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Burma

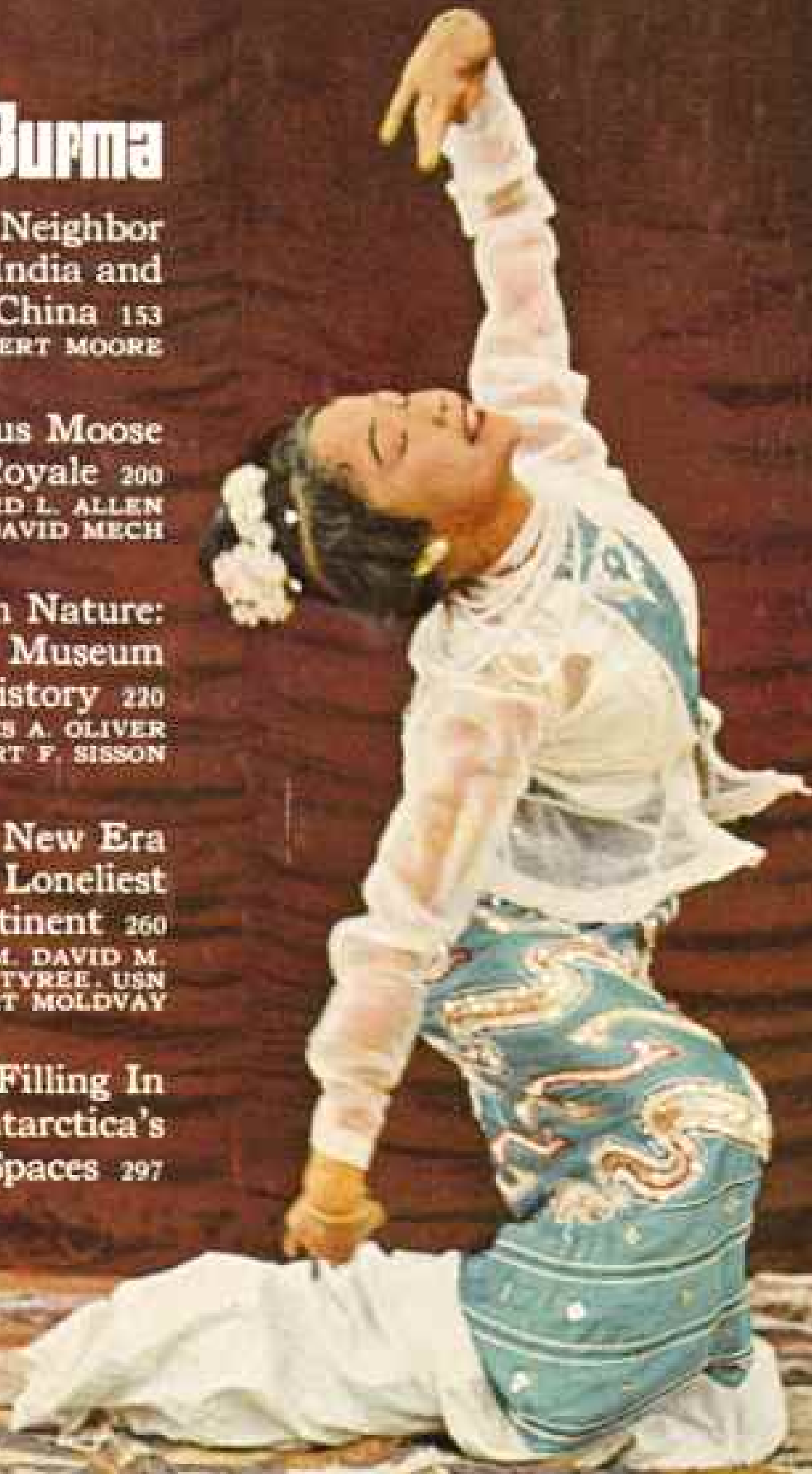
Gentle Neighbor
of India and
Red China 153
W. ROBERT MOORE

Wolves Versus Moose
on Isle Royale 200
DURWARD L. ALLEN
AND L. DAVID MECH

Window on Nature:
American Museum
of Natural History 220
JAMES A. OLIVER
ROBERT F. SISSON

New Era
in the Loneliest
Continent 260
REAR ADM. DAVID M.
TYREE, USN
ALBERT MOLDVAY

Filling In
Antarctica's
Blank Spaces 297



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MARCO POLO came to Burma over the high wild hills of southwestern China and described with astonishment the gold and silver spires of the country's ancient capital, Pagan.

I came to Burma 700 years later by jet airliner and saw golden spires gleaming above the present capital, Rangoon.

But where Marco found a 13th-century Burma broken asunder by invasion—that of the great Kublai Khan of China—I found a free Burma determining her own destinies.

Where the Burma of Marco's day looked out across its mountainous borders at a world overshadowed by the great Khan's power, I found a Burma flanked by nations increasingly enmeshed in a struggle between Communist and non-Communist camps.

Modern Burma, home of 21½ million people, lies strategically between Communist pressure points in Southeast Asia. To the northwest, a long-simmering border dispute between India and Communist China burst forth last November into a massive Red Chinese invasion of India. To the east, Thailand anxiously watched the precarious neutrality of Laos and South Viet Nam's war to wipe out Red guerrillas (maps, page 160).

Cares Swept Away by Festival

Yet Burma seemed curiously isolated from the struggle, especially when its people succumbed to the spirit of festival that marks their frequent holidays. I well remember the scene in Rangoon on January 4 of last year, when Burma celebrated her 14th anniversary as an independent nation.

As in 1948, when the British turned over full sovereignty to the Burmese, high officials gathered in predawn darkness to salute the raising of their six-starred flag—at 4:20 a.m., the auspicious moment chosen by Buddhist astrologers. Later there was a four-hour parade. By night, floodlights lit government buildings; outdoor stage shows presented comedy and other drama, songs, and dances.

As I watched the spectacle, I had the feeling that the Burmese, as a people, didn't have a care in the world. Certainly no other people in all Asia have a more delightful capacity for enjoying life.

Yet, I knew better. During several visits to Burma, I had seen its people working hard to offset the disasters of World War II and the

Actors at Mandalay perform a puppet-style dance. Costumes hark back to the days of the monarchy a century ago.



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Burma

GENTLE NEIGHBOR OF INDIA AND RED CHINA

By W. ROBERT MOORE

Chief, Foreign Editorial Staff

Photographs by the author

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Burma-born statesman U Thant, Secretary-General of the United Nations, contrasts the New York City skyline with scenes of his homeland illustrating this article. The "U" in his name is an honorary title, literally meaning "uncle."

succeeding years. Japanese invasion and Allied liberation left many towns blasted. Even as nationalist leaders sat planning independence, seven of their number were assassinated by political rivals. Where Marco in his day found the countryside "abounding in elephants and unicorns and numbers of other wild beasts," modern-day Burma has known terror from Communist insurgents and armed marauders roving her interior.

"When you consider the tremendous tasks the government has had to face, it is remarkable what it has accomplished," a former British official told me. "The people began with little more than optimism and an enthusiasm for independence. Few leaders had been outside Burma, and no one had much of an idea of government or foreign commerce. The Burmese have had to learn by hard work. And they're getting ahead. Witness, for example, Secretary-General U Thant of the

The Author: W. Robert Moore, Chief of NATIONAL GEOGRAPHIC's Foreign Editorial Staff, knows Burma well. While living and teaching in neighboring Thailand, he visited Burma to provide first color photographs of Shan hill tribes (August, 1930, and October, 1931, *GEOGRAPHICS*). He revisited Burma during its first year of independence in 1948 and again in 1954, 1959, and 1962.



Cars, carts, buses, bicycles, and taxis



ORGANIZED BY W. ROBERT MOORE, CHIEF, NATIONAL GEOGRAPHIC STAFF © N.G.S.

through Rangoon's broad Maha Bandoola Street. Sule Pagoda spires skyward



United Nations, a former schoolteacher" (page 154).

Rangoon also was getting ahead. I had seen the city in the early months of 1948, shortly after the British turned over control. Barbed wire encircled all the government buildings and homes of the ministers, protection against threatening civil strife. Rude huts of thatch and bamboo cluttering the city were crowded with thousands of refugees from a restive countryside. It was unsafe to venture outside town.

The barbed wire has long since gone; so have the bamboo huts. Bombed buildings have been repaired or replaced by new structures. And the refugees have returned home or moved to satellite towns, built on former rice lands just north and east of the city.

Business has increased. More ships now swing on the swift, muddy tide of the Rangoon River. More produce boats come down-

Rangoon Traffic Swirls Around Gold-covered Sule Pagoda

Rangoon derives from Yangoon, "end of strife," a name given to the city by its founder, King Alaungpaya, in 1755, following his victory over the Mons, inhabitants of southern Burma. Most of its buildings rose during 96 years of British occupancy. Many were damaged by bombs during World War II. Small shops encircle the base of Sule Pagoda, axis of the business district.

Schoolgirls on the march twirl flower-decorated hoops on Independence Day in Rangoon. Communist insurgents and political splinter groups have plagued Burma since it gained freedom on January 4, 1948. The federal republic retains no Commonwealth ties with the United Kingdom.



KERACHONGET © NATIONAL GEOGRAPHIC SOCIETY

Sisters carry their sandals on a visit to Shwe Dagon Pagoda, Rangoon's noblest Buddhist shrine (page 163). They wear matching *longyi*, saronglike garments used by both men and women, and flowers in their hair. Temple custom forbids the wearing of shoes.



stream on bellying sail. Launches, barges, and brilliantly painted sampans, scuttling about like water bugs, carry passengers and bring fruit and vegetables to market.

In port I saw many freighters loading rice. Almost two-thirds of Burma's cultivated land is devoted to rice. Before the war, Burma was the world's foremost rice exporter, shipping some 3 million tons of its 7½-million-ton crop. But during the war, and in the disruptions that followed, much paddy land lay untilled. Many rice mills were burned. Now, despite the destructive floods of 1961, production again is near the prewar rate.

Head of Army Seizes Power

Though Burma's day-to-day life appears easygoing, change can come swiftly. In the early-morning hours of last March, General Ne Win, the head of the army, took over the government against what he described as a rapidly deteriorating political situation. He cited the threat of insurgency and pressure from some Burmese states for greater local autonomy. He abolished parliamentary government, arrested Premier U Nu, and established a 17-member Revolutionary Council which announced it would "march toward socialism in our own Burmese way."

It was General Ne Win's second entry into the government. In 1958 he had stepped in at Premier U Nu's request; for a year and a half he had fought Communists and other guerrillas, attacked inefficiency in government offices, and cleaned up the appearance of several towns, including Rangoon.

"The only trouble," a Burmese friend told me, "is that we Burmese don't like too much efficiency. We're a stubborn, independent people."

And an astonishingly diverse people, too, whom Burma must meld into a cohesive nation. Each year on Union Day, February 12, representatives of many racial groups meet in Rangoon to renew their pledge of cooperation.

Early on Union Day morning, I arrived at the City Hall just as traffic around the golden-spired Sule Pagoda (pages 155 and 156) came to an abrupt halt. Around the corner marched

a cheering procession of tribal folk in bright beads, masses of silver bangles, and belts and leg bands of metal and cane. By their distinctive turbans, broad hats, feather-and-bead bonnets, and contrasting patterns of dress, I recognized Shan, Kachin, Chin, Akha, Karen, Bre, and the near-nude Naga.

These people from the remote sections had come to their capital as guests of the government. They represented frontier groups which in 1947, shortly before Burma gained her independence, met with the Burmese in up-country Panglong to pledge full union. The speeches this Union Day re-emphasized the theme of the earlier meeting, that all indigenous people should enjoy the privileges of citizens and share the same responsibilities.

Migrations Create Patchwork of Peoples

Few countries in the world encompass as many diverse minorities as does Burma. Among the 21½ million inhabitants of this Texas-size land, barely three-fourths are Burmese. Some three million are Karens, and on the plateaus of eastern Burma live more than a million Shans. Kachins occupy the mountainous north, Chins the western hills. Settlements of other hill folk dapple many ranges. In all, Burma today holds some 126 racial, tribal, and ethnic groups.

Though Burma often has been divided into small states, strong kings several times welded it into a unified kingdom. The first and most illustrious was King Anawrahta, who established his capital at up-country Pagan in the mid-11th century and ushered in Burma's golden age of temple building.

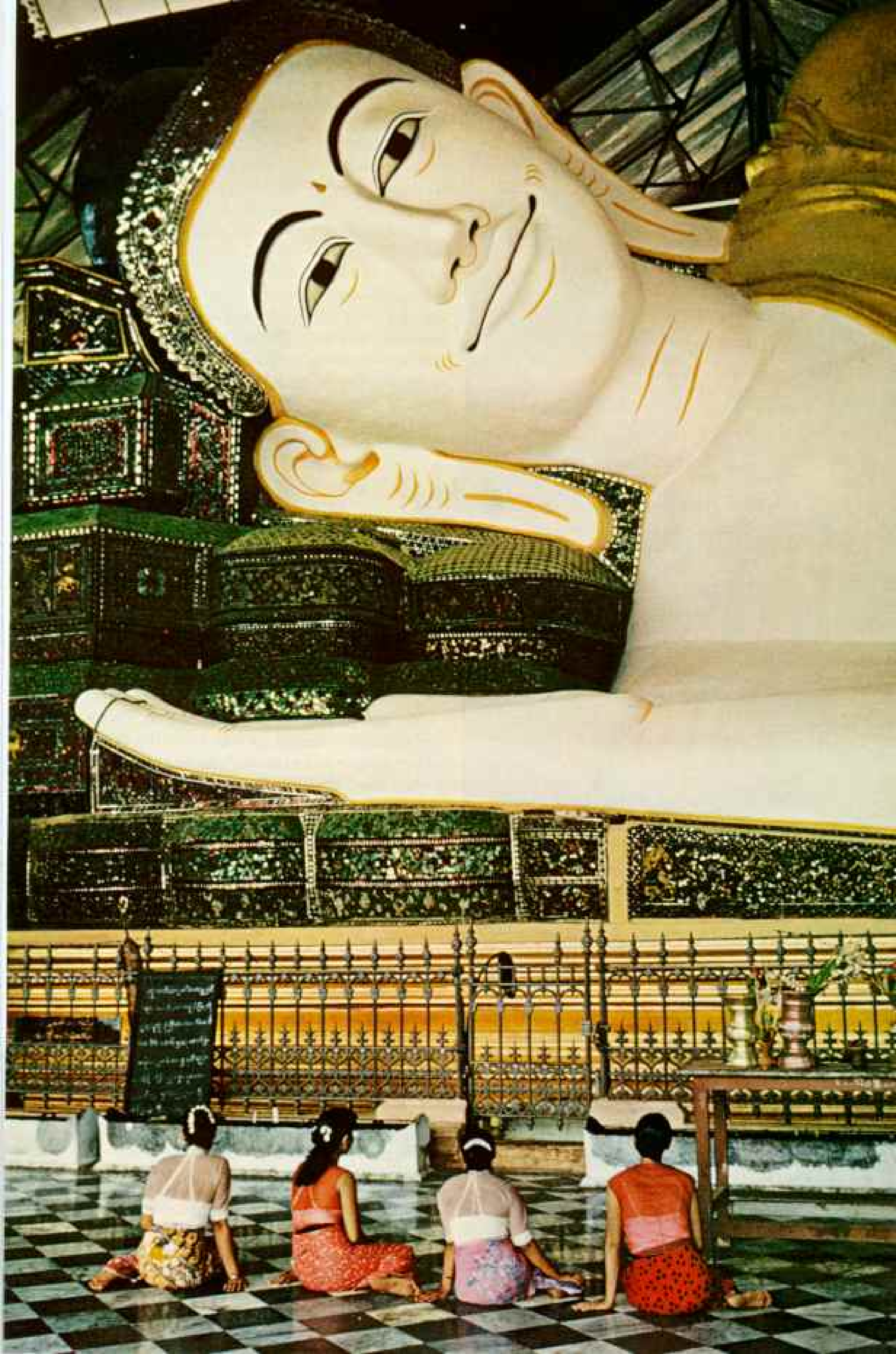
Similarly, Burma today seeks to build national unity and economic strength. Government agencies and development corporations guide the nation's key industrial and commercial enterprises.

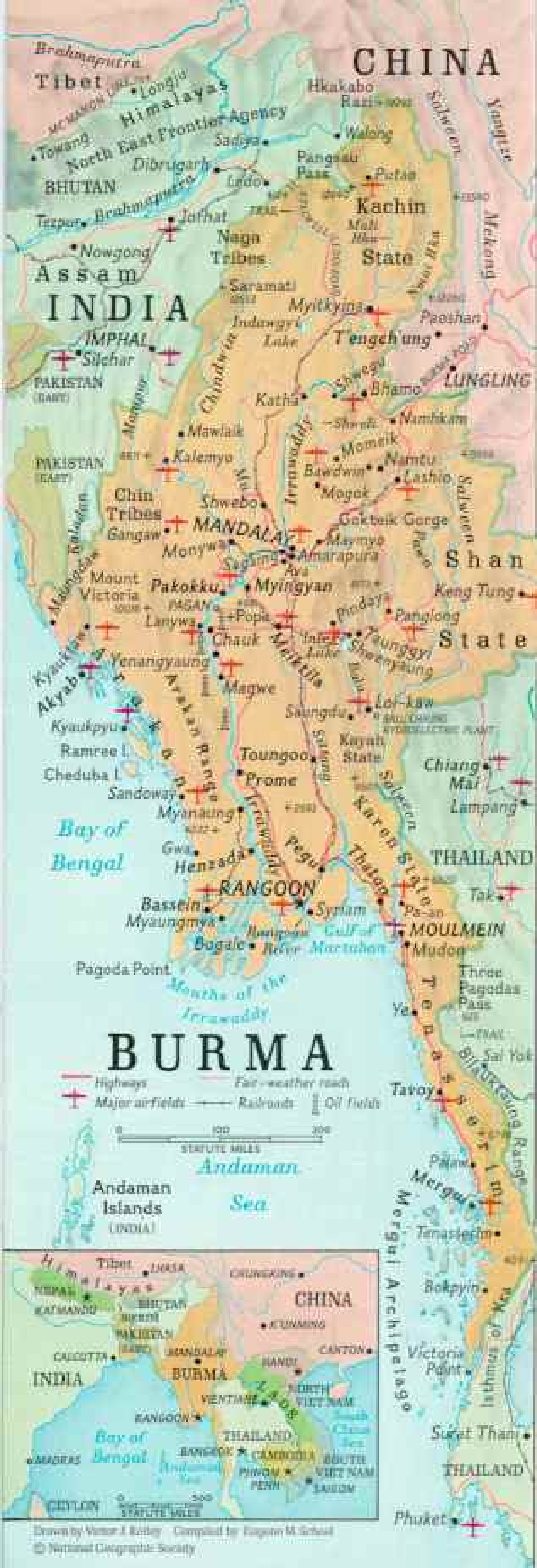
Economic aid from the United States helps the independent Burmese Government in various projects: to improve communications and the water supply; to modernize transportation on the rivers; and to survey a new road from Rangoon to Mandalay.

"Among the most spectacular tasks here," said a representative of AID, the U. S. Agency

Serene Face of Pegu's Reclining Buddha Rests on Mosaic Glass Cushions

Known as the Shwethalyaung, the figure stretches 181 feet and rises 46 feet at the shoulder. Supposedly dating from A.D. 994, it vanished beneath jungle growth after King Alaungpaya destroyed Pegu in 1757. Railroad builders rediscovered it in 1881.





for International Development, "is the reclamation of flooded and war-abandoned rice lands in the Irrawaddy Delta. We provide machines, and the Burmese rebuild dikes and mulch brush into the soil. They have already reclaimed 800,000 acres and protected another 755,000 acres from flooding."

I saw some of the dike building. With Burmese officials of ARDC, the nation's Agricultural and Rural Development Corporation, I crossed the Rangoon River before dawn one day and rode eastward across the paddy fields to the coast. There, snorting bulldozers and earthmovers worked on a dike that was to be 10 feet wide, 5 feet high, and 18 miles long. It would redeem 13,000 acres.

"The salt in the soil will leach out after the first season or so," the ARDC director told me. "Rice is one crop that tolerates some salt."

In another district I saw hundreds of men and women with mattocks digging a 10-mile drainage canal. The laborers, who were paid so much for each foot of dirt removed, worked in gangs, each in its own section. Eventually, the sections would be joined into a continuous canal 5 to 10 feet deep and 15 to 30 feet wide.

