miniature amplifier to feed the readings into an airborne transmitter.

Sounds of heart and respiration, and pulse rate—five reactions in all—were broadcast to the flight surgeon in a plane circling below (page 281). Had any grave abnormality developed, he would have ordered an immediate descent.

Ross's telemetering equipment is checked on an oscilloscope, where a blip of light moving across the screen represents the heartbeat. Like an electrocardiogram, it shows the heart's electrical activity.



Helmeted Aeronauts, Seen Through a Hatch Cover, Take a Dry Run into Nowhere

Shortly before flight day the pilots strapped on parachutes, climbed into the gondola, practiced take-off procedures, and went over check lists. They were photographed with an ultra-wide-angle plastic lens, only one of its kind, made by a General Mills engineer to scan balloon interiors.

Strato-Lab's gondola is a forerunner of space cabins. Its equipment feeds an oxygen-enriched atmosphere to the pilots and maintains an atmospheric pressure equivalent to 17,000 feet. Chemicals remove carbon dioxide and water vapor.

Diagram identifies men and instruments. Radio equipment is not in view.



1. Lieutenant Commander Lewis.
2. Bottom hatch.
3. Observation porthole.
4. Operating charts and notes.
5. Air-circulation fans.
6. Instrument panel: clock, altimeters, rate-of-climb indicator, and temperature gauges.
- 6a. Wallace & Tiernan precision altimeter.
7. Carbon-dioxide analyzer.
8. Control panels.
9. Lieutenant Commander Ross.
10. Recording unit for gamma-ray telescope (removed before flight).
11. Oxygen converter.
12. Air regenerator.



"I can see the trees now, Lee. I see cars on the rim. We're clear!"

The ascent was beautifully routine. At 6,500 feet we reported by radio to the Strato-bowl. Rate of climb was 500 feet per minute.

By 10,000 feet Lee had closed the two hatches and turned our oxygen to full volume. While securing the upper hatch, he saw that someone had pasted on it a caricature of an Indian. The chief's face bore a broad smile, though a dozen arrows had pierced his forehead and chest. Below him were the printed words, "Keep Smiling—Have Faith," and a handwritten farewell, "Good luck!"

Sunlight streamed in the ports, illuminating the gondola, and Lee radioed to the ground a set of instrument readings. He added that we were "calm, confident, and feeling well."

At the tropopause, 36,500 feet, *Strato-Lab*

slowed to a relative crawl. Apparently she had hit a restraining mass of warm air. Regrettably—for balloonists hoard their ballast—Mal pressed a button and released five pounds of fine steel dust from hoppers outside the gondola. Minutes later he dumped five more.

The climb continued; then slowed again at 55,000 feet.

"Our rate of ascent is not satisfactory," Lee radioed. "Five pounds of ballast was just sprayed into the stratosphere."

That did it. Up we went once more; so we opened thermos bottles and took a coffee break. Only one thing seemed amiss: where was the calm, familiar voice of Dr. Barr?

He was more than our physician. His background as an engineer, research scientist, and veteran pilot gave him unique qualifications for advising the *Strato-Lab's* crew. As it in

← A Plastic Jellyfish Tugs at Its Moorings in the Stratobowl

Page 276: Dead calm pervades the bowl shortly before take-off at 6:19 a.m. Light from automobile lamps, photographers' flash bulbs, and movie-makers' floods glints on the snow. The temperature is 3° F.

Shaped like an inverted teardrop, the envelope holds 40,000 cubic feet of helium. A lamplit tent that housed the gondola gleams on the right. Ranch house at lower right belongs to the owner of the Stratobowl.

Here, on an equally cold and snowy morning in 1935, a U. S. Army Air Corps-National Geographic Society expedition sent the balloon *Explorer II* to the world's record altitude of 72,395 feet.

Dawn Streaks the Sky; → the *Lab* Is Ready to Go

Nylon webbing tested for a 6,000-pound pull encircles the aluminum sphere. The gondola itself, resting on a plastic-foam bumper, wears a shroud of polyethylene as insulation against cold. To maintain a balanced temperature, the top is painted a ray-reflecting white and the bottom a heat-absorbing black.

Physicist Charles B. Moore, standing by as an alternate pilot, holds a wind-drift balloon. The authors' coach in aeronautics, he made the first flight in a plastic balloon (1949).

Hubert P. Strom, National Geographic Staff



answer to our unspoken question, he came on the air and reported that frozen brakes had delayed the take-off of his flying laboratory.