Burma Lives for Her Festivals

Yet life in Burma is not all work. To me, the country's charm springs from the ability of her people to be themselves, to enjoy to the fullest their traditional culture.

"We Burmese live for our pleasure, for feasting and for our festivals," a friend told me once. "We work only because we must."

Most Burmese men and women still wear the national garment, the skirtlike *longyi* (page 157). The women show little interest in

Burma's frontiers fringe nations troubled by expansion-minded Communist China. India has resisted Red Chinese troops striking in massive force from the Himalayas. China has never recognized India's northeast frontier, known as the McMahon Line after the late Sir Arthur Henry McMahon, who helped negotiate a 1914 treaty between India, Tibet, and Great Britain.

Boundaries of Burma follow mountain ranges that wall her off from her neighbors. The famed Burma Road provides the only all-year surface route crossing the border.

Gaping, collared lion, called a *chintle*, guards the entrance to Shwe Dagon Pagoda. Mythical ogre sits in the background.





Buddha is bathed from pails of water carried by a worshiper at the Shwe Dagon in Rangoon (right). Each April Burmese celebrate their New Year with a water festival. For three days they douse one another with water; on the fourth day they ceremonially bathe images and feed the monks.

Floral offerings to Buddha accompany the prayers of a young man and his mother,



EXTERIOR BY STEPHANIE BIRKING



Kipling's "beautiful winking wonder," the Shwe Dagon Pagoda drives its golden spire 326 feet into the tropic sky. Shrines and smaller pagodas stud the terrace, which tops a 168-foot-high hill in Rangoon. Matting protects the pagoda's base and encircling spires during regilding with gold leaf.

Children touch flame to candles that spell out the name of an organization conducting a service on the terrace of the Shwe Dagon.



60 DATACHROME (BELOW) AND ATTACHMENTS BY W. ROBERT BROWN, CHIEF, NATIONAL GEOGRAPHIC FOREIGN STAFF © N.G.S.







the permanent waves and pixie hairdos that have swept into Asia. They treasure their glossy black tresses unshorn, twisting them into buns and garlanding them with flowers.

Buddhism dominates daily life. Eighty-five percent of Burmese are Buddhists, and most festivals and fairs are connected with religious observance.

"We care little about getting rich," said a Burmese friend. "We want only enough to keep ourselves and our families from need and, as we grow old, to have something to give to the temples."

The theater-loving Burmese foster their *pwe* ("pway"), the traditional stage show that flourishes on every festive occasion. During the dry season when I was in Rangoon, there was an open-air *pwe* every Saturday evening in Maha Bandoola Square, facing the City Hall. Another, on Sundays, drew crowds to a natural amphitheater beside the Royal Lakes.

To enjoy a street *pwe* as the Burmese do, I bought roasted peanuts and a paper cone of *zithees*—wild plums eaten with a pinch of chili pepper and salt. Next I obtained a big black cheroot from one of the itinerant street-side stands. Thus prepared, I found a seat on the mat-covered pavement.

Spicing my peanuts with the sour-peppery *zithees*, I watched swirling dancers whose liveness seemed beyond the capacity of human joints (see cover), and heard jokes with double meanings as flexible as the dancers' movements. I attacked the cheroot just as the monkey god Hanuman started to battle a demon prince—and found Hanuman far more successful in his battle with the prince than I in my contest with the cheroot.

Golden Bell Soars Above Rangoon

The focus of interest in Rangoon is the glittering Shwe Dagon Pagoda—Kipling's "golden mystery . . . a beautiful winking wonder." Among Burma's thousands of Buddhist temples, this is the noblest of them all. It perches on a hill like a gold beacon, huge and bell-shaped, dominating the city and the surrounding countryside (page 163).

According to legend, a shrine has stood on this site for 2,500 years. It was built to cover eight sacred hairs of Gautama Buddha, which Buddha himself supposedly plucked

Standing as he rows, a Rangoon sampan owner ferries a balloon dealer home from the city as evening sun paints the Rangoon River. They cut across the bow of the Liberian freighter *Euryalus*.



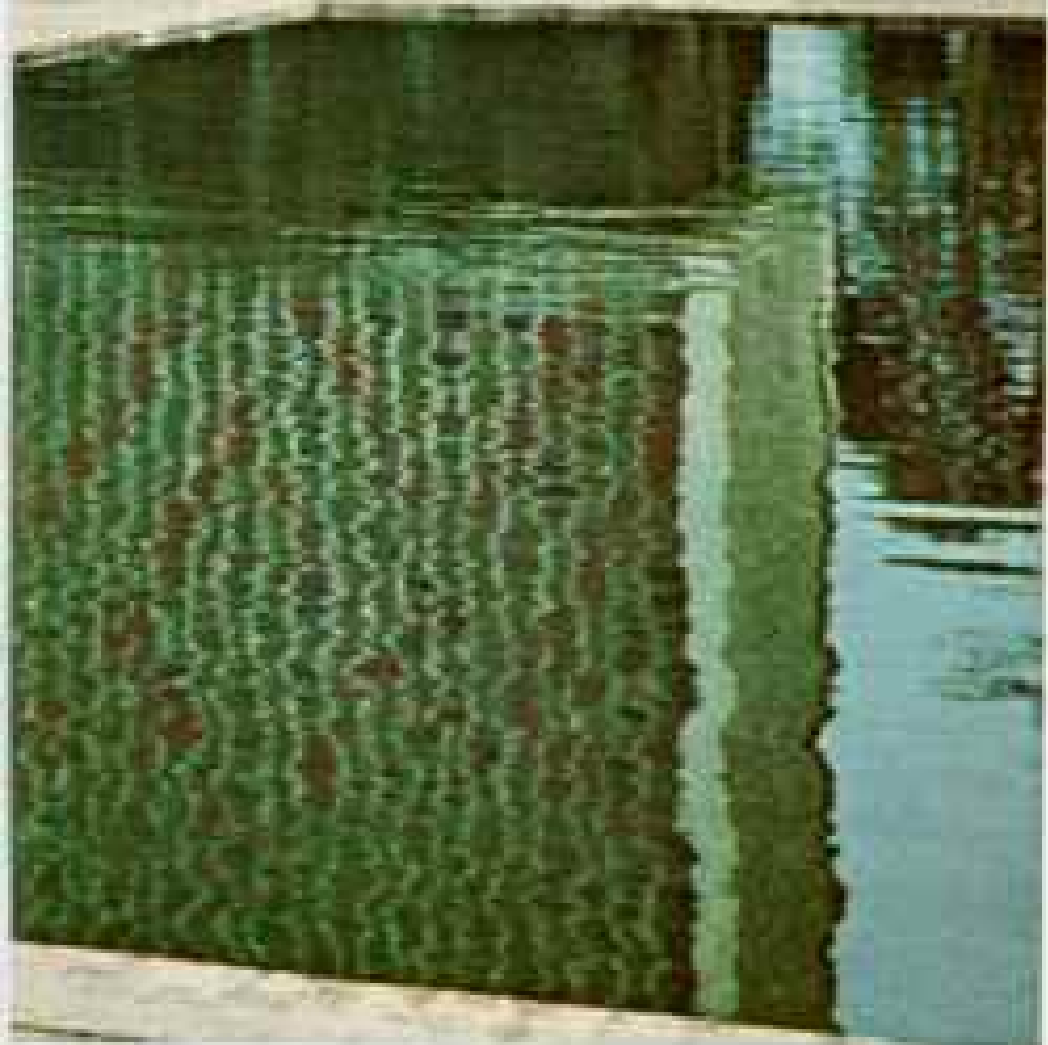
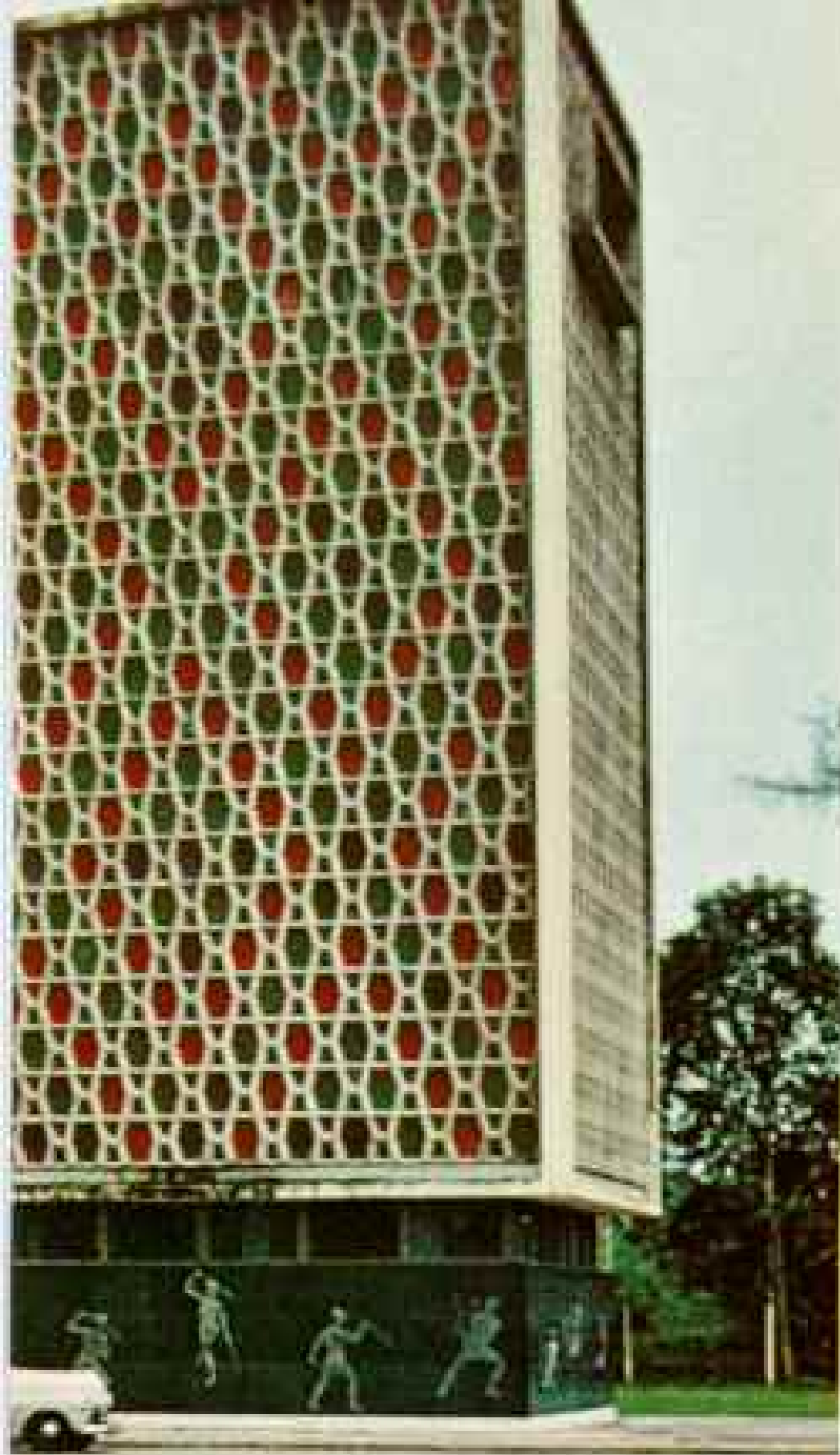
from his head and gave to two Burmese merchants who had traveled to India.

One ruler after another enlarged and embellished this shrine. An 18th-century king, Sinbyushin of Ava, raised the gold-leaf-covered spire to its present height of 326 feet. In 1871 King Mindon added a new *hti* ("tee"), or umbrella crown, and studded it with \$150,000 worth of gold, rubies, emeralds, and diamonds.

Devout worshipers by the thousands daily climb barefooted up the long flights of steps

to the hilltop terrace, 168 feet above the surrounding city, from which the solid masonry pagoda spires upward into the sky. Others take a new and easier way up—one of two elevators in towers beside the shrine. These towers are connected to the hilltop terrace by high covered walkways.

I was determined to walk. I took off my shoes—for signs in English at the entrances say "Footwearing Strictly Prohibited"—and climbed the steps past rows of stalls selling flowers, toys, gilded Buddhas, and incense.



Students Take a Last Look at Books Before Classes

Burma maintains some 12,000 primary, secondary, technical, and professional schools. Rangoon University (above) enrolls about 12,000 students. Men and women have equal standing. Classes in the Faculty of Science occupy these postwar buildings.

Bright mosaics pattern the inner courts of the science buildings.

On the high terrace, all around the base of the soaring spire, stand glass-mosaic shrines, pavilions, and gilded chapels with Buddha images. Here worshipers kneel, burn incense, and pray.

As I stood watching a group of men applying gold leaf to the side of the massive central spire, a Burmese stopped to talk. He asked if I would like to join them. So, buying a packet of 24 gold sheets for five Burmese *kyats* ("chots"), about \$1.05, I added my small glitter to the shrine's glory.

Burma's Pagodas Still Built by Hand

During early years of residence and travel in Asia, I had often thought how difficult it must be, with little or no equipment, to build the towering spires studding Buddhist lands. Six years ago I saw how artisans meet the challenge. I was on a visit to Pegu, 50 miles northeast of Rangoon. Several times the capital of lower Burma, Pegu today is only a small town. Numerous shrines in varying stages of disintegration strew the bush and outlying fields.

As I drove toward the town, I saw a tapering spire thrusting high above the paddy fields and treetops. Nearing it, I discovered a large unfinished pagoda completely enveloped by a weblike cocoon

FORBES/ROBERTS © NATIONAL GEOGRAPHIC SOCIETY





of bamboo scaffolding. At its base, hundreds of men and women were at work.

Long brigades of people passed bricks and pans of sand toward the construction. The only machinery in sight was a small concrete mixer and a windlass hoisting brick and mortar to men working high in the cloak of scaffolding. Everything else was done by hand—a massive pyramid of masonry being erected by human muscle in a manner that has been followed in Burma for centuries.

On my recent visit, when I reached Pegu, I found the 300-foot-high pagoda finished. Its entire surface gleamed with gold leaf.

The pagoda was not altogether new. Another stood here for centuries, until an earthquake toppled it in 1930, leaving only its lower section standing. Before erecting the new spire atop it, workmen cut deep grooves in the old mass of brick and inserted iron bars and railroad rails, to help the structure withstand future tremors.

Another shrine at Pegu, known as the Shwethalyaung, long lay forgotten. Then, in 1881, railroad builders found that a jungle-covered mound concealed a colossal reclining Buddha. Now completely restored, it smiles enigmatically at visitors, one of the true wonders of Burma (page 159).

On my way back to Rangoon, I passed a Buddhist monastery near several large rubber plantations. Groups of men worked on a towering gilt-paper bamboo structure atop a four-wheeled carriage.

"A cremation," said my companion. We stopped and learned that an elderly *pongyi*, or monk, had died and was to be cremated next day. Part of the courtyard was covered with matting, and a pavilion had been set up for an orchestra. In Burma, cremation is

an occasion for rejoicing, particularly a *pongyi-byan*, the "return to the great glory," when a monk passes to the realm of the gods.

I returned next day just as the coffin was loaded into the gleaming carriage. Fifty men clutched the ropes and hauled it to the pyre 200 yards away. In noisy byplay, the pullers would haul the carriage forward a few yards, then others would drag it back, as if to delay the dead monk's departure. Men, women, and children walked in the procession, many carrying sticks of sandalwood on their heads to add to the pyre.

Brass Coils Stretch Women's Necks

So vivid are the echoes of Kipling's musical "paddles chunkin' from Rangoon to Mandalay," that I felt it almost heresy to visit up-country Burma other than by boat. Yet besides the route up the muddy Irrawaddy, Burma's Mississippi, there are also a road and a railway (map, page 160). Or one can fly, for the extensive routes of the Union of Burma Airways lace the whole country.

I chose a piecemeal trip, flying first north to Loi-kaw, capital of Kayah State. The plane passed over river-threaded rice plains and forests, then climbed above sharp mountain ridges. Some hilltops stood denuded by tribal folk who cut away forests to grow crops.

Kayah State is no larger than Connecticut, but it has eight main ethnic groups. Most spectacular are the Padaung, whose "giraffe-necked" women ornament themselves with high collars of coiled brass.

These tribes dwell in the hills and seldom come to town. To visit them, I rode into the hills with a jeep driver who knew the tribal languages.

At the Padaung village of Saungdu, women

Gleaming new library of the International Institute of Advanced Buddhistic Studies fosters Burma's religious culture. Ford Foundation funds helped to build the library, designed by American architect Benjamin Polk, of Calcutta, India.

Library's reflecting pool mirrors strollers. Monks in henna-hued robes look down from the terrace.



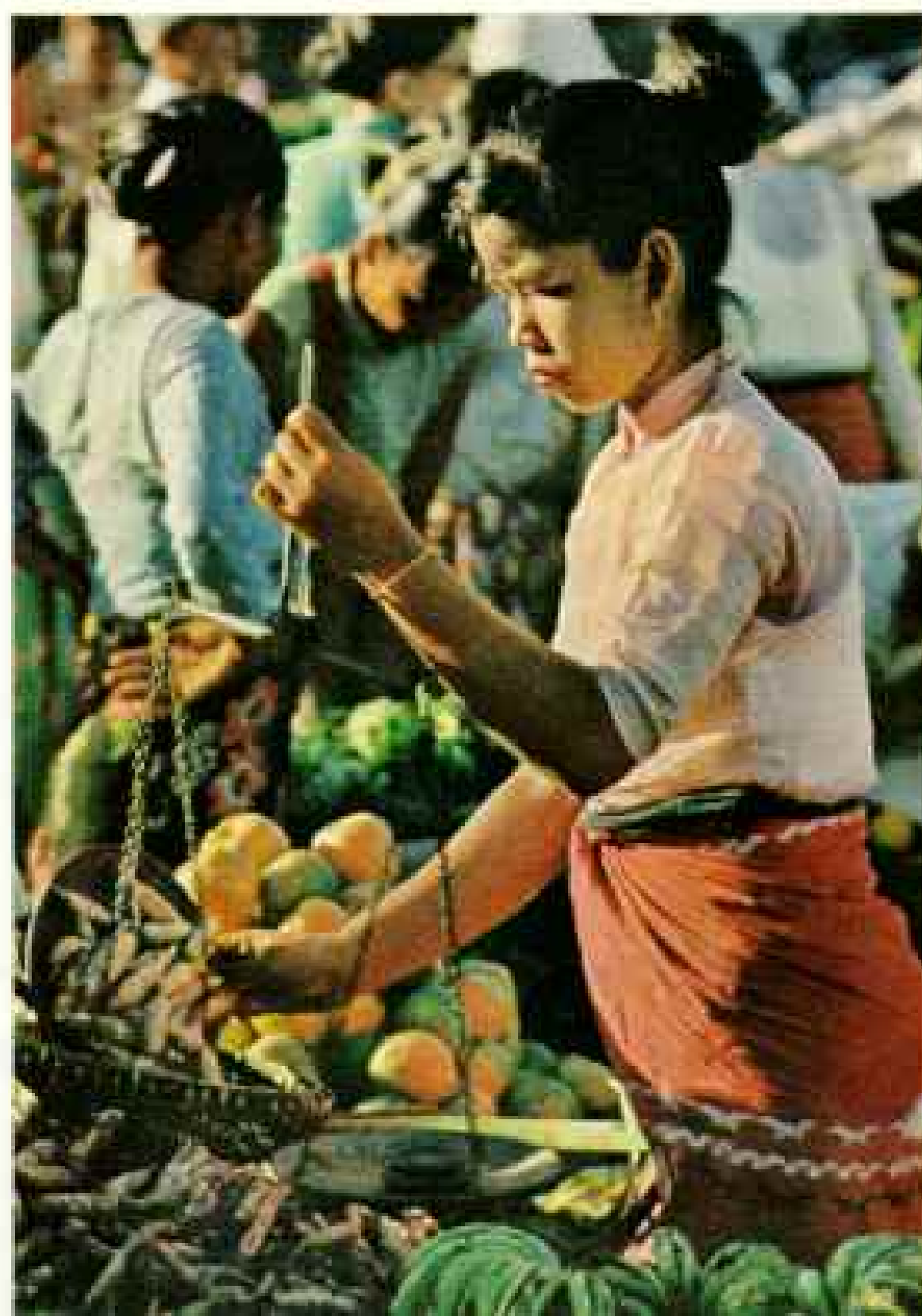
PHOTOGRAPH BY LEO LOU AND HIS ATTACHEMENT BY W. ROBERT WOOD. © N.Y.S.