At 8:47 a.m. we gave our altitude as 70,500 feet, with a gondola temperature of 38° F. and a relative humidity of 60 percent.

When the *Strato-Lab* leveled off at 76,000 feet, our sense of isolation from earth could not have been more complete.

The interior of the metal sphere was pleasantly sunlit; the temperature rose to a comfortable 40° F. We breathed with ease, for the atmosphere of our lofty chamber seemed fresh as a sea breeze.

Just the same, we kept a careful check on the instrument that registered oxygen pressure. Our lives depended on its reading.

We had now ascended above 96½ percent of the earth's atmosphere. Only a ⅛-inch thickness of aluminum separated us from a near-vacuum. A leak could have whisked away our life-giving gas, fed into the gondola from a five-liter tank of liquid oxygen.

But the reading held steady. Though the cabin had been pressurized at the equivalent of 17,000 feet, we were breathing an atmosphere in which the oxygen content had been enriched to a point slightly higher than that at sea level. Meanwhile, chemical absorbents were keeping our carbon dioxide and moisture content well within tolerable bounds.

"Firmament of Surpassing Beauty"

As we neared top altitude, Lee rubbed the frosty condensation from one of our Plexiglas side ports and peered out. "Malcolm," he exclaimed, "look at this!"

The earth was almost totally hidden by cirrus clouds, but from the horizon up we gazed upon a firmament of surpassing, breath-taking beauty.

To us as meteorologists, the sky's appearance was meaningful and extremely interesting. Unfortunately, we had only brief minutes, instead of hours, for study, and our observations did not agree entirely.

To Lee the sweep of sky adjacent to earth seemed an intense white, but this intensity vanished almost immediately above the horizon. It became part of a band of white, several degrees in width, that shaded to a very delicate blue-white at its upper extreme. Here, with definite demarcation, the sky changed to blue, light at first but soon deepening to the shade we knew as earth dwellers.

Above that narrow band of familiar blue—and again abruptly—the color gradually darkened into a hue seemingly alien to the sky, a magnificent shade indescribable in its richness.

Thus Lee saw two narrow bands, one of white and one of light-to-medium blue, and the second was terminated by a well-defined deeper color. Mal, on the other hand, saw the distinct white band, but the blue above it shaded very gradually into the darker tones.

From the upper port we could see 20° from zenith. There the sky appeared nearly pitch black to both of us; yet, to our disappointment, we saw no stars.

"This Is an Emergency..."

It was time to get to work. We groped in equipment bags for cameras and light meters. The first order of business would be a picture of the instrument panel. Lee stretched out his hand to accept a camera—and at that moment it happened.

"We're going down," Mal said. It was not an exclamation; his voice was puzzled, almost disbelieving. But the altimeter needle was dropping.

Quickly we jumped into our seats, fastened safety belts, and hooked faceplates on our pressure helmets—emergency procedure.

To each of us the association of hitting ceiling and starting downward meant but one thing—our balloon, in some unknown manner, had superpressured, or built up too much pressure of helium. We knew the capabilities of plastic balloons; the degree of superpressure they could withstand was almost infinitesimal. Doubtless the envelope had burst.

Now would come the long, sickening plunge to mid-altitudes. Our cargo parachute would blossom in the stratosphere, but the atmosphere there lacked sustaining density. We must brace ourselves for a fall of thousands of feet per minute before the chute took hold.

Suddenly the descent rate quickened. Our stomachs seemed to rise and float around within our bodies. It's the same initial sensation one gets in a fast elevator descent, but greatly enhanced and prolonged.

Lee hit the radio transmitter button and began broadcasting an urgent distress message. As he released the button, the voice of Dr. Barr filled the gondola:

"...congratulations. Congratulations on a fine flight!"

Mal clasped both hands to his helmet and

burst out with a loud, incredulous, "What!"

The explanation then occurred to us. Dr. Barr had been talking when the distress message went out. He hadn't heard it.

Again Lee described the situation, and this time Dr. Barr's unruffled voice requested instrument readings. Once more we had failed to communicate with him.

"I cannot give them to you at this time," Lee replied. "I cannot give them to you. We are in an emergency situation. We hit 76,000 feet, and now we are descending rapidly. We are standing by to pass 70,000. We are buckled in with our seat belts. No shoulder harness. We have our faceplates on but not down. We are rotating and have a decided elevator feeling. Passing 70,000 feet."

Colleagues Note Rate of Fall

While Lee paused for breath and to regulp his stomach, Mal transmitted.

"All stations, All stations. This is an emergency. An emergency situation. We can read our altitude. Please keep track of it so you will know what our rate of descent is. We are coming down to 68,000 feet. Stand by. Mark!"

He continued calling off the altitudes, "marking" each as it passed. By then everyone knew we were in real trouble.

The elevator feeling lessened at 63,000 feet, then disappeared. This was confusing, for we had thousands of feet to fall before the chute could "bite in." Looking up, we saw the blessed balloon was still there and we became even more puzzled. If it had developed a rent, the polyethylene should be in tatters by now.

Perhaps the electrically operated valve in the top of the balloon, used to release gas in descending, was open. But a check of the control panel showed the valve closed.

We exchanged glances; there was no need for words. We had functioned as a team for most of a five-year period. The next move was apparent to both of us.

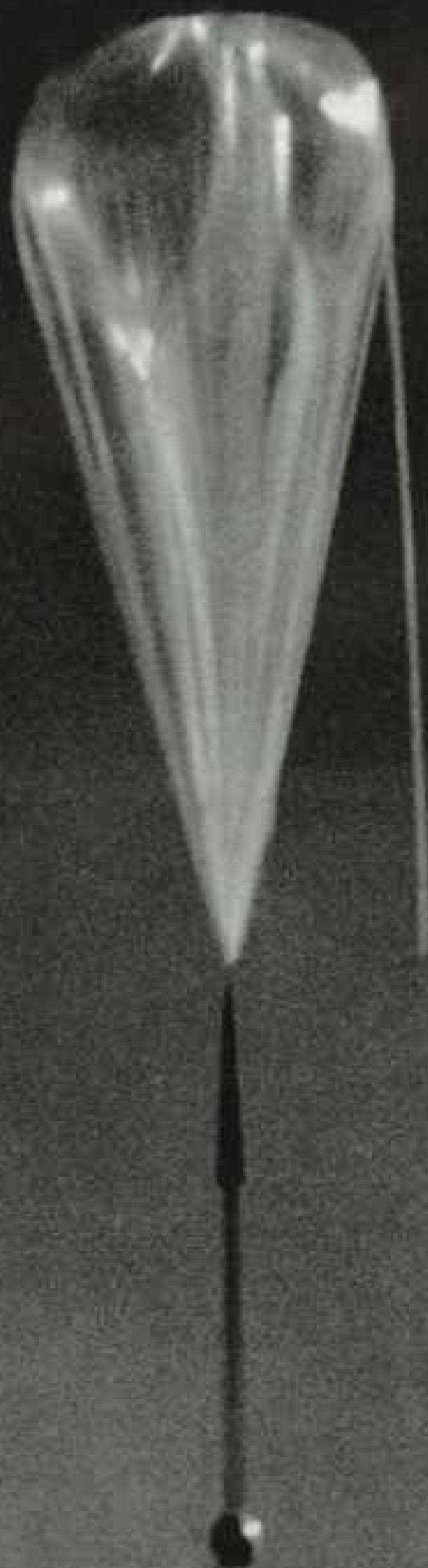
Lee informed Dr. Barr that the *Strato-Lab* would dump ballast and explained our reasoning. We were convinced that we would have to release the balloon and use the cargo parachute at some lower altitude. But there was no reason to shock-load the chute with unnecessary weight.

So, as we passed 58,000 feet, Mal pressed the button and showered out 165 pounds of ballast, but with no immediate result. Mo-



A Ghost in Infinity, *Strato-Lab* Floats at a Record 76,000 Feet

The National Geographic photographer took this shot with a telephoto lens from an Air Force jet flying at 42,000 feet. Moments later he saw the balloon dropping some 4,000 feet a minute. An automatic valve for dumping excess helium failed, releasing a burst of gas. Clouds at 25,000 feet hid the sight from ground observers.



ments later, however, the descent rate slowed.

While reassuring, it by no means ended our danger. For various and complex reasons, a descending balloon accelerates in the troposphere. If we went down too fast, masses of cold, slack plastic might flutter and tear.

We had been using an airways radio channel, and our voices had attracted two private aircraft. One of the pilots, who must have been descended from a box holder at the Roman spectacles, radioed his friend in the other plane:

"Don't go yet. They're going to jump any minute now."

We didn't quite appreciate this viewpoint!

Dr. Barr, from the Navy aircraft, radioed a "mayday" call, or S O S, and effectively cleared the channel for our exclusive use. Now we could talk to Dr. Barr, and he told us we were over South Dakota's rugged Badlands. Stay with the balloon as long as possible, he advised, and let it drift farther south.