VEDACHANDER © NATIONAL GEOGRAPHIC SOCIETY

Girl winnows rice in the breeze. Her entire family works the soil. Burma devotes two-thirds of its tilled land to rice.

Vegetable and fruit vendor at Rangoon's open market weighs a pan of starchy arrowroot. Bananas and oranges surround her,



sat in front of their homes, cleaning beans and chick-peas or spinning cotton. Because of the numerous coils of brass they wear between knees and ankles, they sat with their legs extended before them (page 177). On one woman I counted 44 loops on each leg. This lady wore another 21 coils around her neck—a total weight of 50 pounds or more.

The brass is both heavy and hard to bend, but the neck collars are shaped perfectly. The work, I was told, is done entirely by the women, and once the coils are in place, they stay.

Out on the hill clearings where a number of women were chopping away the bush, I saw a notable exception. One woman's collar had been cut off, but she had worn it so long that she held her slender neck and chin as if the coils were still there.

Though they lack the Padaung brass collars, the women of the Yinbaw, Kayah, and Bre tribes we visited wear more brilliantly colored costumes. They also have their own ideas of beauty. Above the calves of their legs and about their knees they wear so many loops of cane or lacquered cord that they can hardly walk.

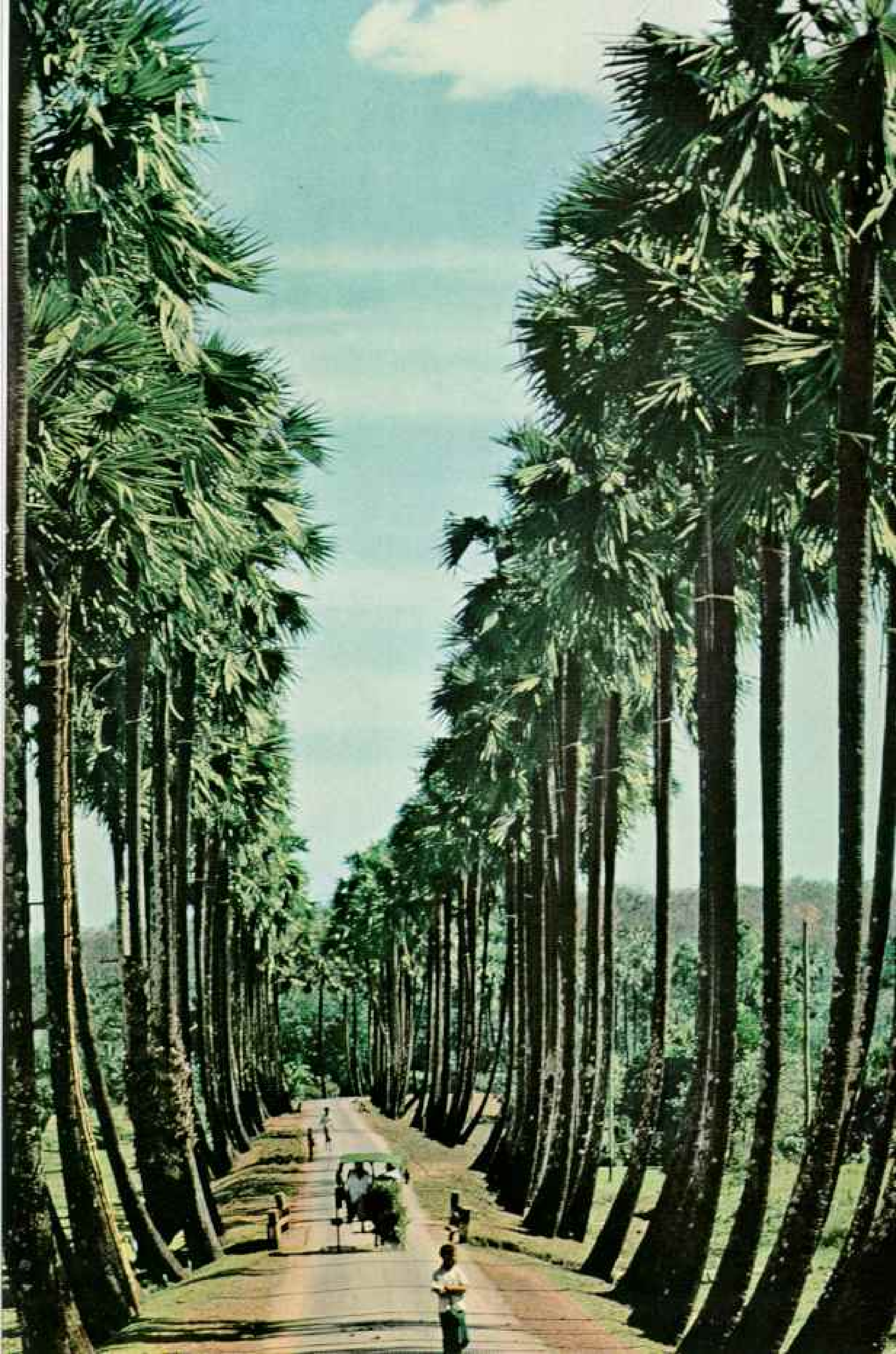
One of my objectives in Loi-kaw was to visit the new Balu Chaung hydroelectric plant, 12 miles southeast of town.

On the way we stopped at a rocky hillside and watched workmen with Italian advisers install equipment for quarrying marble. Then we twisted down into a wild jungle canyon, into which the lovely Lawpita Falls tumble. Here, some 1,400 feet below the edge of the plateau, stands the power plant, built by the Japanese as part of war reparations to Burma. With three generators installed, the plant already produces 42,000 kilowatts. Eventually it is expected to produce twice as much.

The Balu River flows from Inle Lake, 75 miles to the north, most attractively situated between high hills and famed for its so-called floating islands (pages 172-4). Some 17 villages perch stilt-legged around the fringes of the lake. The islands I saw do not really float, but are built up by mud and weeds dug from the lake bottom.

I watched boatmen using long-handled basket scoops to fill their boats with mud.

Lofty palmyra palms bracket a highway near Moulmein, a port at the mouth of the Salween River. Bamboo ladders enable sugar makers to climb the trees and tap the palm hearts for their sweet sap.





Dikes as Straight as Highways Rib
Rich Rice Lands Fringing Inle Lake

Seventeen villages and many isolated farmhouses
perch on stilts above the muck. Flooded areas



ROBERTO © NATIONAL GEOGRAPHIC SOCIETY

await the dry season for planting. During the wet season, boatmen wielding sickles will cut the

harvest and stack it on rafts. Higher fields edging the central channel already have produced a crop.





FEDERHORNED © NATIONAL GEOGRAPHIC SOCIETY

Inle Lake housewife poles harvested rice along a canal. Stilt-legged houses stand above water or "floating islands" made of mud dredged from the bottom.

Leg rowers on Inle Lake balance surely on their shell-like boats. To visitors they appear just a step away from a dunking. Bowing with the sweep of the oar, they use arms as fulcrums while propelling their craft with powerful leg strokes.

Spearing for fish caught in his bamboo trap, a leg rower holds it down with one foot.

They put this mud on vegetable gardens and flower beds.

Here, too, live Burma's remarkable leg rowers. I followed some fishermen until my own boatman grew weary. I saw them drop stiff, bell-shaped bamboo traps to the lake bottom and spear the fish thus engaged (below).

Whenever a fisherman moved a trap, he let it trail beside his boat, holding it with one hand. With the other arm and one leg he propelled the oar, making good speed forward (opposite, below). Thus I saw for myself how the men of Inle Lake must have come to row with their legs.

I have seen few sights on water more exciting than the races on Inle when the boats are filled with men, each standing on one leg, all furiously sweeping their oars in unison as they race toward the finish line.

On a lofty hill a few miles from Inle Lake lies the resort town of Taunggyi, at a temperate 4,690 feet above sea level.



During the days I stayed there and traveled to Pindaya, famous for its caves turned into Buddhist shrines, I several times passed through the village of Shwenyaung. And not once could I resist stopping, for a 12-day temple festival was under way.

Pwes, or stage dances, drew full crowds, but the big attraction was gambling. Young and old jammed bamboo booths to stake their pyas and kyats at variations of roulette, dice, and the old shell game (page 178).

"Gambling is a popular way to get money for temples, a means of fun and of getting taxes," a Burmese explained. "The government taxes the gambling-stand owners and gains thousands of kyats it otherwise would not have." Even so, the new revolutionary regime has since banned gambling.

I had become so used to seeing flat rice fields that I was struck by the wheat I saw growing on these rolling hills. The red soil also produces cabbages, peanuts, and potatoes.

Potato growers, however, have a strange way of planting. They level the field, then hoe it into uniform mounds. In these they place manure and burn it. Seed potatoes are thrust into the ash that remains. The potash gives quick results, but much fertilizer and labor are wasted. Now agricultural experts are trying to change the planters' methods, but custom dies slowly.

Air Road to Mandalay

Again taking to the air, I crossed ranges of hills where fires from jungle clearings sent up white smoke, and came to the broad central plain of the Irrawaddy River.

Near Mandalay I looked down through the heat and haze upon dry rice plains. The land lay golden brown except for bands of green edging the river course. These green strips were fields of corn, tobacco, pulse, yams, and truck vegetables, planted on sedimented lands exposed during the months of low water.

To most Burmese, Mandalay is the heart of their land, for this was the capital until the British captured and exiled King Thebaw in 1885. Here, they feel, their culture centers, as it once did in earlier capitals—in Amara-pura, Sagaing, Ava, and classical Pagan.

In Rangoon I had met a traveler just returned from Mandalay. "War ruined the city," he told me. "It isn't worth visiting any more."

True, some of the spirit and glory of old Mandalay vanished when the palace was bombed out. No longer can one see the or-

nately carved wooden halls and ornamental gardens where King Thebaw ruled in haughty grandeur in the last century and dallied with his wives and concubines. But the red brick walls and the wide reflecting moat of the royal city remain, and other bits of traditional Mandalay also endure.

The sound of music led me one day to the State School of Fine Arts, Music, and Drama, where a class of young girls played on boat-shaped harps (page 185). Boys thumped gongs and drums. In other classrooms students 9 to 18 practiced explosive swirling dances. One 10-year-old king had a hard time keeping his crown at a dignified angle.

Beaters Pound Out Leaves of Gold

The measured thump, thump of heavy pounding drew me another day to another ancient art—goldbeating. In small workshops, men of the goldbeater's guild melted and purified gold in crucibles in tiny charcoal furnaces. Then they pounded lumps of gold the size of a silver dollar into flat rods about a foot long. These rods were passed through hand-cranked rollers. Repeated hammering, heating, and rolling flattened and stretched the rods into ribbons three-quarters of an inch wide and 55 feet long.

Next came the beating. The ribbons were cut into small squares and the squares placed between layers of heavy, parchmentlike bamboo paper. Men bound these together into packets with deerskin covers, ready for beating with a sledge hammer on an inclined block (page 180).

The period of beating was measured by a timer, a coconut-shell cup with a small hole in its bottom, floating in a bucket of water. When the shell filled, it was emptied and again set to refill.

Turning each packet during the pounding, the men beat out the bits of gold evenly, to the diameter of about two inches. These were divided into smaller sections for further beating. At last the gold sheets were about five inches in diameter and thin and light as a breath. Each sheet was a fantastic 1/200,000 of an inch thick—thinner than the layer of ink printed on this page.

Deft-fingered women transferred the delicate leaves to paper, cut them into 2¼-inch squares, and put them in folders. A 98-leaf package sold for 15 kyats (\$3.15) wholesale.

Gold leaf gives glitter to Burma's temples. Temple visitors buy the small squares to



REPRODUCED BY W. RICHARD MOORE, CHIEF, NATIONAL GEOGRAPHIC FOREIGN STAFF © W. R. M.

Heavy Brass Collars Stretch Necks of Padaung Women

Some 50 pounds of metal apiece adorn these wives, who live in the hills of Kayah State. Coins and silver bracelets increase their burden. Spiral collars, never taken off, make it difficult for them to see their work as they shell beans. They sit straight-legged to reduce the strain caused by the leg coils.

Mother puts baby in a basket within easy reach. Young girls wear only a few loops, which are later replaced by the heavier coils of womanhood.





press on the Buddhas. So much gold has been added to one bronze Buddha in Mandalay that his hands and parts of his body have all but lost their shape.

Shrines and temples stud this land in such amazing numbers that I asked a friend, "How could Burma afford to build so many?"

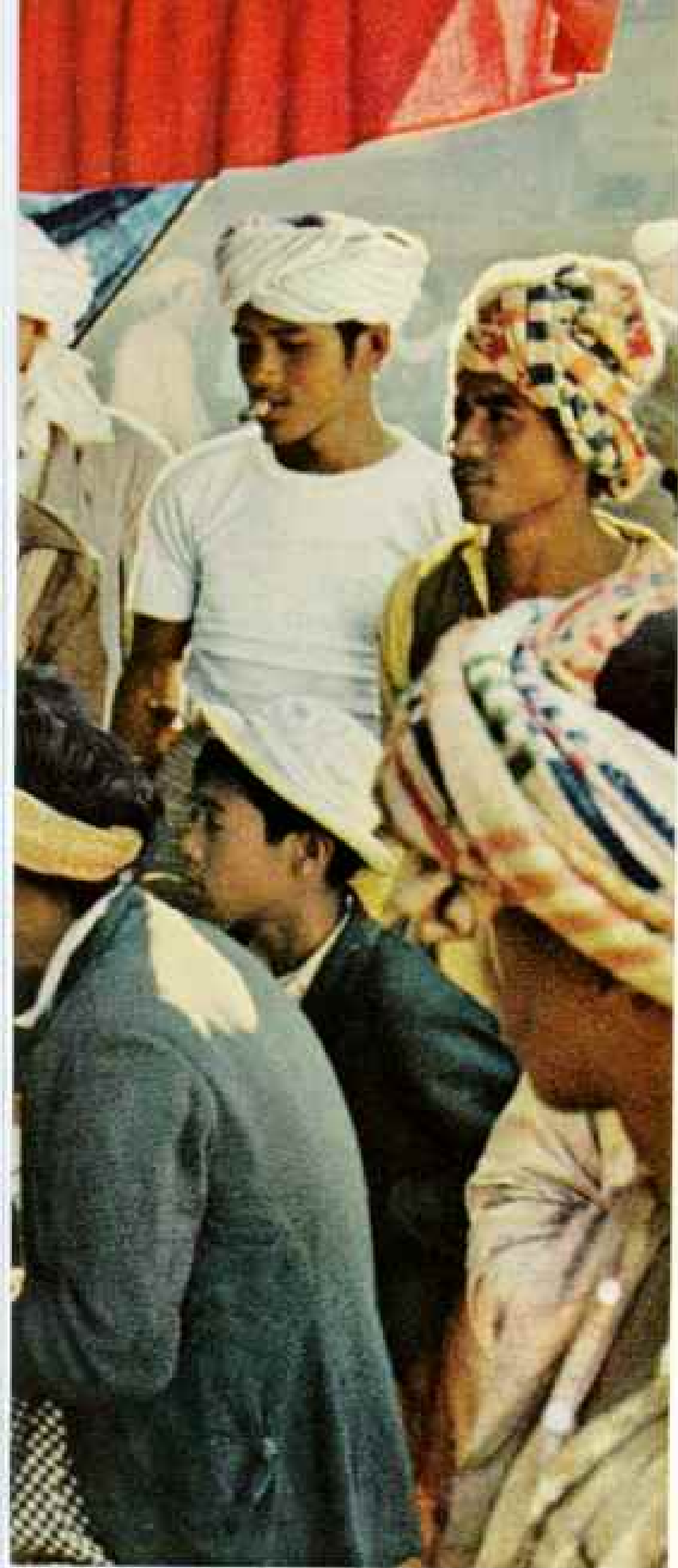
"Haven't you heard," he asked, "how our ancient capital, Pagan, acquired its temples?"

I hadn't, and so he told me the legend of the hermit Shin Issagona, who sought the philosopher's stone to turn base metals into gold. Like many a hopeful alchemist, he felt he had all the proper ingredients. But

he failed. Disgusted, he threw the mixture into a cesspit. There was a flash of flame and a plume of smoke. Acid in the cesspit had provided just what was needed.

Shin Issagona took the magic stone he thus obtained and told the people of Pagan to heat caldrons of base metals. Then he touched each caldron with his stone. And by his magic, everyone acquired an abundance of gold to contribute to building temples.

Seeing so many shrines all around Mandalay, I was ready to believe that story. Gleaming marble and whitewashed spires rise like forests of fir trees whitened with snow.



PHOTOGRAPHS BY LADON AND KUNYUNDA © NATIONAL GEOGRAPHIC SOCIETY

Rooster, Fish, Tiger, or Turtle? "Try Your Luck!" Cries the Barker

Gambling lures countryfolk to a temple fair in Shwenyaung, a village in central Burma. Bath-towel turbans identify Shans, members of the Thai race. The revolutionary government that seized power last March has banned games of chance.

Burma's version of rice cakes consists of crisp thin sheets called *mon-le-bway*, meaning "whirlwind cake." Made of rice-flour batter, the sheets fry feather-light and are filled with air bubbles.

Biggest and densest of these "forests" in Mandalay is the Kuthodaw (Royal Bounty) or Maha Lawka Marazein Pagoda (next page). It possesses the world's biggest religious book—729 marble tablets on which are carved the Buddhist scriptures. Each tablet has its own shrine (page 183). The shrines stand row upon row, rank upon rank, in a great rectangle about the tall central pagoda.

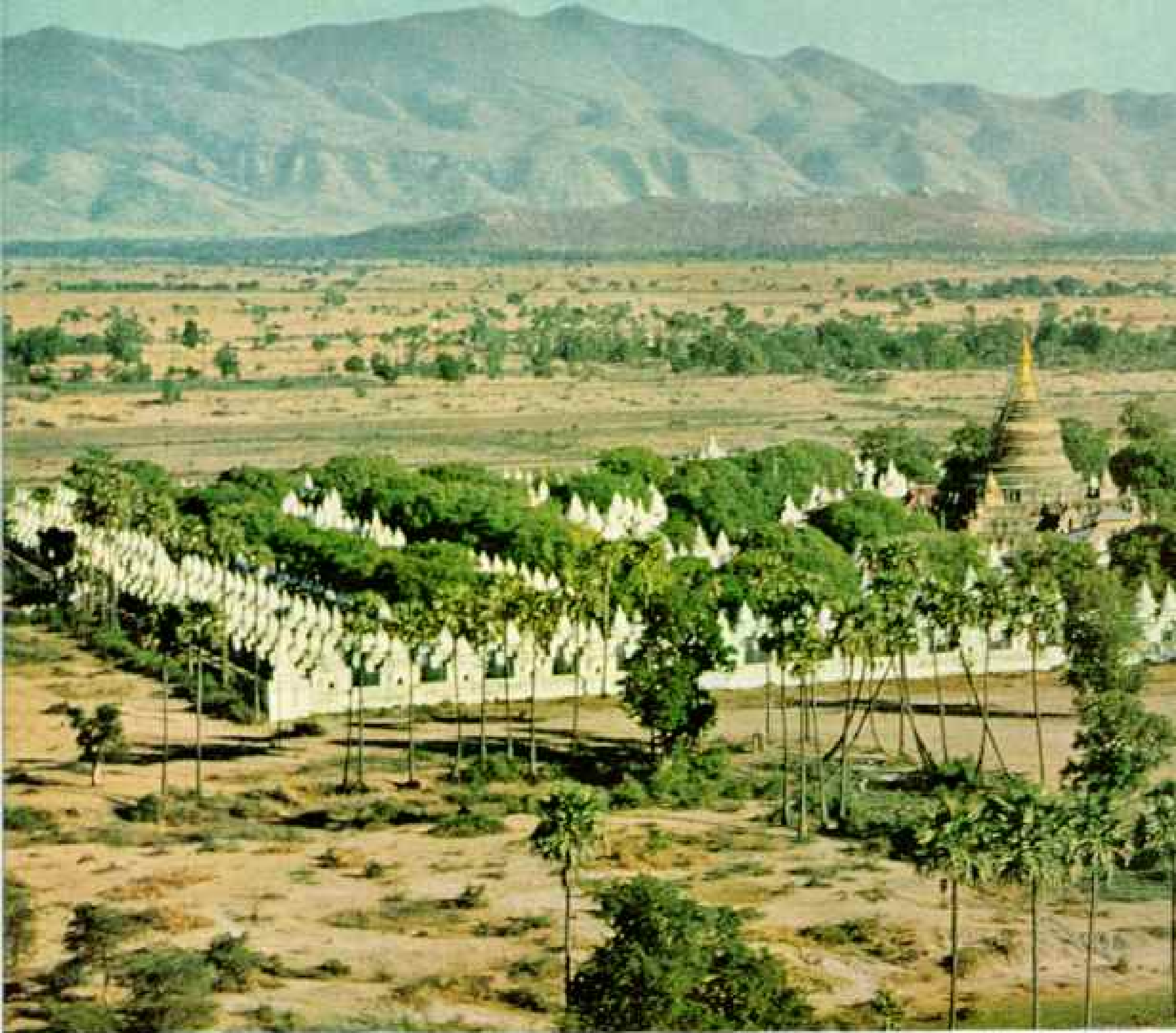
Months to Weave a Skirt

Elsewhere in Mandalay I watched stonecutters carving marble Buddhas (page 182), and silversmiths making ornate bowls and trays. I came, too, upon the weaving of *acheik longyis*, skirts of such complex, broken-patterned designs that once they were worn almost exclusively by Burmese royalty.