Ballast Gone, Fall Rate Increasing

We drained the rest of our ballast; now there was none to help in landing. At 35,000 feet the descent rate began to creep up; it passed 1,000 feet per minute...reached 1,200...1,500... But, once we were well within the troposphere, the rate did not increase; surprisingly, it varied between only 1,300 and 1,400 feet per minute.

Another wordless conference ensued. We could press a button that would set off a dynamite squib and free the balloon from the gondola. But should we rely upon the cargo chute? It might carry us into the Badlands, where the gondola could roll down a mountain. Landing with personnel chutes wouldn't be much safer. Why not stick with it?

Our ballast had been dumped by actuating valves in the bins outside the gondola. But these bins were so constructed that not all of the steel dust would drain off through the valves. Some 20 pounds, which we called residual ballast, still remained.

← Going Down! The Bag at 35,000 Feet

At this altitude the *Strato-Lab* entered a denser layer of atmosphere, and the authors feared that acceleration would tear the shrinking plastic envelope. In that event, they planned to release the balloon with an explosive charge and bring the gondola down with the cargo parachute (between ball and bag). If that failed, they would jump in their own chutes.

However, the balloon held together. By dumping all ballast and 200 pounds of equipment, the pilots slowed their descent and landed safely. (page 282).



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✦ Flight Surgeon, at His Desk Aloft, Coaches the Balloonists by Radio

From aviation, in which he piloted Army Air Corps planes and commercial airliners, Captain Barr turned to medicine. Graduated, he became a naval aviator and flight surgeon.

In this laboratory plane Captain Barr tape-recorded the Lewis and Ross heart and breath actions broadcast from the balloon. Here he is advising them not to parachute into the South Dakota Badlands.

➔ At a window of his plane, Captain Barr strains for a sight of the terrain toward which the balloon is drifting.

Robert F. Flinn, National Geographic Staff

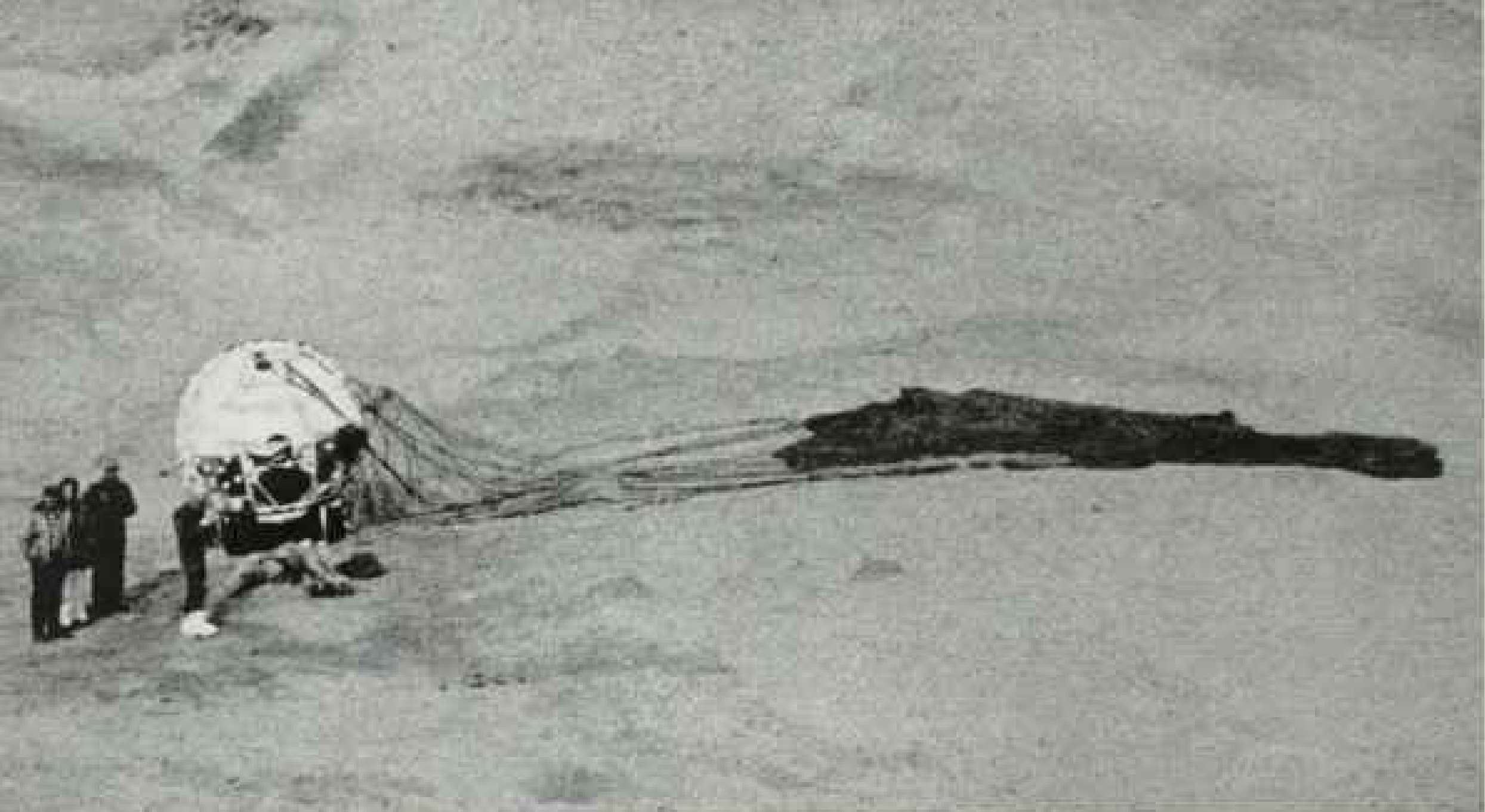
It could not be jettisoned in the normal fashion, but it could be blown out. Now Mal closed a switch, and dynamite caps tore holes in the bottoms of the containers.

At 17,000 feet, when outside air pressure equaled interior pressure, the hatch covers popped open. A quick glance below revealed that we were over desolate terrain, and we began heaving things out: oxygen converter, instrument panel, radio, trays of chemical absorbents, oxygen analyzer, air regenerator.

Most of the equipment had been bracketed down in a manner that facilitated easy removal during an emergency. But some pieces simply had to be uprooted and torn out.

When the air regenerator went overboard, we sprawled near the hatch, completely jaded, and watched it fall with small-boy interest.





Each of us tried to guess the moment of impact, exclaiming "Now! Now!" Meanwhile, we were only 7,000 feet high and descending better than 1,000 feet per minute.

The hatch covers stayed with us until the last minute. At several hundred feet above earth we jettisoned one of them, jumped into our seats, and fastened safety belts. Lee kicked the second cover out at 30 feet.

Our final task, firing the explosive charge that would sever the balloon from the gondola, had to be judged to a nicety. If the balloon were freed too soon, we would fall like a stone. If too late, we would hit, bounce like a ball, and then fall heavily.

As a safeguard against accidental release, two switches had to be closed before the firing mechanism would work. Mal threw the first one and, seconds later, just at the moment of touchdown, Lee closed the second. The gondola rolled to one side, rebounded to an upright position, and was still. We had been aloft four hours and four minutes, slightly less than half the anticipated flight time.

Injuries? Not so much as a scratch. The descent rate at impact, about 800 feet per minute, had been double the normal landing speed, but a thick Styrofoam pad beneath the gondola cushioned shock.

We clambered out, shook hands, and took a long, appreciative look at our surroundings. In the distance we saw our balloon, floating away on the wind. It was later picked up, intact, 15 miles southeast of our landing place.

Our colleagues say we landed in a bleak, desolate, sandy basin. Well, they're literal-minded; to us that spot in Nebraska will always seem as beautiful as a flower garden.

↑ Gondola Lands on a Nebraska Ranch; Visitors Gather Quickly

Unused cargo parachute has collapsed at the end of its lines. Cut loose at the moment of impact, the gasbag has drifted off; it was recovered intact 15 miles away. The extreme fragility of polyethylene balloons forbids their use a second time. Usually they are given to the finders. Farmers prize the material as a wrapper for foods in the deep freeze. The same substance is used for bags in which housewives buy carrots, oranges, and other produce.

This view was shot from the flying laboratory.

↓ Admirers of Capts. Albert W. Stevens and Orvil A. Anderson, who piloted *Explorer II*, the aeronauts unfurl the flag of the National Geographic Society, co-sponsor of the record-breaking 1935 flight. Their feet are bundled in polyethylene to shut out cold. Photograph was made by an airplane pilot who followed the balloonists down.