Few tasks are more painstaking or demanding of time than the weaving of this cloth. Each small portion of the pattern requires several separate bobbins, each with a different color of thread.

"How many bobbins are you using?" I asked an elderly woman in the shop I visited.





REPRODUCTIONS BY W. ROBERT WOOD



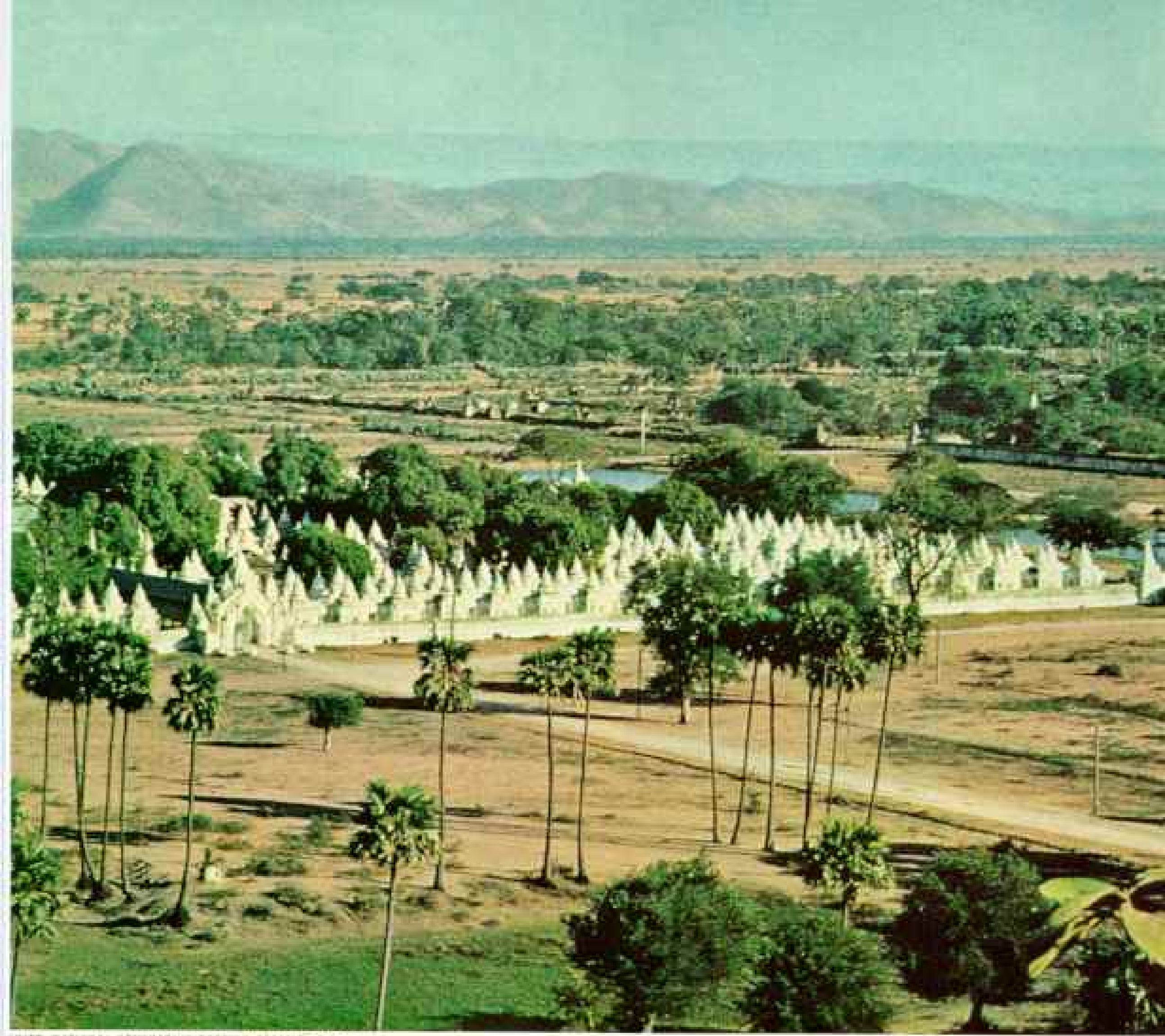


PHOTO BY NATIONAL GEOGRAPHIC EXPEDITION STAFF © N.G.S.

Forest of pinnacles studs Mandalay's Kuthodaw Pagoda, which King Mindon built in 1857. Small spires house 729 marble tablets (page 185) of the Buddhist canon. Bamboo scaffolds permit regilding the main pagoda. Shan Plateau borders the plain.

Goldbeaters of Mandalay pound metal gossamer-thin

Dollar-size lump of refined gold at far left will be worked into a narrow rod, then drawn between rollers into a 55-foot-long ribbon.

Sledge man at center beats bits of ribbon, held between goldbeater's skins in a leather binding, until the metal is as thin as 1/200,000 of an inch. Metal harness holds binding on a stone anvil.

Women place the fragile gold in protective folders. Their product will gild temples and statues.





EDSACHWONER © NATIONAL GEOGRAPHIC SOCIETY

Mandalay artisans on *Kyauk-sit-tan* (Street of the Carvers) shape marble statues of Buddha with mallets and chisels made from old files.



"One hundred and forty-four," she replied. "On this pattern I can weave only one or two inches a day."

So that I might see the pattern, a girl held a mirror beneath the loom. The weavers themselves see only the reverse side of the *longyi* they work on.

Today Mandalay has only a few *acheik* weavers left. The cloth is too expensive for most Burmese to afford. But here and at Amarapura, hundreds of hand-shuttle looms clack busily beneath piling-raised homes as weavers turn out simpler silks and cottons.

Expanding University Just 16 Years Old

Not all of Mandalay's culture echoes from the past. The University of Mandalay is as new as today and as hopeful as tomorrow. "We started in 1947 with only 129 students," university officials told me. "Now we have nearly 3,000."

I must have seen most of them, for in the morning and late afternoon virtually all of the city's *longyi*-clad young men and women seemed to be bicycling to and from classes.

War turned Mandalay into a city of jeeps. Hundreds of them, used as taxis, buzz through the streets, rivaling the throngs of bicycles and tricycle pedicabs.

"Know what a used jeep costs?" asked a driver I hired. "Seven thousand kyats." Since a kyat is equivalent to about 21 cents, this was nearly \$1,500—and those jeeps were 18 years old! But most Burmese simply cannot get new cars from abroad, so stiff are import restrictions. A nearly new Chevrolet would cost close to \$9,000, my driver told me.

We took off toward Maymyo and Lashio, the Shan towns to the northeast. Our route formed a link to the much publicized war-time Burma Road, over which goods were trucked into China.*

A few miles eastward from Mandalay the road twists and climbs to the Shan Plateau. Trucks and jeeps reach the crest hot and breathless from the sharp ascent.

Maymyo (*myo* means "town"), pleasantly situated at 3,500 feet, surprises with its name and its appearance, for both are British in

* See "Burma Road, Back Door to China," by Frank Outram and G. E. Fane, NATIONAL GEOGRAPHIC, November, 1940.

Oxcart wheels get a trim of paint in Mandalay. Tires of iron serve as well as rubber in muddy fields or dusty lanes. Though trucks increase, rural Burma still relies heavily on the oxcart.

origin. The name comes from a Colonel May of the Bengal Army, who commanded the military headquarters established here in the 1880's. The town became the summer residence of the British officials of Burma, and its half-timbered houses and bright gardens still remind one of a tranquil English town.

In the market place I saw broad-batted, turbaned Shans threading among the stalls. And on the road later, we passed their slow-moving oxcarts (page 186). We seemed to have entered another country, for in both costume and language these plateau people contrast sharply with the Burmese. Like the Siamese and the Lao, they belong to the Thai race that spread from southern China.

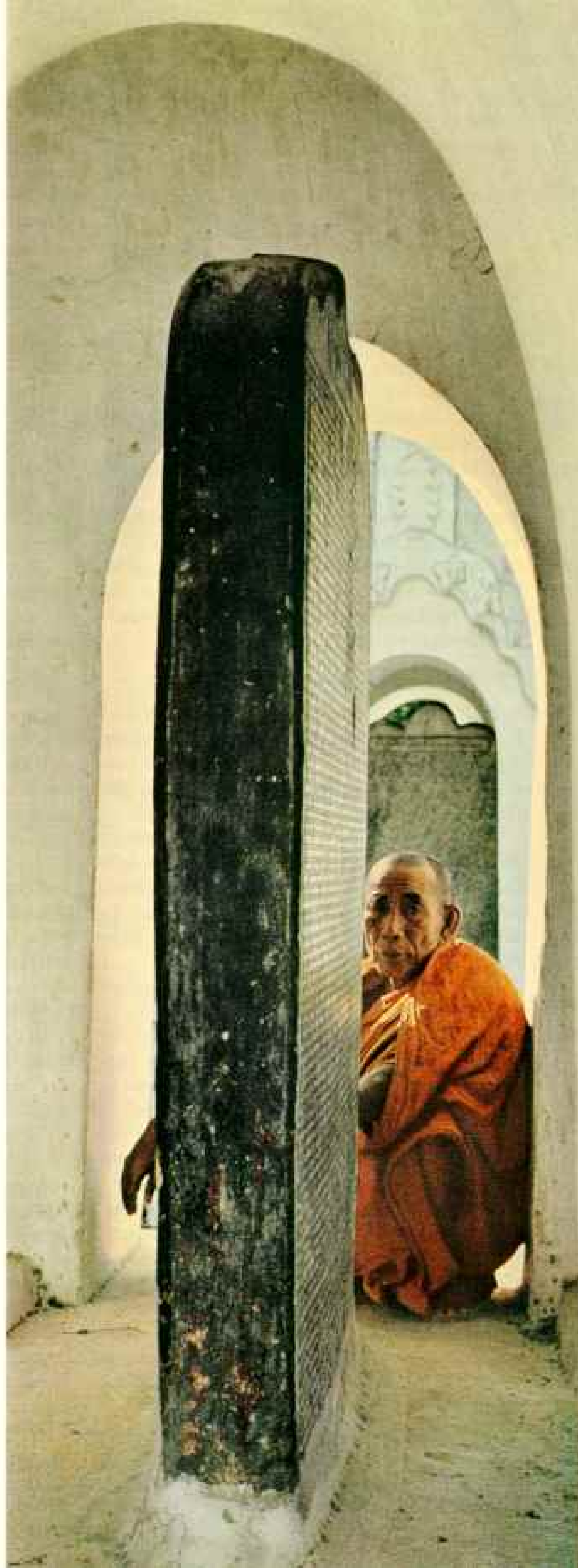
Amid Burma's wealth of mineral deposits, the region around Bawdwin and Namtu, northwest of Lashio, has proved to hold special treasures in lead and silver. Its complex of ores also yields copper, zinc, and nickel.

To women particularly, the mineral finds at mountain-girt Mogok, farther westward, have greatest appeal. For here is one of earth's few sources of fine Oriental rubies, among them the rare pigeon-blood stones (page 197).

To reach Mogok, I backtracked to Mandalay and caught an early-morning plane for Momeik on a branch of the Shweli River (map, page 160). Thence, in company with a friend from Mogok, I climbed by jeep up the kinking mountain road to 5,000 feet and dropped into Mogok's hill-hemmed rubyland.

There may be romance in the rubies and sapphires mined here, but much hard work goes into their finding. Part of the narrow valley lies raw with a chaos of pits, pools, and piles of culled

Marble page of Buddhist scripture has its own shrine at Kuthodaw Pagoda. This and 728 similar slabs bear texts revised at King Mindon's order in 1871.



sands where small groups of men dig and wash the gravel by hand. They work in the wet; in winter the water temperature descends to the 40's. But always they hope to find a fortune in a single stone. It happens, but more often the rewards are modest indeed.

Along the road between the mines and the town, we passed broad-hatted women dealing in the smaller, poorer quality stones which attract some Indian buyers. In the town's center gather most of the buyers, sellers, commission men, and hangers-on. They sit in open-front Chinese cafes or stand on the corners—a remarkable bourse that functions only while sunlight falls on the streets.

You see a man take a stone from a tiny tin box or a bit of cloth carried in the belt of his longyi. Another jiggles the stone, twists it in the light, and holds it to his eyes as if his hand were a microscope. There's talk, more talk; other stones are examined for color and flaws. And, mysteriously, bargains are made and deals concluded.

Myitkyina Known to Allied Troops

Many British and American soldiers and flyers remember Myitkyina, capital of Kachin State in Burma's far north. This region saw much fighting against the Japanese as the Allies battled their way back into Burma.

Through here was cut the famed Ledo or Stilwell Road from Assam in India to join the Burma Road, which incidentally approximates Marco Polo's route into Burma. In World War II, many dramatic missions were flown from nearby airstrips.

Coming to Myitkyina now, I landed on one of those same airstrips.

"You should see Myitkyina during the *manau*," friends had told me. "It's the biggest celebration of the Kachins, with sacrifices to the *nats*, their primitive nature spirits."

I reached Myitkyina two days before the *manau* began. Our plane was met by a charming reception committee—some twenty young Kachin women in traditional Kachin costumes, with elaborate silver neckpieces and bangles on their blouses (page 190). But—a modern touch—they all wore lipstick.

Later I saw hundreds of Kachins, Marus, Lisus, and Lashis assembling from all parts of the state. Many of their women were so shy that they obviously had never before

traveled far from their mountain villages.

"Only once in three years can we afford to celebrate a *manau* on such a scale," a Kachin official said. "This year we have 29 buffaloes for sacrifice—one for each of the 28 *nats* being honored, and one for all the *nats*."

Preceding each sacrifice, a priest and attendants brought baskets of rice, eggs, salt, and wine in bamboo tubes. Before a bamboo shrine the priest set down the baskets and said incantations over them and the buffalo. Then the beast was speared and butchered and the horns and skull left on the X-shaped poles to which the beast had been tethered.

Dancing followed on a large circular terrace, around tall painted *nat* poles, reminiscent of American Indian totem poles (page 188). About these gathered musicians with flutes, drums, cymbals, and gongs.

Two chiefs wearing high feathered head-dresses and long mandarin robes led off the dancers, followed by one tribal group after another. Round and round they went, as if in a gigantic snake dance, at times breaking into separate groups or surging circles, and then converging again. Just to stand and watch became weirdly exciting, hypnotic.

The dancing and music continued off and on for three days. One evening I went to see another event, so different from the *manau* that it was hard to imagine both in the same town. Two-score young women staged a fashion show and beauty contest, and athletic young men lifted weights and displayed their muscles. Some girls patterned postures on what they had seen in movies. Others were understandably shy. All were charming.

When the celebrations ended, the tribal groups headed homeward by truck and afoot. I drove aboard the ferry to cross the sprawling Irrawaddy, then started the 130 miles south to Bhamo along the Stilwell Road.

"Bhamo will be a good place to see elephants working teak," I had been told by U Maung Maung Gyi, a state timber official, when we talked in Rangoon. "Burma possesses the world's largest supply of teak. See our Bhamo manager, U Ko Ko. He'll arrange a visit into the forest for you."

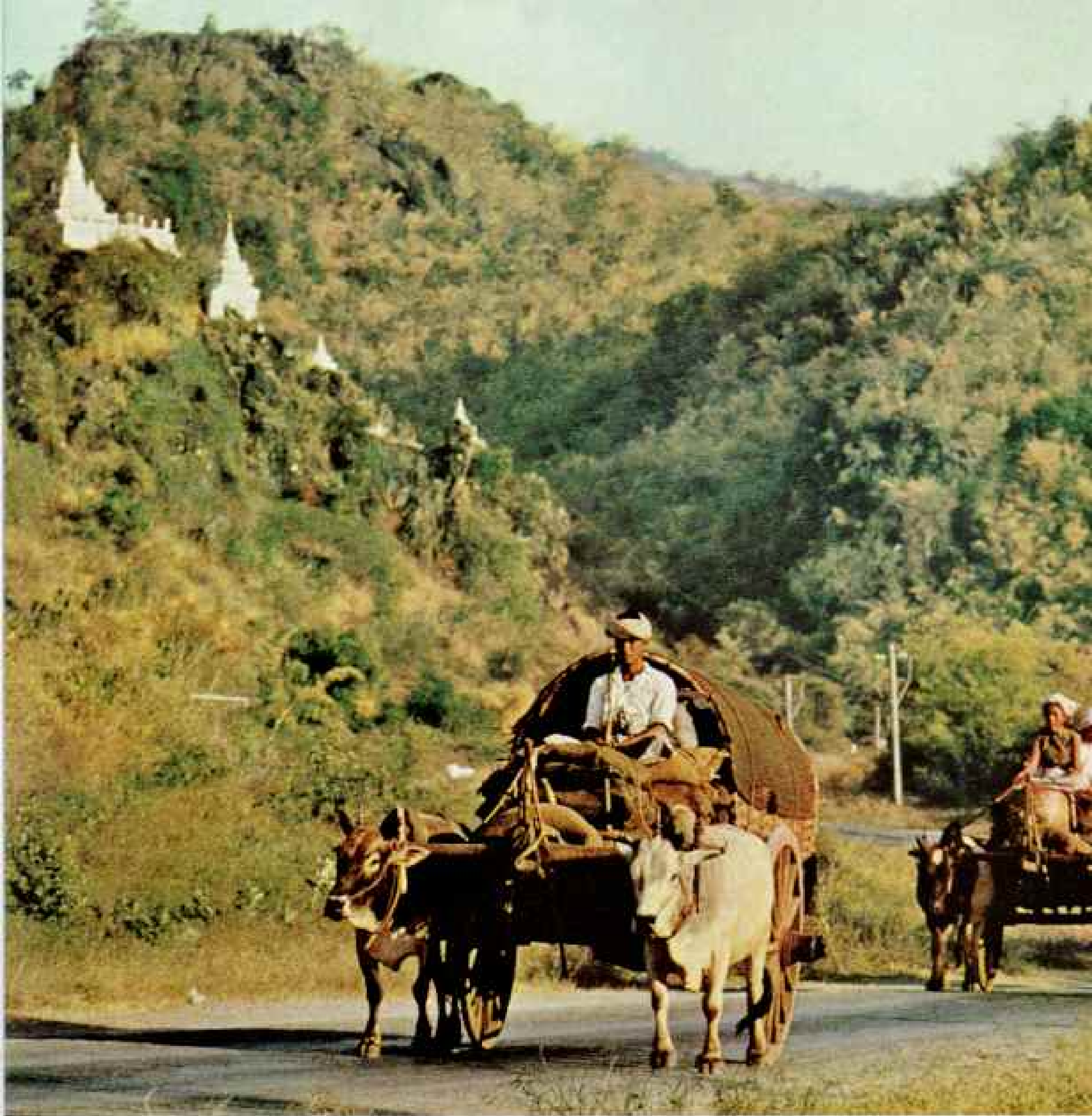
When I called on U Ko Ko, he wanted to accompany me. But he could not get away immediately. Could I wait two or three days?

Meanwhile, would I like to drive to Namb-

Slender Fingers Pluck the Silken Strings of a *Saung-gauk*, the Burmese Harp

Student of the State School of Fine Arts, Music, and Drama in Mandalay, the girl wears the costume of the old-time royal court. Comb and flower decorate her hair in the classic manner. Because silk is so fragile, most *saung-gauks* now use nylon strings.





kam to see its market and call upon Dr. Gordon Seagrave, the noted "Burma Surgeon"? Yes, the road was open—no trouble with insurgents. Within the hour, U Ko Ko had arranged my trip with the genial driver of a jeep taxi—58 miles for 6 kyats total, or \$1.25.