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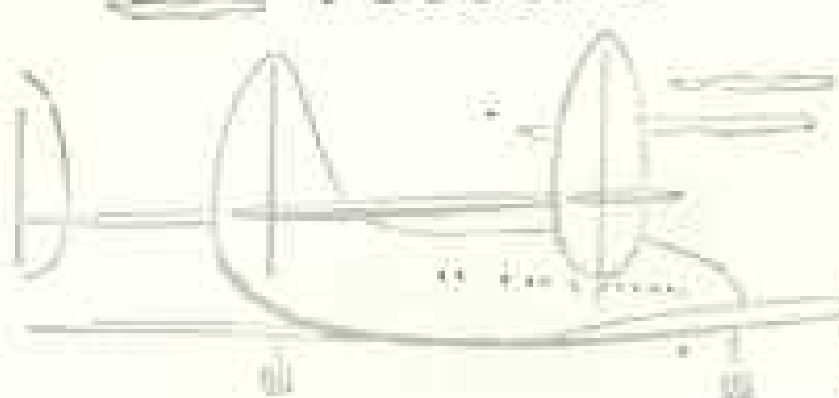
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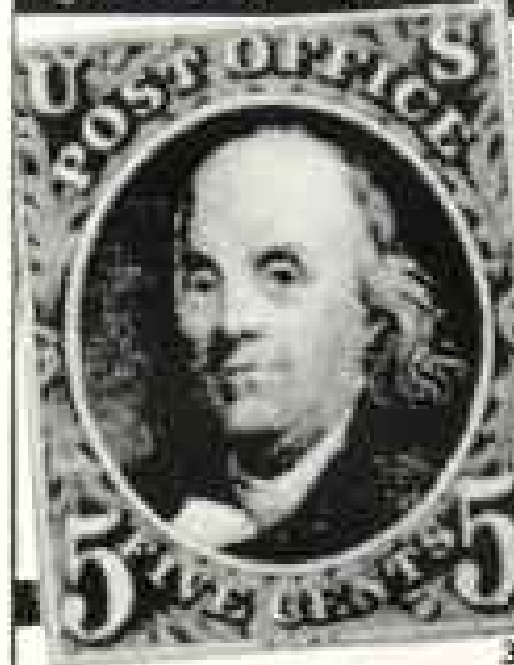
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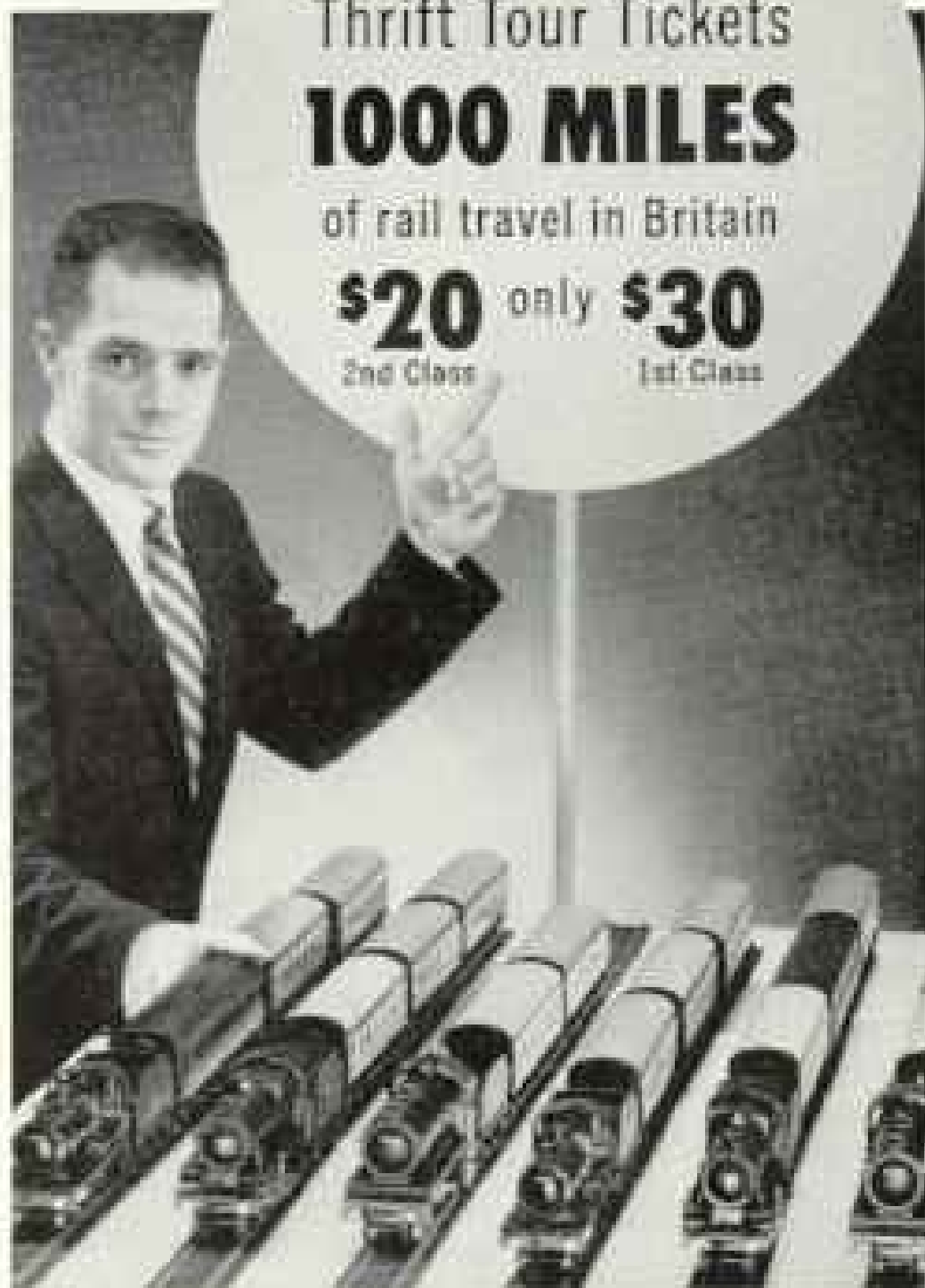
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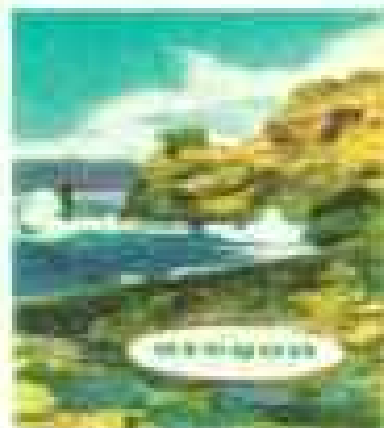
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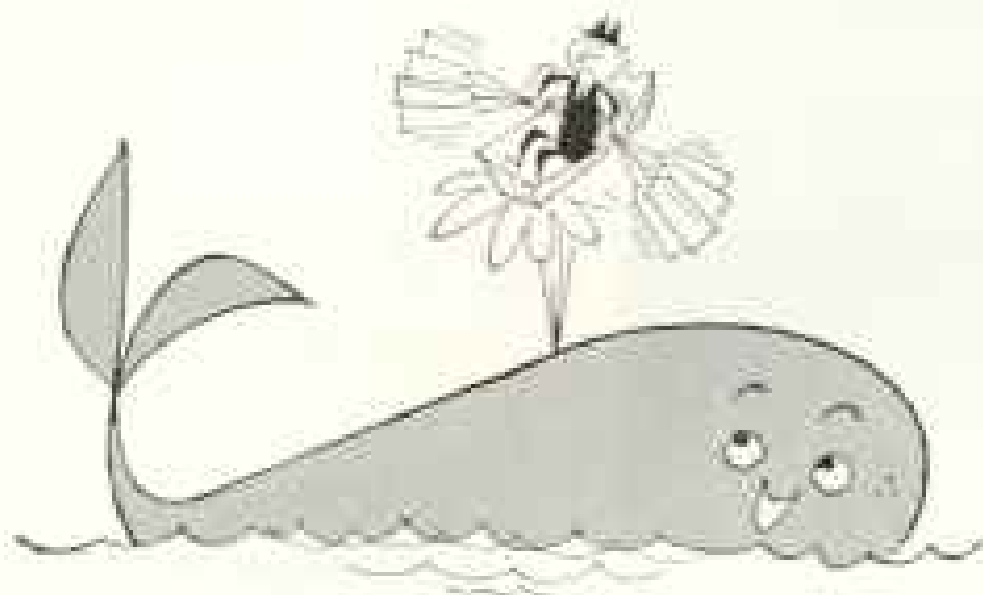