"Burma Surgeon" Carries On

Early next day I was off—one of six passengers in the jeep. Four others, with bundles and baskets, jammed a trailer. The road took us within sight of Communist China's frontier.

At Namhkam I met Dr. Seagrave, son, grandson, and great-grandson of missionaries to the Karens of lower Burma and 28th member of one family to serve lifelong in this

country. After medical training in the United States, he returned to Burma in 1922 with a young wife and baby daughter and began his healing work in this remote border town.

Just now influenza and dysentery had put him "a bit under the weather," he said. But nothing had reduced his enthusiasm for his beloved hospital and the work of his nurses.

During the war his Burmese nurses gained fame for their work with General Stilwell's forces. "My Union of Burma before there was a Union," Dr. Seagrave called them, since they came from many racial groups. And an ever-growing union they have become, for Namhkam has trained more than 700 nurses.

I made the rounds of the hospital with Dr.



LESLIE GRUBBS © NATIONAL GEOGRAPHIC SOCIETY

Seagrave's assistants, Dr. Donald Olmanson from Minnesota and Dr. Violet Poo Nya, a Karen. The hospital, much expanded since the war, consists of 13 river-stone buildings.

"And this," said Dr. Olmanson as we entered one wooden structure, "was the first building here. We've been trying to get rid of it, but we have too many patients."

Half of Namhkam's patients, I learned, live a day's travel away, many two or three days, and some much farther.

"When people are sick enough to come to the hospital," Dr. Olmanson said, "usually we have to treat them for two or three diseases at a time, and often for five or six."

Tuberculosis runs high, dysentery is com-



Armed guard polices a corkscrew mountain road in Gokteik Gorge between Mandalay and Lashio. Close by, a trestle lifts rail traffic 870 feet above the canyon.

Oxcarts roll down the road from the Shan Plateau northeast of Mandalay. This highway and the railroad to Lashio linked Mandalay with the Burma Road, built prior to World War II to supply China against invading Japanese. White-washed shrines festoon the ridge at left. Cart drivers are Shans, a people numbering more than a million who occupy northeastern Burma.

mon, and so is hookworm, a cause of anemia.

I noted relatives and friends of patients sitting everywhere. Dr. Olmanson smiled:

"Oh yes, it's the custom for the whole family to accompany a patient. Occasionally we find a husband wanting his ill wife to lie on the floor while he takes a nap in bed!"

Elephants Haul Teak Logs to Water

Back in Bhamo, I found U Ko Ko ready for our trip. To get to the timbering, we traveled up the Irrawaddy and then followed a side stream into the jungle until we came upon two dozen elephants at work (pages 192-3).

Some hauled logs from the hills to a high embankment, tilted them over the edge, and

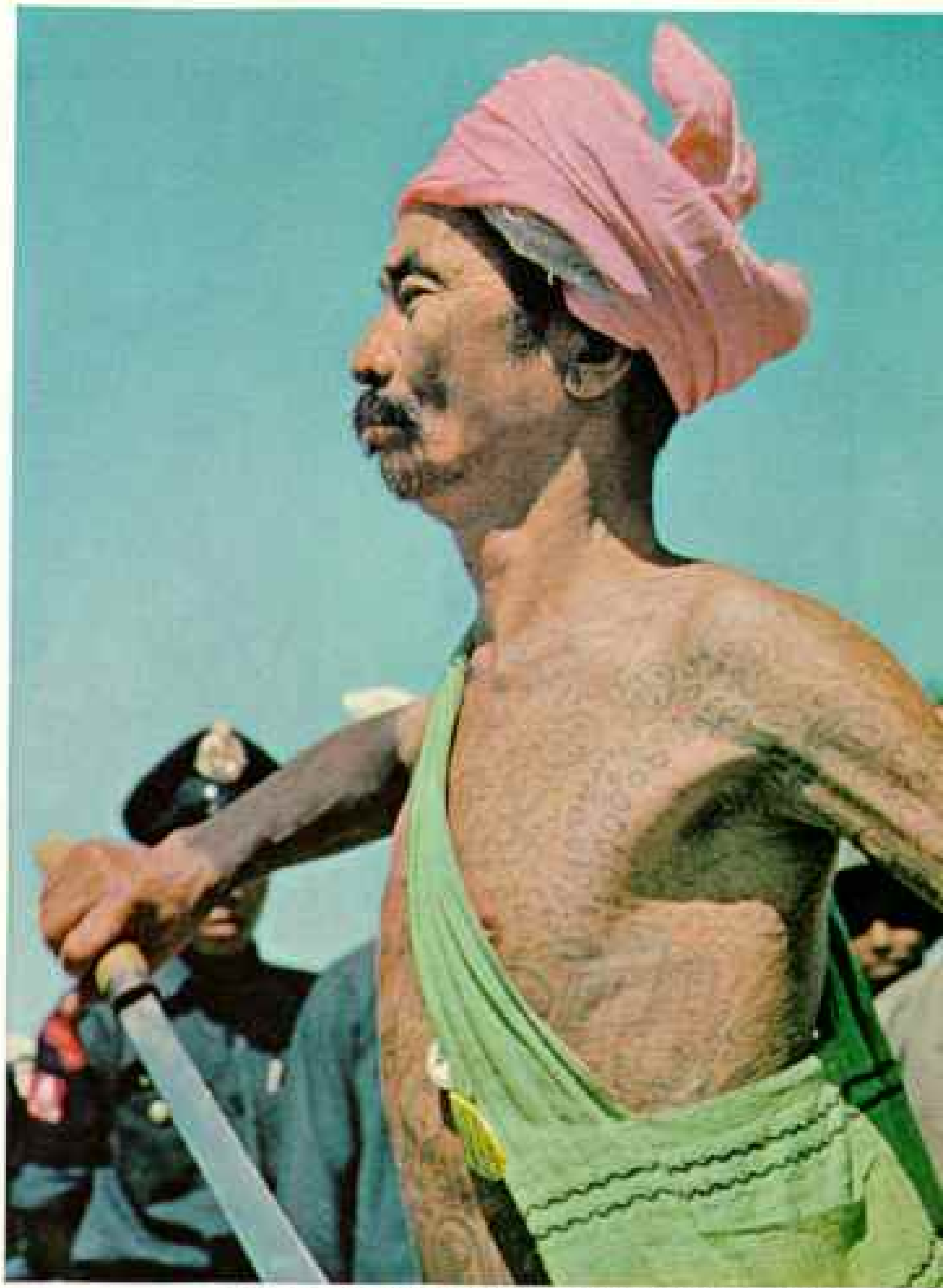




Tiger teeth, beads, and hair tufts decorate a bearded Naga tribesman visiting Rangoon.

Painted posts, raised for a spirit festival, stand like totem poles in Myitkyina. Kachins wave fans and perform a snake dance beneath Maypolelike streamers.

Tattooed Shan draws his machetelike *dab* for a sword dance.



CHRONICLES BY W. HENRY MOORE © NATIONAL GEOGRAPHIC SOCIETY

let them roll crashing into the valley. Others dragged logs into midstream so that the first rise of water would lift them downstream to the Irrawaddy. There they would be tied into rafts for the long voyage to Rangoon.

"We're almost finished here now," U Ko Ko said. "We'll soon move the camp downriver. This area won't be worked again for 25 years."

Teak timbering is no overnight operation. Trees of cutting size must be girdled and left standing for three years before they are cut. Otherwise they would be too full of sap and too heavy to float. Hauling usually takes another season before the logs reach the river.

Chunkin' Down the Irrawaddy

I traveled from Bhamo "back to Mandalay" by an Irrawaddy stern-wheeler (page 194), puddles chunkin' like the old flotilla boats of Kipling's day. During the two-and-a-half-day trip, we passed high-sterned riverboats being rowed for lack of a breeze. Bamboo rafts, with crew huts atop them, drifted in the current with long sweeps steering them.

From Mandalay I took another stern-wheeler southward to ancient Pagan.

Hardly had Mandalay Hill faded in the haze when we came abreast of the temple-studded hills of Sagaing. Soon we passed beneath Ava Bridge, the only railway-highway crossing over the Irrawaddy. The countryside appeared drier and drier, in places almost like a desert.

"We're in the rain shadow of the Arakan Range," explained a Burmese agricultural expert on board. "The southwest monsoon drops nearly 200 inches of rain on the coastal side of the mountains, but here we're lucky to get more than 25 or 30 inches. Even that is irregular and patchy. That's why the main crop you see taken aboard is cotton."

Within sight of Myingyan, distant Mount Popa loomed like a cone of dead cinders, as indeed it is. For it is an extinct volcano.

"Only things that really flourish around Popa," my acquaintance remarked, "are the hamadryads, or king cobras."

I knew about the cobras. On one of my



Lashi maiden attends the New Year festival in Myitkyina.



Black Lisu's cap: beads, buttons, and bangles of brass.



KEDACHONES © NATIONAL GEOGRAPHIC SOCIETY

Counting the price with her fingers, a beaded Maru bargains for a silver bracelet at the Myitkyina fair.

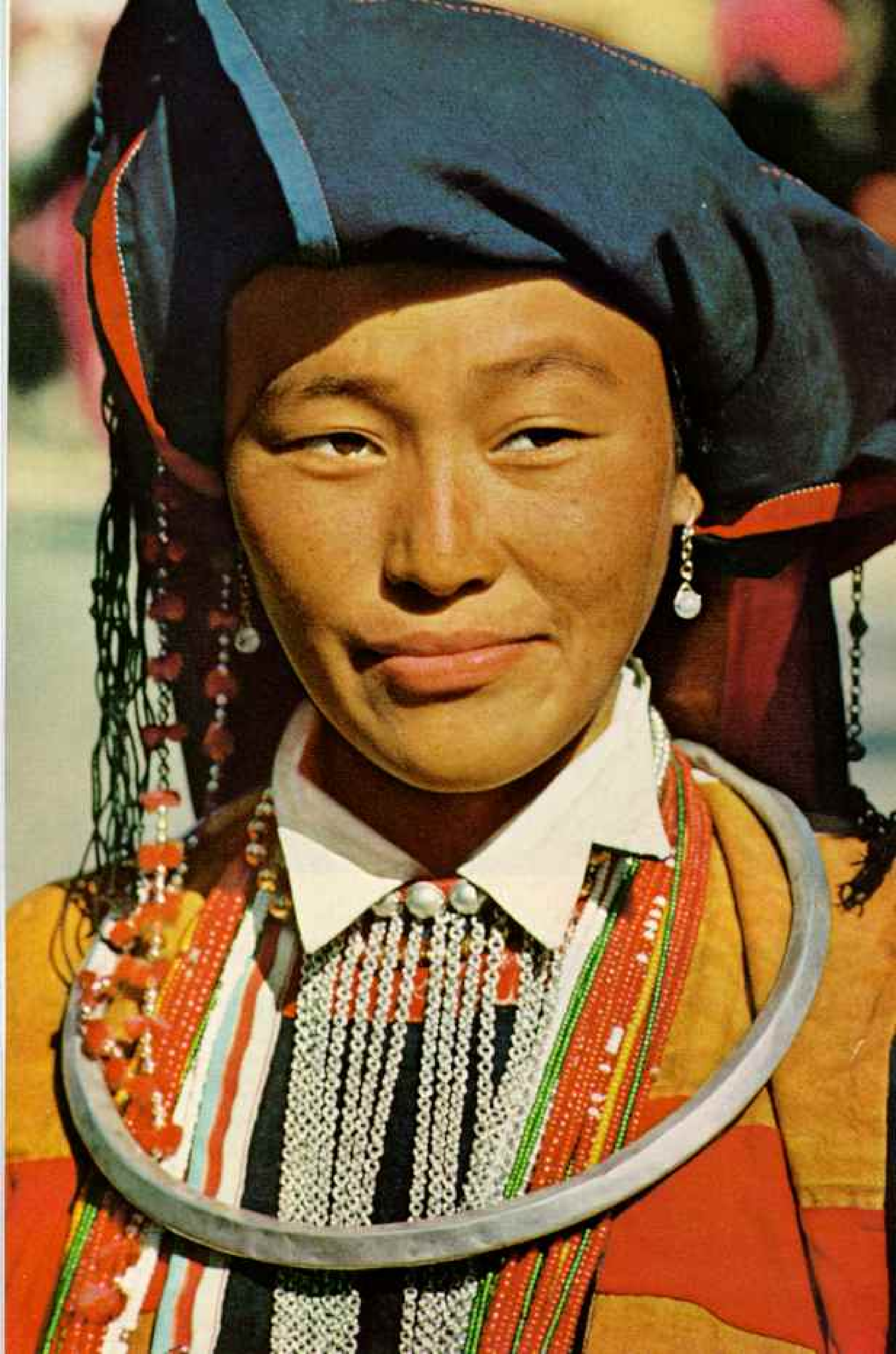


Tribal folk of Kachin State

NO COUNTRY of its size has a greater variety of tribal and racial groups than Burma. There are 126 languages and dialects. Burmese, the dominant group, dwell mainly in the Irrawaddy Valley.

White sneakers lend a modern accent to the silver-ornamented costumes worn by Gauri Kachin girls. Cane belts gird hips, and cloth leggings cover legs. Kachins call themselves Jinghpaw, meaning "man." Together with the Azi, Maru, Lashi, and Nung, they are closely related to the Burmese, who arrived in earlier migrations.

Beads and silver adorn a girl of the White Lisu, or Yawyin, a tribe akin to the Lolo of China.





“Elephints a-pilin’

BURMA has some 2,000 working elephants. Most are born in captive herds, but a few are still caught in the wild. Tractors and cables have taken over their timber jobs in some forests.

These cows, accompanied by

Baths are frequent. Elephants do not work under the blazing sun or during the hot season.



SHIRAZ FRIMES © NATIONAL GEOGRAPHIC SOCIETY

earlier visits to Burma I had met Saya Tin and his wife, who made a business of catching cobras about Popa and displaying them before audiences in Rangoon. At the climax of their performance, they kissed the snakes.

They had several king cobras, one 15½ feet long and as thick as Saya Tin's arm, with a quick and savage temper.

"There are larger ones at Popa," Saya Tin had told me, "but I cannot handle them. Their hoods are too large to grasp."

When I returned to Rangoon on another visit, I learned that Saya Tin had been struck by a cobra and had died.

Not only king cobras haunt Mount Popa. Supposedly it is also the favorite spot of the nats, the nature spirits. Centuries ago this was the Mount Olympus of Burma, and the king came every year to consult *Mahagiri*, the main spirit of the Great Mountain.

Today many Burmese still cling to the ancient belief in spirits, good and evil. In many places I saw "nat trees" with bits of cloth tied to their branches. At their bases stood altars and offerings of rice and fruit. I recalled a story told to me by an American official. A Burmese employee of the American Embassy had drowned during

teak": Kipling

their unweaned calves, haul teak logs to a creek, where the next flood will start the timbers down the Irrawaddy River to Rangoon.

Pig grease keeps breastbands from chafing. Bark provides padding for wooden saddles.

Bull tusker aligns logs in the stream bed. If they jam, he artfully frees the key timbers.





a picnic. His family insisted on a written release from employment to place with his body; otherwise his spirit would continue to return to the office where he had worked.

At the river town of Nyatungu I disembarked, clambered into a jeep, and rode four miles to ancient Pagan, the city of temples and spires that amazed Marco Polo.

Five Thousand Shrines by the River

In no other place in the world have I seen such a concentration of religious shrines. Thousands of pagodas stud the landscape as if myriad stalagmites had been deposited by piety dripping from the skies. They crowd so close together that one wonders how there ever was space enough for the city's palaces and private dwellings.

Some Burmese sources claim that here there once were 4,486,733 pagodas. The fact is that now there remain some 5,000 shrines in a strip of 16 square miles along the Irra-

waddy. Many are little more than heaps of brick, but some are almost perfectly preserved. A few are still in use, gleaming with fresh coats of whitewash. Original frescoes still decorate many of the shrines, and colors gleam bright on the small barrel-domed Upali Thein, or Ordination Hall (page 198).

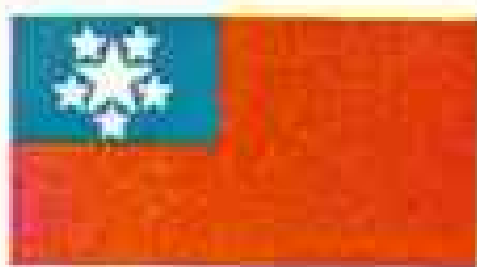
I spent long days clambering up and down hundreds of steps, treading endless corridors and terraces, walking on brambles, sandburs, gravel, and crumbled brick—and all without shoes, for showing respect to a Buddha extends even to temples abandoned for centuries, their Buddhas broken or vanished.

Many tales linger about the shrines. The saddest is that of the arrogant King Narathihapati, who built the Mingala-zedi Pagoda and rang down the curtain on Pagan, in 1287, through his cowardice.

He killed several ambassadors sent by Kublai Khan, whose armies had swept southward through China. But when Kublai

BURMA: facts and figures

THOUGH FOUR OF EVERY FIVE persons work on the land, Burmese also engage in a variety of occupations, from making pharmaceuticals to prospecting for rubies.



GOVERNMENT: Republic. **AREA:** 261,789 sq. mi. **POPULATION:** 21,500,000. 75% Burmese of Tibeto-Mongolian stock; remainder minority tribal groups, also Indian, Chinese.

LANGUAGE: Burmese, some 175 other languages and dialects. English taught in schools and widely spoken. **RELIGION:** 85% Buddhist. **ECONOMY:** Agriculture (rice, oilseeds, sugar cane, tobacco, rubber). Leads world in teak exports. Mines tin, tungsten, lead, zinc; important source of jade, ruby, sapphire. **MAJOR CITIES:** Rangoon (pop. 800,000), capital, port; Mandalay, silk weaving; Moulmein, shipbuilding. **CLIMATE:** Hot in months before and after monsoon rains of May-Oct.; cool season Nov.-Feb. Rangoon daily high average 97° F. April, average low 65° F. January.

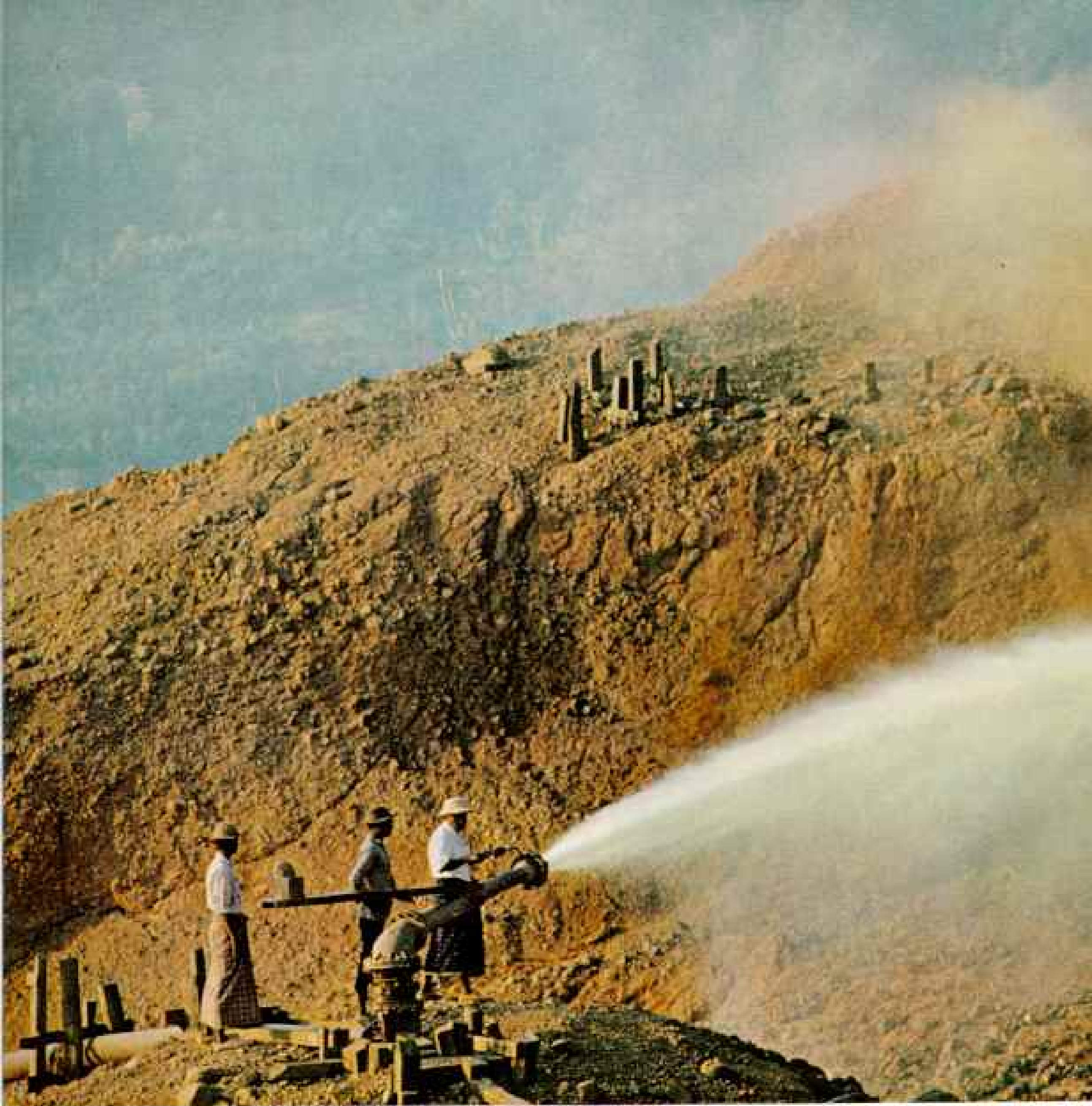


Stern-wheeler *Padashin* Loads Cargo and Passengers

Plying between Bhamo and Mandalay on the upper Irrawaddy, the shallow-draft vessel halts at Shwegu, a town noted for its red-clay pottery. First-class passengers occupy the forward cabins. Others carry their own blankets and sleep on deck. Some bring lunch hampers; others buy food at way stops. Double-sterned sampans cluster along the shore.

"Whackin' white cheroot," as in Kipling's day, gratifies a fish vendor in a village on the Irrawaddy. Using a cornhusk as wrapper, she mixes the leaves of trees with the tobacco. Umbrella-size hat shields her from sun.





Rushing torrent from a hydraulic jet sluices away a mountainside near Tavoy, on the Tenasserim coast, and redeems tin ore. Torn loose, the red earth flows through catchment boxes that trap fine black granules of cassiterite (tin dioxide).

Khan's troops invaded his lands, the king did little with the "36 million soldiers" he had boasted about.

He fled and sobbed, "I am become a poor man," because his cooks served him only 150 dishes for dinner, instead of the customary 300. His people called him Tarokpyemin, the "king who fled from the Chinese," and he was poisoned by his son Thihathu. Thereupon the Pagan dynasty collapsed. The western Arakan region became independent, the Mons revolted in the south, and Shan dominance grew in the north. Decaying Pagan became the tombstone of a golden era.

I drove southward from Pagan on a cart-rutted track to Chauk and to Yenangyaung, the "stream of ill-smelling waters," where oil derricks stand as thickly as temples in Pagan.

Before the war, Burma's wells yielded 275 million imperial gallons a day. A pipeline ran to a refinery near Rangoon. When the Japanese invaded, the British demolished these installations. British and Burmese engineers have restored production again, through a joint enterprise, the Burma Oil Company.

"Today we're producing about 400,000 imperial gallons a day in two new refineries," an official told me. "Burma uses it all."



PHOTOGRAPHS BY W. HILLET MOIRE © NATIONAL GEOGRAPHIC SOCIETY

Oil derricks edge the Irrawaddy at Chauk. British and Burmese, in partnership, operate other fields at Lanywa and Yenangyaung. Refineries in Chauk and Syriam process 400,000 imperial gallons of crude a day.



AS CAPTIONED

Rare star ruby (right) reflects light with a star effect. Weighing seven carats, it is worth some \$8,000. Pendant ruby, with hole drilled for chain, also reveals a characteristic pigeon-blood red.

Ruby dealer sorts second-grade stones she bought from miners at Mogok in the mountainous north.

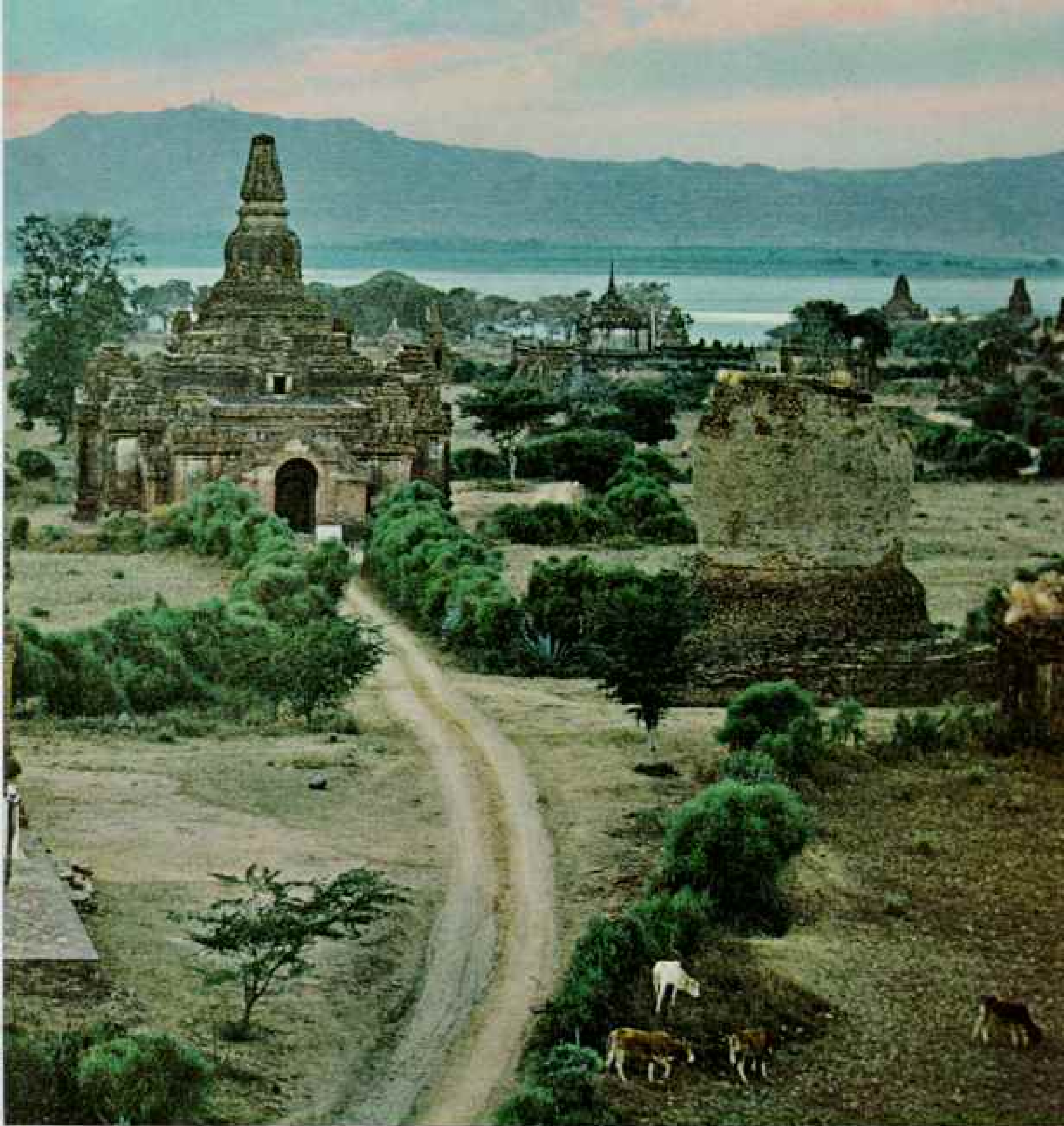




Five thousand temples stud Pagan, Burma's golden-age capital by the Irrawaddy. Rising



Frescoes, still bright two centuries after repainting, decorate the Ordination Hall in old Pagan. This scene shows Gautama Buddha with his followers, one of many portrayals of the holy man's life that cover walls and ceiling of the 13th-century shrine.



PHOTOGRAPH BY NATIONAL GEOGRAPHIC SOCIETY

in the 11th century, the city flourished until Kublai Khan's armies captured it in 1287.

From Chauk, I crossed the river to Lanywa airport, beside another forest of oil derricks. There I caught a plane to Rangoon, where I headed down the long kite-tail Tenasserim coast to Moulmein, Tavoy, and Mergui.

In Moulmein, nostalgia lingers for the days when the town was a busy British port. But the view from its "Ridge," atop which stands the old Moulmein Pagoda, is as fine as ever. In one direction lie the city and the Salween River; in the other spread rice plains from which rise limestone crags, eerie as the precipitous rocks in Chinese paintings.

Farther south, near Tavoy and Mergui, rich tin mines produce approximately a third of Burma's 1,500-ton yearly output. I watched hydraulic jets rip away steep slopes to uncover the tiny grains of ore in the red earth (page 196). And I wondered how Burma, independent for 15 years, will fare in the years to come.

From its southern tip to its mountainous north squeezed between India and China, Burma is a long land, a rich land. Given peace, it can indeed become the pleasant land its gentle people yearn for. **THE END**

Wolves Versus Moose on Isle Royale

By DURWARD L. ALLEN and L. DAVID MECH

THAT RARE SOUND, the timber wolf's haunting *owoo-oo-oo*, came to our ears one iron-cold February night on Isle Royale, in Lake Superior.

Dave Mech and I and two others were the only human beings on the 210-square-mile wilderness island, heart of Isle Royale National Park, Michigan. Fifteen bleak miles of ice separated us from the nearest mainland, the Minnesota-Ontario border country (map, page 206).

With the aid of an airplane, Dave and I, biologists from Purdue University in Indiana, were making field studies of the wolves and moose that share this roadless domain. Our aim: to study the hunted and the hunters in this unique natural laboratory, and their relationships to the vegetation that supports the entire wildlife community.

Our Aeronca Champion ski-plane had settled on frozen Washington Harbor at sundown. After supper in our winter headquarters shack above the inlet, Park Ranger Roy Stamey and our bush pilot, Donald Murray, had snowshoed to nearby Windigo Ranger Station to check the generator that provided our electricity. A few minutes later our door burst open.

"Out of it, men!" Don shouted. "The wolves are howling!"

Dave and I pulled on boots and jackets, and through the moonless dark we hurried down the trail on the hillside above the harbor. Across the ice, half a mile to the north, a ridge loomed black against a faint aurora. Somewhere over there, the wolves were in wild and joyous celebration.



BARED FANGS and bristling hackles bespeak a gray wolf's excitement. Buzzed by an airplane and cut off from the pack, Canis lupus turns in mid-stride to confront the flying monster.



ILLUSTRATION BY DURWARD L. ALLEN © NATIONAL GEOGRAPHIC SOCIETY

Brushing snow from the Aeronca Champion, Philip C. Shelton begins a long day of flying. Donald E. Murray (left) will pilot him above Isle Royale National Park, Michigan, to watch wolves and their quarry. A ten-year study by Purdue University, with support by the National Park Service, National Science Foundation, and the Wildlife Management Institute, seeks to learn how predators affect animals on which they prey.

Wolves on the hunt break for cover as the airplane approaches. The pack has been known to range 45 miles in a day. Isle Royale supports 22 or 23 wolves, descendants of animals from Canada that crossed some 15 miles of Lake Superior ice in the late 1940's.

The lead cantor was an impressive basso. His low-pitched moaning set off the others, who joined in on higher notes with drawn-out whoops and wails, yips and yipes—and yes, even barks, although some have said that wolves never bark.

At intervals there were chummy duets, melodious arias, and rambling obbligatos. Then a mass chorale of resounding splendor.

I couldn't help thinking of the adjectives commonly applied to wolf howling: horrible, eerie, blood-chilling, demoniac. Not so. In three winters of study on Isle Royale, this was the only time we heard a concert, with all stops out, from close at hand. For us it was

a thrilling fulfillment of the wilderness setting—the grand opera of primitive nature.

The performance went on for about ten minutes, then trailed off into afterthought howls and whines. All was silent on the ridge; appropriately, even the backstage aurora was fading. The only sound was the thump and thud of ice straining against the rocky shore. Then we realized we were shivering.

The Vanishing Timber Wolf

Around a coffeepot at our long table, we relived our experience, and Roy raised a question that may have bothered us all:

"The way the world is headed," he remarked, "I wonder how many people will ever get to hear what we heard tonight."

"As far as the United States is concerned," said Dave, "if they don't hear it in Alaska or Minnesota, they won't stand a chance."

He referred to the little-known plight of

The Authors: Wolves and moose confined to an island "laboratory" lured Dr. Durward L. Allen, Purdue University wildlife professor, and his graduate students into their ten-year Isle Royale project. L. David Mech wrote his Ph.D. thesis on the first three years of the study.

the gray, or timber, wolf. In all the United States south of Alaska, only northern Minnesota harbors a reasonably safe breeding population of wolves. The long-harassed animals of upper Michigan and Wisconsin are down to perhaps a couple of dozen. Whether they are breeding is uncertain; they seem to be on the way out. Occasional stragglers may cross our boundaries from Canada or Mexico, but these soon go the way of their trapped and poisoned forerunners.

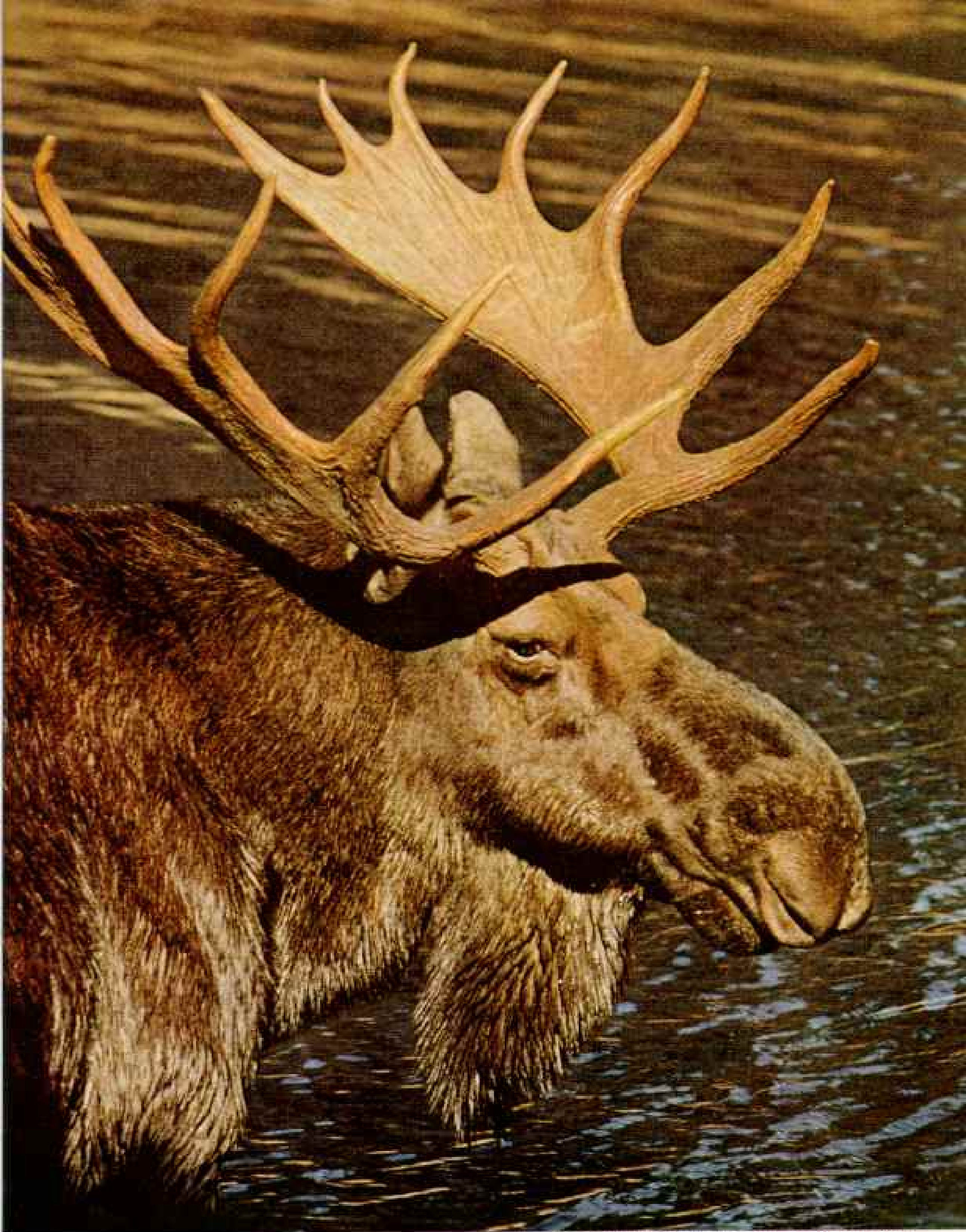
In many states we have coyotes or coyote-dog hybrids, and there are red wolves in the south-central region; these sometimes make newspaper headlines as timber wolves. But

the truth is that Lobo is gone from nearly all his old haunts.

About 14 years ago wolves crossed the ice from Ontario to Isle Royale. By coincidence, their new home was a national park, where wildlife is protected. They found a ready food supply in the moose, which had overpopulated and overbrowsed the island.

Dave Mech, a graduate student in wildlife management at Purdue, began studies of the wolf and its prey in 1958, as part of a ten-year program. In 1960, Philip C. Shelton undertook his overlapping research on beaver-wolf-moose relationships. Both students were working for their doctorates.





PHOTOGRAPH BY FREDERICK A. TRUSLOW © NATIONAL GEOGRAPHIC SOCIETY

Five-foot spread of antlers crowns one of the world's most dangerous animals, a bull moose in rutting season. Bellowing with rage at having his courtship interrupted, this Isle Royale bull, an estimated eight feet tall at the shoulders, charged wildlife photographer Fred Truslow and drove him into a small lean-to with nothing but insect screen between them. Only by freezing motionless did Mr. Truslow escape being seen and trampled by 1,600 pounds of furious moose. When finally the bull turned away, his quarry emerged and made this long-lens picture—from a distance of 34 feet.

After the mating season, bulls lose their antlers. Like the cows, they use their hoofs to fight off wolves.

During periods of seven weeks for three winters, Dave and Don Murray, the pilot, coursed Isle Royale by ski-equipped plane in nearly every daylight hour of good weather. They tracked wolves for hundreds of miles along well-traveled shelf ice, over lakes and bays, and on ridgetop trails. They watched *Canis lupus* in every phase of daily activity: trekking, sleeping, mating, playing, and hunting and killing moose.

"Dave," I asked following that February concert, "is this glee club across the ice the big pack of 15 that you've been tracking?"

Dave nodded. "I think so. When Don and I left them this afternoon, they were headed for Washington Creek. That's their route to the harbor, and they could have made a kill over there. If they are curled up on the ice in the morning, we'll know."

That is how it was. By early light we saw nine wolves scattered along the shore at the creek mouth. Probably there were more in the woods. For two days we kept discreet watch on them from the hillside.

On the third day, after the pack had trotted off westward in their usual single file, a fine snow began falling. Dave stepped into his snowshoes and headed across the harbor toward where the wolves had been. It was dark when he returned to our shack. He laid the jawbone of a moose calf on the table.

"One of them left that for us on the ice," he said. "If this snow keeps up, we'll never find any more of the calf. By now there are only a few bones scattered over the ridge."

In their summers on the island, Dave and Phil Shelton had only rare glimpses of a wolf. By analyzing scats, or droppings, gathered from a hundred miles of foot trails, they learned that moose—especially calves—and a few beavers were the main summer foods.

Deep Water Stops Pursuit by Wolves

During the season of open water, adult moose may be especially difficult to kill; an alerted moose can avoid trouble by wading in so deep the wolves would have to swim to attack. In 1958 three campers at Tobin Harbor told me they saw this happen. They watched a moose enter the water and then face the shore.

"Next thing we knew," said one, "three wolves were there on the rocks. They walked up and down the shore a few times and looked the moose over. I guess they decided it was hopeless, because they soon went back into the woods."

The relative safety of water vanishes with the coming of freeze-up and deep snow. Then our own field work becomes more rewarding. In good weather, by following tracks, we can see wolves almost daily from the air.

Lakes and bays offer this cow a retreat that vanishes after winter's freeze begins

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Isle Royale forms the largest land mass in Superior, deepest and coldest of the Great Lakes. Indians mined copper here 3,800 years ago. Vacationers come in summer; biologists work in winter as well.

"Most shameless panhandler at our door," the authors called this Isle Royale squirrel, a distinct subspecies of the red squirrel.