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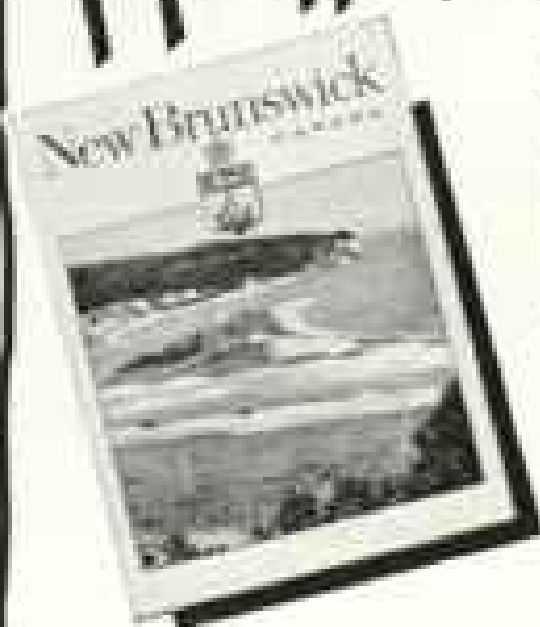
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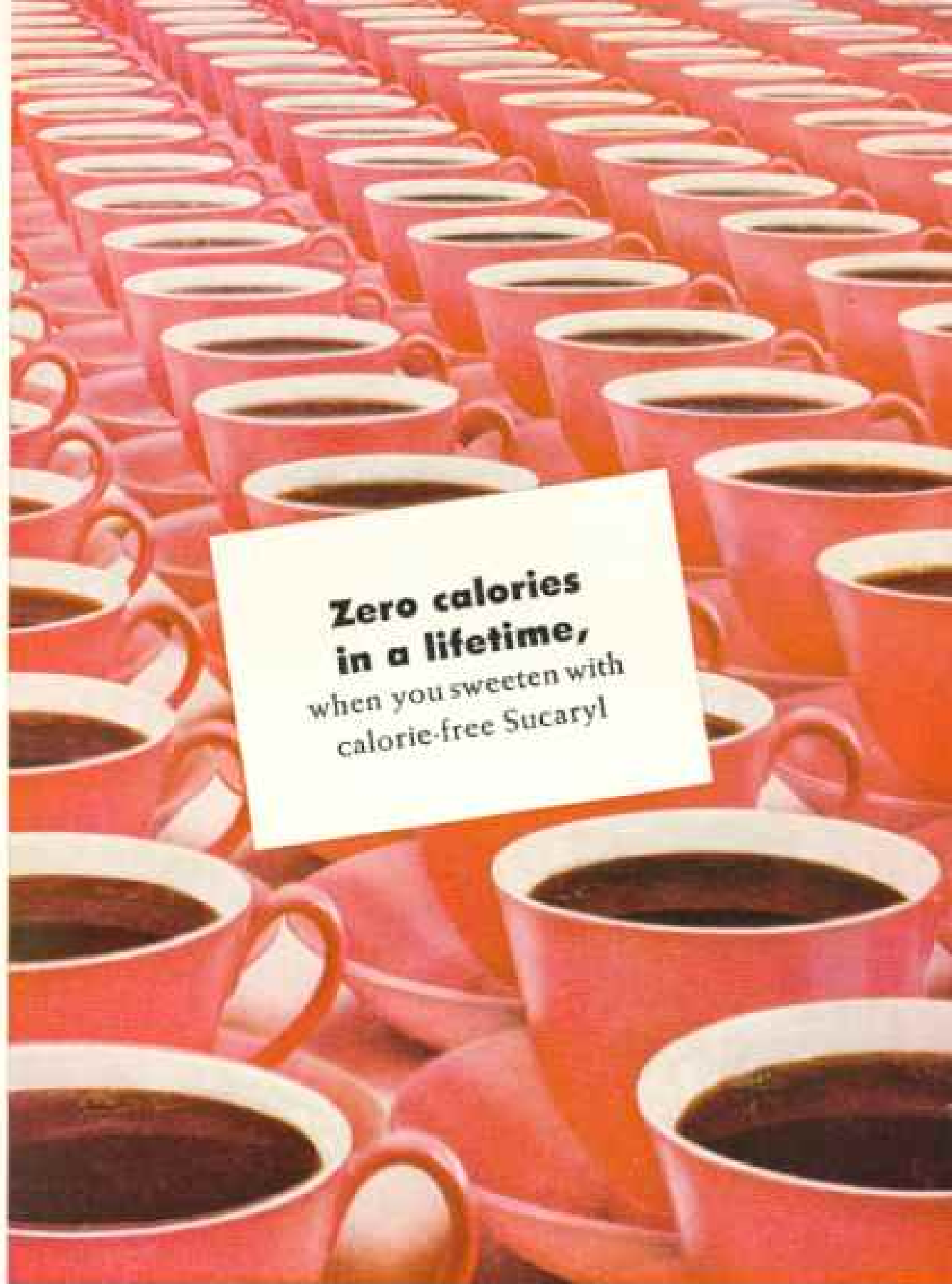
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