Shelf of ice along the south shore forms a favorite wolf travelway. Here scientists studying the predators must reach moose kills on snowshoes because lake, treacherous ice, and swamp bar ski-plane landings.



PHOTOGRAPHS BY EDWARD L. ELLEN © N.A.A.

In our first three winters the Isle Royale wolves numbered a minimum of 19, and more probably 21 or 22. Most observations were on Dave's pack of 15 or 16. It soon became obvious what their winter diet was—moose. Beavers keep to their lodges, and there is nothing else worth hunting. Several times Dave and Don saw wolves flush snowshoe hares without giving chase.

On the average, the big pack killed a moose every three to four days. But seldom did daylight, weather, gas supply, and good luck combine to let us witness this life-and-death drama from beginning to end. Dave and Don watched wolves stalk or chase some 136 moose, but they saw complete, successful hunts only four times.

Rare Sight: Battle to the Death

Here is Dave's account of a successful hunt on February 12, 1960:

Shortly after noon, Don and I were flying the shoreline. Southwest from Siskiwit Lake, we picked up a string of wolf tracks which led six miles to the head of Siskiwit Bay and a mile up the Feldtmann Ridge Trail. There we lost the prints in a maze of moose trails; so we began circling.

Suddenly, there they were—the familiar long line of 16 wolves, snaking through a snow-clogged blowdown. When they reached Lake Halloran, they lay on the ice and rested.

The pack was traveling south. We scouted ahead and found a cow moose and calf half a mile away. A mile farther down the shore, we saw a lone cow standing on a ridge. Don

looked back at me and pointed to the gas gauge. "Got to refuel," he shouted.

Half an hour later we were over the wolves again, south of Lake Halloran. They had approached to within a few yards of the cow and calf.

Protecting her calf, the cow defiantly faced the pack. As the wolves approached, she leaped at them, lashing out furiously with her forefeet. From overhead we could sense her anger as, with ears laid back and mane erect, she held her ground.

The wolves got the message, too. They

scattered in panic before each charge, then stood around considering. After several minutes, to our surprise, they abruptly left and went on south.

Must not be hungry, I mused.

Not until later did we recognize this to be common behavior. The wolves have a prudent fear of their dangerous quarry. They frequently give up and move on when a moose deliberately stands and defies them. We found that the pack stalks or "tests" about 12 moose for every one they kill.

As we watched, the pack reached the Lake

Roving pack trots single file on lake ice. "This is the way our wolves commonly appear, the way we remember them from one winter to the next," say the authors. Smaller females run third and fourth; others appear to be males.

Moose head for cover across a frozen lake. In deep snow their long legs can outrun wolves.

Bull at right has shed antlers, his glory during courtship. Moose are the largest antlered mammals.

208



ALL EXCEPTED BY HERRING L. ALLEN



Superior shore and headed southwest on the shelf ice. A few minutes later they stopped and spread out. They were 200 yards downwind of the lone cow on the ridge.

Then, with ears stiff, tails level, and noses into the wind, the 16 wolves stood still as pointers for several seconds, a picture of concentration.

Suddenly they sprang to life and rushed together, touching noses and wagging tails. It was as though something was communicated—as no doubt it was. A large wolf headed off toward the moose, and the rest

funneled into the woods behind. Deliberately they pushed through the snow, head to tail, like a string of dark sausages against the white. We have seen that formation many times before an attack. Only the animated tails betrayed their high excitement.

A hundred yards away on the ridge, the cow saw them. She hesitated, then began moving away. That seemed to trigger the wolves' pent-up urge. In complete abandonment, each for himself, they catapulted up the slope in ten-foot bounds. Within seconds, several were beside the cow. She ran a few yards,



HEADPHONE (LOWER PHOTO) BY L. DAVID WEAH © N. S. S.



Time to beat a retreat! Alerted by the clicking of a camera, a wolf suddenly spies the man behind it and loses his curiosity.

then backed into the spruces. More wolves arrived and began lunging at their huge prey.

Don nosed the plane down, and we made several passes within a hundred feet.

Cow moose average about 800 pounds. With bristling mane, ears flattened, head low, and neck extended, this one was a formidable antagonist. Each time a wolf lunged, she countered with a forefoot, striking in several directions.

But just when she seemed to have the situation in hand, she tried to run. First she charged her attackers and sent them scurrying. Then the race was on. Several of the pack tore at her rump and flanks, but she brushed them off in a clump of trees.

Deadly Teamwork Ends the Struggle

Now she was headed straight toward the blind edge of the 50-foot ridge, with the wolves running close at her hocks. She would have to face them there, I thought. Instead, she plunged directly over the edge, with the wolves swarming over her.

That was the end. A few minutes later the moose was dead, and the pack began to feed.

Circling overhead, Don and I faced a problem. Whenever possible, I needed to autopsy a wolf-killed moose to determine its state of health. Within an hour, the viscera would be eaten. It was more than two miles to Lake Halloran, our nearest landing place. Could I snowshoe to the kill, get the job done, and be back at the plane before sundown? Don glanced at a cloud bank in the west and shook his head. I agreed, so we turned toward Windigo and a late lunch.

Next morning, after waiting out an early fog, we found the wolves scattered around a hillside opening, half a mile from the kill. Some slept in a tight curl or lay with tawny, bloated bellies turned up to the sun. Others sprawled on the snow like great furry dogs before a hearth. They were obviously gorged.

In midafternoon the animals straggled back to the kill for another feeding. By the end of the second day there was a network

Aerial View of Life-or-death Drama: Healthy Moose Repels 14 Hungry Foes

Tracking Isle Royale's wolves, the biologists' plane came across this battle in the snow. The moose stoutly withstood the pack's onslaught. After a five-minute skirmish against lunging hoofs, the attackers decided they had a poor prospect and trotted away to seek a weaker quarry.







Striking his tent, a biologist moves on. Dr. Durward L. Allen, director of the Isle Royale project, spent a cold night in the woods in an effort to record the wolves in full voice, a microphone (right) aimed at a kill close by. Three inches of snow fell, and not one note came from the chorus. In three winters, the authors heard the "grand opera of primitive nature" only once.

Browsing moose clips aspen twigs as winter fare. Before the day is out, the animal may eat 25 pounds of forage. Some 35 years ago, moose numbering possibly 3,000 overpopulated Isle Royale. As they stripped off the browse, starvation and disease reduced the herd to a few hundred. Today wolves limit the herd to about six hundred, and young trees and brush are coming back.

HE EXTRACTS (BELOW) AND PHOTOGRAPHY BY DURWARD L. ALLEN (©) NATIONAL GEOGRAPHIC SOCIETY



of trails about the carcass, and it was being dismembered. On the third day only a great patch of hair and blood marked the scene. What wolves we could locate were widely distributed, chewing on bones or making forays a mile or more up the ridge.

The leftovers of this carcass might weigh 100 pounds. In little more than three days, the 16 wolves and a flock of ravens had disposed of roughly 700 pounds of moose.

It was par for the course. Based on estimated weights, our records indicate that the wintering wolf on Isle Royale eats an average of 13 pounds of flesh, hair, and bone per day. This includes days—sometimes three or four in a row—when it doesn't feed at all.

On the fourth night after the cow met her fate, Dave concludes, the wolves left the area, and it was a week before we saw them all together again.

As you might guess from Dave's account, the pattern for our winter wolf watching is now well established.

Isle Royale, 45 miles long and three to nine miles wide, offers a scenic sampling of our northern wilds. From June to September, thousands of tourists leave their cars at Houghton, Michigan, and cross Lake Superior on the National Park Service boat that makes three round trips a week. Many stay at the cabins or in hotel accommodations offered by Rock Harbor Lodge and Windigo Inn at opposite ends of the island. Others get closer to the natural scene by using the hiking trails or small boats and camping in scattered shelters on bays and lakes.

After Labor Day, the park staff begins closing up. The island is abandoned at the end of October. In December, winter closes in, and Isle Royale can be reached only by a plane on skis.

About February 1, our field party flies in from Eveleth, Minnesota—Don and a passenger in the Aeronca Champion, the other two men and all our gear in a Cessna 180. Thereafter, supplies are flown in about every two weeks.

Pup, Born on the Isle, Joins Pack

Our first flights to find wolves are always eager ones. In 1961 there were wolf tracks at the head of Washington Harbor, and Dave located a kill before the Champ touched down. On February 1, 1962, Don and I, out for the first time, spied the familiar string of black dots scattered across the ice of Mud

Lake. We counted, and then sang out practically together, "Seventeen!"

It was the largest pack ever seen together on Isle Royale, and one of the largest anywhere. Something new had been added. On a later flight we spotted the addition—a slender, gangling animal sitting on the ice wondering what the big, rackety bird overhead was up to.

"That's a pup for sure," Don called back, and I agreed. Later Don and Phil Shelton saw the animal again and got several more counts of 17 on the large pack. For the first time in four years, to our knowledge, a young wolf had been reared on Isle Royale.

Caribou Once Roamed Island

Over the years, the makeup of the island's wild community has changed. Sixty years ago there were no wolves or moose at all, and few if any beavers. At that time lynx and marten were part of the fur catch, but these disappeared. By the mid-1920's beavers were becoming conspicuous, and coyotes and foxes had arrived from the mainland.

The common animals seen by today's park visitor—red squirrel and snowshoe hare—have been there since primitive times. Probably that is true also of the mink, muskrat, two species of weasels, and one kind of mouse that complete the list of terrestrial mammals.

In early days the island was a range of one big-game species, woodland caribou. These migratory animals probably moved to and from the Canadian mainland, some 15 miles away. They could have crossed by swimming the open water or by walking the bridge of ice that sometimes forms in winter. But caribou disappeared from Lake Superior's north shore in the early decades of this century, the last one having been seen on Isle Royale in 1926.

As caribou declined in Canada, moose increased; by 1912 a few had crossed to Isle Royale and were thriving on the abundant browse—buds, twigs, and leaves. Protected from hunting by Michigan law—Isle Royale was not declared a national park until 1940—the moose herd doubled and redoubled.

Moose became the island's most famous attraction. In 1929, Adolph Murie and Paul Hickie of the University of Michigan found Isle Royale vastly overpopulated with moose—at least 1,000 and possibly as many as 3,000—compared to today's late-winter esti-

mate of 600. The moose's favorite food supplies were riddled: lilies and other water plants, American yew, aspen, birch, balsam, mountain ash, and dogwood.

Murie and Hickie recommended immediate reduction of the herd. If it were not done, Murie said, "the moose will begin to be eliminated by disease and starvation." His prediction was borne out; Isle Royale moose died off to a low level.

A ravaging fire in 1936 destroyed large areas of forest, but it also produced some benefits. The big burn developed a new growth of brush-stage vegetation—ideal moose browse. The moose survived, and the herd slowly began to build up again.

For naturalists and administrators, intriguing questions arose: What would happen if there were wolves on Isle Royale? Would they strike a reasonable balance with the moose herd and hold it at a level that could be supported by the annual growth of browse? Or would the wolves, amid plenty, get completely out of hand and wipe out the moose?

No one knew. But while naturalists pondered, wolves reached Isle Royale across that winter ice bridge. In the late 1940's, observers in Canada reported wolf forays toward Isle Royale. By 1949, wolf tracks were positively identified in the park.

While the wild wolves were establishing themselves on the island, an experiment was made with zoo-bred wolves. Four animals from Detroit were released. As predicted, they became a nuisance, pulling clothes off the line at a fisherman's cabin and terrorizing visitors. Two were recaptured and a third was shot. That left Big Jim, who became something of a legend.

Big Jim, Pariah of the Pack

The story of a wolf that might have been Big Jim is worth telling:

In February and March, 1957, James E. Cole of the Park Service spent 17 days flying the island with pilot Jack Burgess without radio or base-camp help. When their plane was disabled on Siskiwit Lake with a broken landing gear, they set out across Siskiwit Bay, snowshoeing toward their camp.

For six hours, a single wolf ambled along a quarter-mile behind them. When they rested, it lay down and waited. Its manner, said Cole, was that of a "friendly but cautious dog." He suspected that it might be Big Jim.

Dave Mech's abundant notes on the winter period in 1959 tell of a lone wolf that trailed along in the rear of the pack of 15. Obviously, this one wanted to belong but was not accepted. It cowered and retreated when

Detectives on Snowshoes Collect Evidence for a Scientific Inquest

Isle Royale's wolves often leave investigators nothing but a few bones and scraps of hide. In this case, the jawbone of a cow moose gives telling information to L. David Mech (left) and Dr. Allen Worn. Worn teeth betray her age—about 16 years. Lumpy jaw, a bone infection, probably interfered with her feeding. Poorly nourished, she proved easier prey for the wolves than a healthy animal. Her skull lies on twenty inches of snow.



Man's glove spans two pawprints. Wolf's hind foot made the upper impression.

Defatted bone marrow (left) attests the weak condition of a moose when the wolves pulled it down. Other victim's whiter marrow still possesses reserves of fat.



SCALPHORN BY J. DAVID MECH (L) & ALLEN WORN

chased, and it fed last at a kill. The following winter an "inferior-acting" wolf could sometimes be seen among the others, and in 1961 and 1962 there still was a wolf that dropped out frequently to go its own way.

Was Big Jim finally accepted by his kind? We can only speculate.

Rules Govern Wolf Society

Watching Isle Royale's wolves has confirmed something already known: Wolves are intelligent and well organized socially. They have rules.

The large pack of 15 to 17 commonly occupies the southwestern two-thirds of the island. During the first three winters of the study, an independent group of three wolves was frequently seen along the north shore. The three made their own kills and often fed on a carcass for a week or two. They prudently kept their distance from the others. Dave and Don saw one of them flee wildly across Moskey Basin with an advance guard of the large pack in deadly pursuit.

The wolf pack appears to defend its hunting range against aliens, as a dog defends its home grounds. This probably is a natural mechanism that spaces out a population for best use of habitat resources.

The large pack has its own internal struc-

ture. Single animals or pairs may leave the pack and travel alone for a few days. Sometimes a group of five does likewise; these could be a family of earlier years. Such splittings-off may leave seven, eight, or nine hunting together for a time. Then, one day, all 16 or 17 are strung out along half a mile of trail.

The social intolerance of the wolf seems to extend to other "wild dogs." The last coyote track was seen on Isle Royale in 1957, and suspicion centers on the wolf. Dave Mech saw wolves kill a fox they found feeding on a moose carcass.

Much seems to depend on the mood of the wolves—possibly whether they are full-fed or not—and the smaller animals may sense this. Phil and Don saw an improbable sight at the remains of a carcass in a swamp near the head of Siskiwit Bay. Snow was packed down over a considerable area around the kill, and numerous wolves idled about, sleeping or chewing on bones. A snowshoe hare ran through the scene, and a fox sauntered away within 10 or 20 yards of several wolves. Off to one side, only 50 yards from the dead moose, another fox was curled up sleeping!

Wolves and ravens evidently have an understanding. A flock of some two dozen ravens appears regularly with the large pack. At every kill they share the wealth with en-



thusiasm. The morning after that serenade at Washington Harbor, I had a fine opportunity to study this relationship.

A week before, we had placed some moose remains on the ice in front of a lean-to on Washington Creek. As I entered the blind from the rear, the entire flock of ravens went up from the bait.

The wolves had come this way; I could see their trail leading down to Washington Harbor. At the creek mouth some 300 yards away, nine of them were curled up on the ice.

During the day an occasional raven or two would visit the bait, but they did not stay. The keen birds were suspicious, even though I was hidden. Possibly their caution influenced two wolves that came up the creek.

I thought these animals would feed, but they were "spooky." Something was wrong. After giving me several minutes for pictures, they vanished into the woods.

The wolves at the creek mouth began moving around, rousing one another and engaging in nose-to-nose conferences, with much wagging of tails. Then a free-for-all frolic was on. The animals frisked, chased, and threw up showers of snow, while half a dozen ravens sat among them seeming to enjoy it all.

Several times, when a wolf leaped playfully at a raven, the bird rose a few feet in the air and dropped back again. I could not help feeling that, through eons of evolution, these two species had found a common cause.

Is Wolf Population "Saturated"?

As we gather new facts, we keep coming back to some basic questions. What is the future of this marooned wildlife community? Is the moose herd being whittled away? Are the wolves selecting out diseased and decrepit animals? These are vital questions for the National Park Service. Director Conrad L. Wirth and his staff have a pressing interest in the answers.

A critical question concerns the reproduction of the wolves. Will they build up and take greater toll of the moose herd?

An adult male timber wolf may weigh 100 pounds; a female about 80. A large wolf and a small one that keep together are recognized

as a pair. Mating has been observed several times, but to our knowledge no pups have been reared—with the single exception noted last year. For at least three years the wolf population stood at 21 or 22.

One might think that these socially sensitive animals have a birth-control program. Is one wolf per ten square miles a "saturated" population? Were more pups born that failed to survive? Could there be a food limitation in the spring rearing season? The wolves are aging, and some must inevitably drop out. Will there be corresponding replacements? What will happen to the organization of the large pack? These are things that can be learned on a limited island range.

Moose Believed Stable in Number

And what of the moose? In 45 hours of flying during February and March, 1960, Don and Dave covered the entire island on patterned flight lines. They tallied 529 moose, the best count yet. Allowing for animals missed, Dave estimated the population at 600.

A healthy breeding stock of that size might produce some 225 calves per year. From what we have seen of wolf-killed moose, accidents, drownings, and disease, year-round losses may well be of the same order, in which case the herd would be stable from year to year.

Surveying the food supply, with browse abundant in the big burn area and increasing elsewhere, we believe the moose have enough for health and high breeding productivity.

Are the wolves killing animals of all ages? We have examined remains of 68 winter kills whose age could be determined by size of animal or degree of tooth wear. Not unexpectedly, calves bear the brunt of predation: 20 of 68 kills were moose less than a year old. After that, with a single exception, there is a gap in kill records until the six-year class.

Evidently a moose between one and six years old is at the height of its vigor and unlikely to be a victim. The bulk of the adult kills are estimated at nine to ten years old, after which the number of moose in each yearly age group grows progressively smaller. Probably a few hardy animals escape a reckoning with wolves until they reach 18 or 20.

Pack Patiently Awaits Weakening of a Moose Whose Wounds Stain the Snow

Exhaustion, shock, and stiffening muscles sap this aged cow's ability to use her battering hoofs, and the milling wolves bide their time. If she bolts, they head her off; if she lies down, they force her up, allowing her no rest. When night comes, they will make the kill. Raven in tree (foreground) will share the feast.



Healthy, vigorous moose survive attack in two ways. Some stand and fight. Others, as soon as they see wolves, head off across country at their rapid long-legged trot. Struggling through deep snow, wolves may keep up for as much as two or three miles, but eventually they lie panting in defeat.

Of the 48 wolf-killed adult moose on which we have some health information, 11 were afflicted with lumpy jaw, a destructive infection of bone that usually occurs at the base of the oldest teeth. Fourteen animals had bone marrow depleted of fat, indicating the last stages of poor condition, from one cause or another (pages 214-15). Only four carcasses were sufficiently intact so that the viscera could be examined—and all four had lungs loaded with golf-ball-size cysts of the hydatid tapeworm.

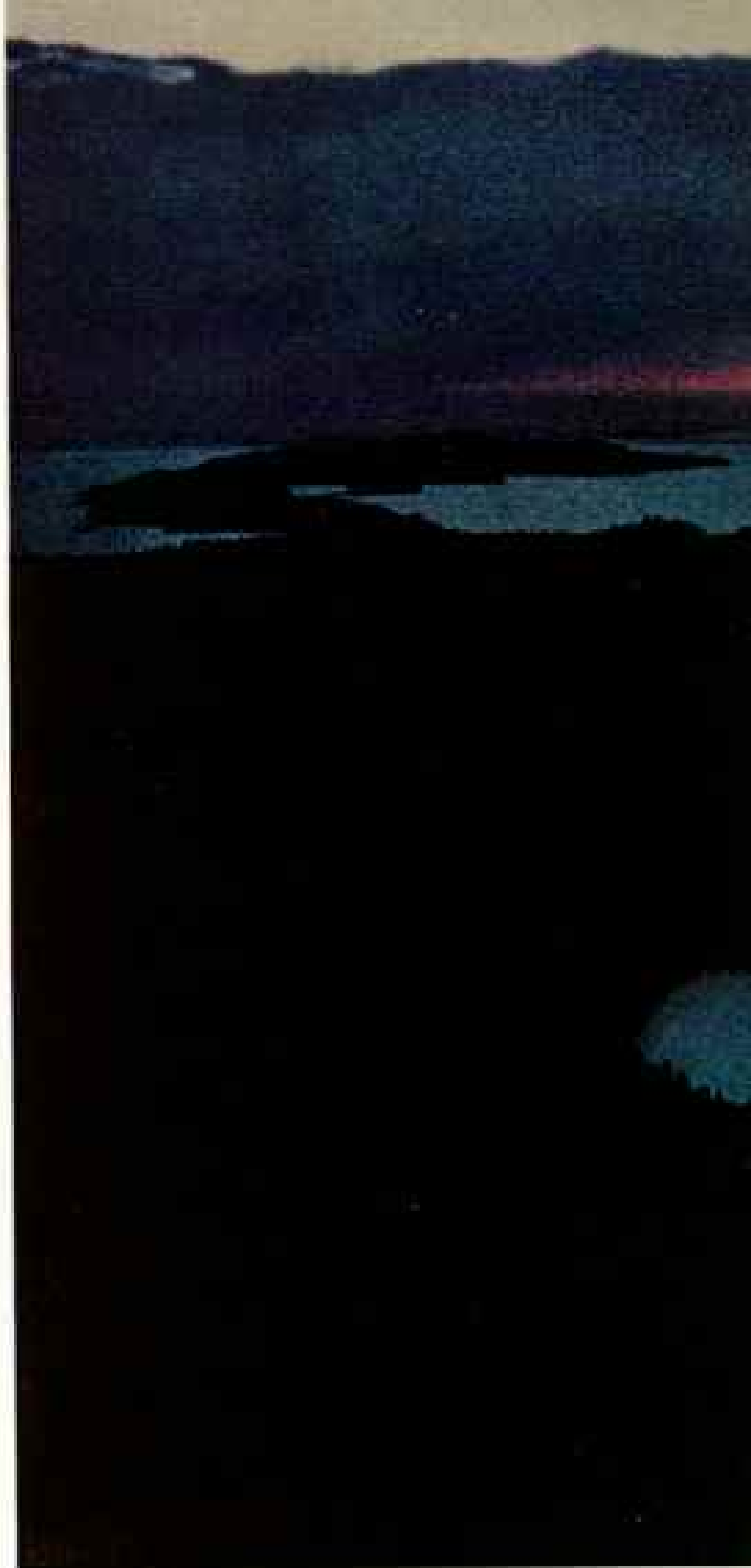
Practically every patch of hide we examine has at least a few "winter" ticks, parasites that sometimes kill big-game animals. Ticks may be especially thick on animals with other ailments, as the following record suggests.

In the second week of March, 1961, in late afternoon, Don and Chief Ranger Ben Zerbey

Setting Sun Gilds Clouds That Promise a Respite From Winter's Storms

Strato-cumulus formations say tomorrow will be fair over ice-locked Washington Harbor. Arctic storms often ground the scientists' plane. The wolves, meanwhile, may move 20 miles, requiring a tedious search to find them.

Gorged wolf, resting on the ice, lazily lifts its head as the scientists' plane flies past.





ACCOMPLISHED BY EDWARD J. ALLEN (BOAT) AND PHILIP C. BRIDGON © NATIONAL GEOGRAPHIC SOCIETY

saw a lone wolf keeping expectant watch on an injured moose. Tracks showed that the main pack had attacked this moose and, for unknown reasons, moved on. Each time the moose attempted to lie down, the wolf would threaten it—obviously a weakening process.

The wolf evidently killed the injured moose that night, for it was feeding on it the next morning. When Dave snowshoed to the carcass, he found a thin and disease-ridden animal with 35 tapeworm cysts in its lungs and the heaviest tick infestation yet seen.

Wolves Cull Out the Old and Ill

All these observations indicate a rigid culling of animals inferior because of age or infirmities. It seems highly significant that we have found one or more kinds of disability in 45 percent of adult, wolf-killed moose. It

must be remembered that in most cases we had only a few bones to examine.

Wolves and people—are they compatible in a park? We see no reason why not. Several times Dave Mech has snowshoed to a kill and frightened the pack from its feeding. He stood quietly on a carcass while the wolves came romping back on a trail to within 60 feet of him. There was a skidding to a stop, a look, a sniff, and they were gone. In summer the wolves lie so low that visitors seldom get a glimpse of them.

Our studies thus far indicate that the moose and wolf populations on Isle Royale have struck a reasonably good balance. It seems likely that, for decades to come, the voice of primitive America will still be heard on winter nights on a remote wilderness island in Lake Superior.

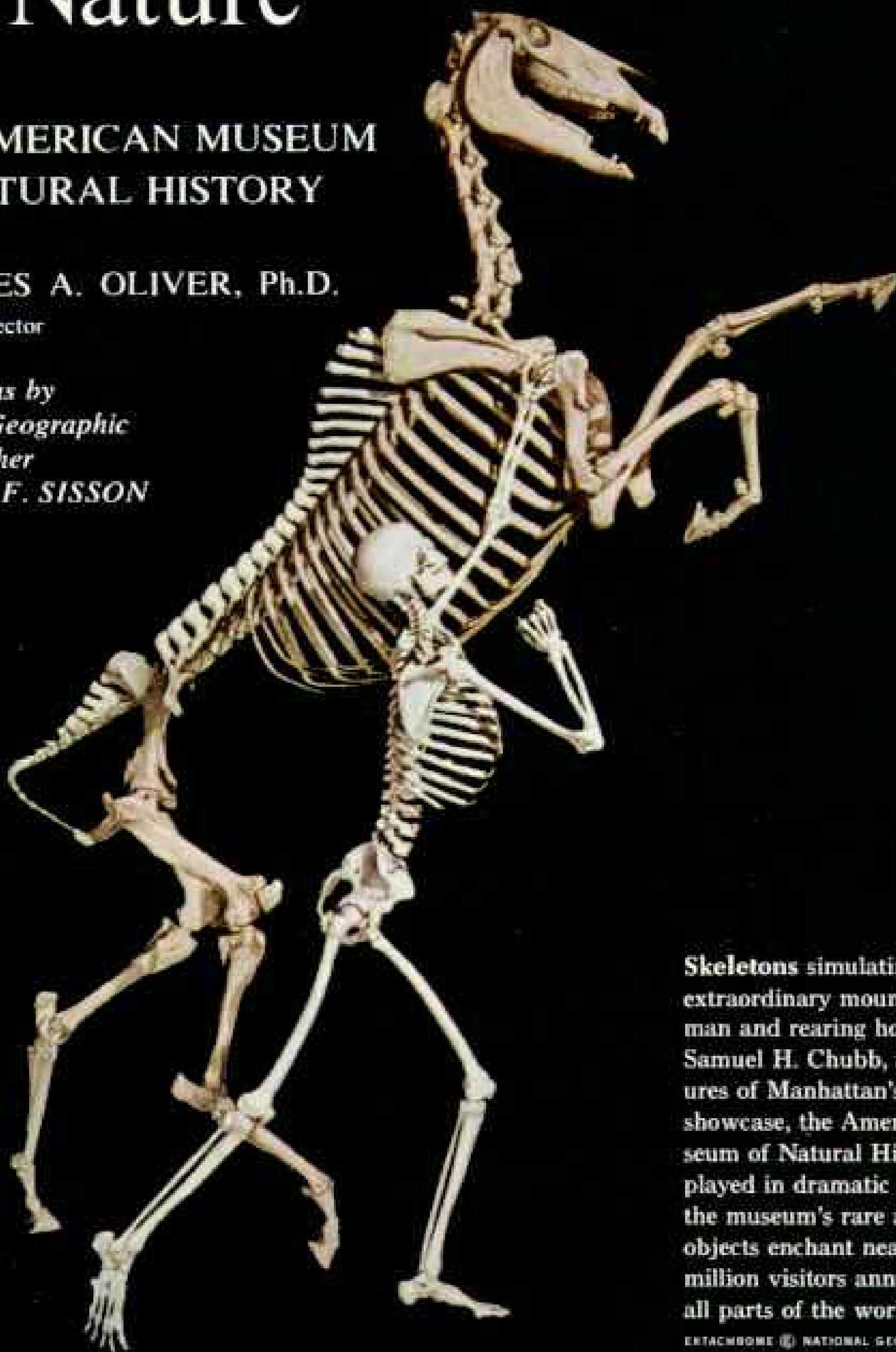
THE END

Behind New York's Window on Nature

THE AMERICAN MUSEUM
OF NATURAL HISTORY

By JAMES A. OLIVER, Ph.D.
Museum Director

*Illustrations by
National Geographic
photographer
ROBERT F. SISSON*



Skeletons simulating action, extraordinary mountings of man and rearing horse by Samuel H. Chubb, are treasures of Manhattan's famed showcase, the American Museum of Natural History. Displayed in dramatic settings, the museum's rare and exotic objects enchant nearly three million visitors annually from all parts of the world.

ENTACHROME © NATIONAL GEOGRAPHIC SOCIETY

WE DO OUR BEST at the American Museum of Natural History to answer hundreds of questions daily. But I fear we have so far failed one hopeful five-year-old visitor.

He stood at the entrance to Roosevelt Memorial Hall, fronting on Central Park in New York City, while his mother pulled out a coin and dropped it into a contributions box. (Such small gifts help the admission-free museum offset operating expenses.)

The boy watched the red wooden box expectantly, until his patience finally flagged.

"Well?" he demanded. "What's going to come out?"

Now here, if one pursues the notion, stands a vending machine to dazzle the imagination. Think of the marvels it might dispense:

The head of a baby mammoth, or a clutch of fossilized dinosaur eggs. Thirty-five smoked human heads, lavishly tattooed. The biggest meteorite ever pried from the earth. A herd of seven African elephants, superbly mounted. A Tibetan trumpet carved from a human thighbone. A model of a common housefly, 40 times larger than life-size.

Gateway to Far Places

But the museum is much more than a marvelous vending machine. It grants the visitor passage, as well, to an enchanting moment in a far-off place or time.

Here, in sun-dappled bamboo forest, a shy African bongo lifts lyrelike horns in the instant before flight. By an arctic stream, an Alaska brown bear rears its bulk to catch the stranger's scent. A naked Cashibo warrior aims a long arrow into the dim green tangle of Peru's Montaña. Petrels and albatrosses pace a sailing ship off New Zealand.

A few million years before its kind will mysteriously die, a ghostly *Allosaurus* stalks this day's kill—the larger *Brontosaurus*—in a Texas marsh. And tonight, whisked into the 14th century, you see in the heavens above New York City that Vega, not Polaris, is the North Star; 12,000 years hence the Southern Cross hangs, easily visible, above the horizon.

Quite a magic box!

As its Director, I confess frankly to a feeling of awe about the American Museum of Natural History. And the feeling has grown since I first saw it as a college student some thirty years ago.

Perhaps the visitor's first surprise is the discovery that this is not a single building, but 19 buildings, bafflingly interconnected (pages 230-31). Together they comprise one of the

largest municipal structures in New York City.

Inside, protected by four acres of glass, more than 2,300 habitat groups, mounted specimens, showcases, dioramas, and scientific exhibits fill 58 great halls and alcoves open to the public. As a gateway to nature, this institution has few peers.

The museum's visitors in one 12-month period included Premiers Jawaharlal Nehru of India and Antonin Novotný of Czechoslovakia, and Crown Prince Akihito of Japan. The Prince arrived carrying a paper bag stuffed with leaves, twigs, and acorns he had collected; museum scientists identified the specimens for him.

Prince Akihito and our other famous visitors shared a common denominator with the 2,900,000 persons who passed through the museum's doors last year: an abiding curiosity about the world in which they live.

Chilean Mummy Still "Perspires"

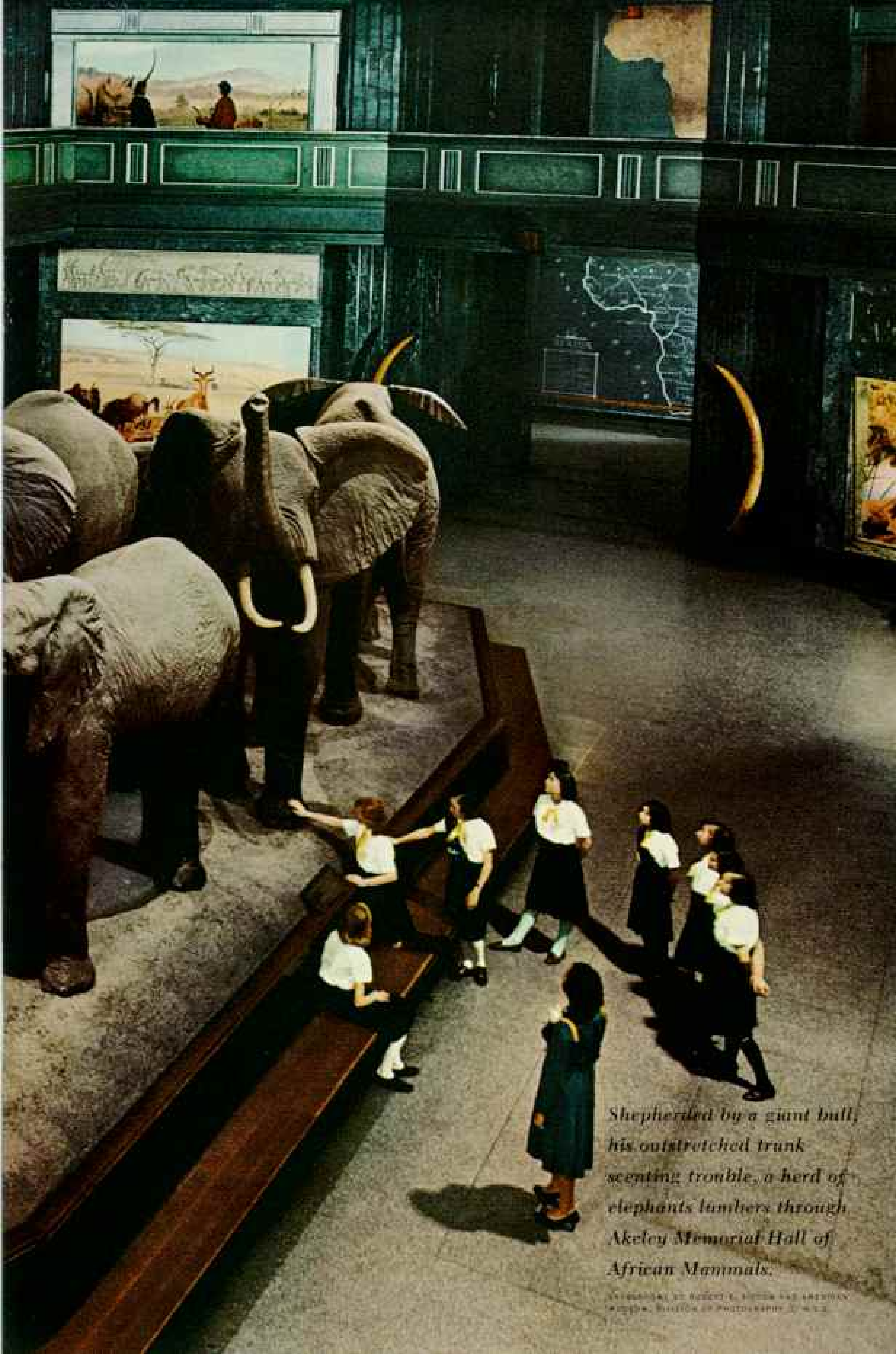
Although the museum's magnetism reaches round the world, most visitors naturally come from New York and surrounding communities. And they display an appropriate sense of ownership. Many call it simply "The Museum," as though no other existed. I have met New Yorkers who have never set foot inside it; but I know none who has contented himself with a single visit. It would be as unthinkable as eating one salted peanut.

Simply to walk the museum's 23-acre maze of corridors, exhibit areas, laboratories, offices, and storerooms requires roughly ten hours. And this demands steely self-discipline. It leaves no time for a lingering look at the bones of an extinct, ten-foot-tall moa from New Zealand, or the blackened mummy of a prehistoric Chilean copper miner, who still exudes a strange "perspiration" when the humidity is just so.

During such a brisk tour, a visitor would pop his head into 13 scientific departments and into the office of my eminent predecessor, Dr. Albert E. Parr, now our Senior Scientist. The visitor would meet more than 600 employees, ranging from curators to carpenters. He would see research associates (almost 100 of them labor here, unsalaried, simply

The Author: Dr. James A. Oliver, zoologist and conservationist, became Director of the American Museum of Natural History in 1959. He first served the museum in 1942-48, except for three wartime years with the United States Navy, and spent 11 years in university and zoo posts before returning as Director. He has written three books on reptiles, his first field of research as a scientist.





Shepherded by a giant bull, his outstretched trunk scenting trouble, a herd of elephants lumbers through Akeley Memorial Hall of African Mammals.

AN EXHIBIT BY THE U.S. NATIONAL MUSEUM, WASHINGTON, D.C. PHOTOGRAPH BY PHOTODISC INC.



for the love of science), artists, preparators, electricians, attendants, and cleaners (who regularly scrub space equivalent to 10,000 kitchen floors). He would hurry past the museum's own power plant and printing shop, tannery, gift shop, and 175,000-volume natural-history library, one of the world's finest.

Still, he would not have seen it all; that would require trips to museum field stations maintained for scientific research—to Long Island, Bimini in the British West Indies, Florida, and Arizona.

Nine-tenths of the museum's scientific treasure lies, like most of an iceberg, unseen by the public. Our attic overflows with priceless artifacts; our basement bulges with irreplaceable bones. A quarter of a century ago, someone placed a \$30,000,000 valuation on the museum's collections—a doubtful appraisal at best. How can a price be put on 3,000 meteorites or more than a million shells?

Rows of insect- and dust-proof cabinets, vaults, and storerooms safeguard more than 2,000,000 anthropological specimens; some 800,000 birds; 12,000,000 insects and arachnids; 100,000 fossil vertebrates, including the greatest group of dinosaurs in any museum; nearly 200,000 mammals, and 200,000 amphibians and reptiles.

A St. Bernard That Played Dominoes

Ninety-four years of gifts, bequests, purchases, trades, and expeditions have filled this reservoir to the brim. The museum in its early years accepted nearly every proffered hoard of birds' eggs, fish scales, rocks, and arrowheads. Perhaps its labyrinthine storage areas still conceal such early acquisitions as "5 large ears Corn"; "2 Fangs of Serpent"; "1 piece of Teak from ship, 'Royal George'"; or the wretchedly stuffed pelt of "the celebrated St. Bernard dog, 'Apollo.'" (Apollo



MAN IN SPACE

At the top center of the exhibit is a replica of Colonel Glenn's Mercury capsule, which was launched on October 8, 1958, and carried the first American into orbit. The capsule is a small, spherical, pressurized aluminum cylinder, about the size of a large suitcase. It is designed to carry a manikin or a small animal, and to return safely to the earth. The capsule is attached to a larger, cylindrical structure, which is the model laboratory in space. This structure is designed to carry a team of astro-scientists into orbit 350 miles above the earth. A manikin wearing a reflective silver coverall over his space suit floats above the hull to check meteorite damage. Spectators at left watch an animated film of orbital flight.



RE-ENTRANCE BY NATIONAL GEOGRAPHIC PHOTOGRAPHER ROBERT F. ZIEGLER (© 1958)

Astronaut John Glenn's face greets visitors to Theodore Roosevelt Memorial Hall, site of the Man in Space exhibit. A replica of Colonel Glenn's Mercury capsule hangs from the ceiling at center. Aries, a representation of a model laboratory in space, "flies" at right. A pressurized aluminum cylinder as large as a luxury trailer, Aries is designed to carry a team of astro-scientists into orbit 350 miles above the earth. A manikin wearing a reflective silver coverall over his space suit floats above the hull to check meteorite damage. Spectators at left watch an animated film of orbital flight.

diverted New Yorkers of the 1830's with an apparent talent for playing dominoes.)

Today a department head rapidly acquires the grace of a bullfighter in sidestepping doubtful donations. One visitor arrived with a dead lobster under his arm. He had dressed the crustacean in top hat and cutaway coat. A curator examined the gift gravely, swallowed his conscience, and declared that this *objet d'art* merited the company of nothing less than old masters. The would-be donor departed, quite pleased, with directions for reaching the Metropolitan Museum of Art.

Many donations, of course, have been

princely; the museum owes its priceless scientific collections largely to the generosity of men who were not scientists themselves. J. P. Morgan purchased and donated two collections of gems assembled by Tiffany & Company for the Paris Expositions of 1889 and 1900. They cost him \$200,000 and form the glittering nucleus of today's Morgan Memorial Hall of Minerals and Gems (page 232).

Mrs. Harry Payne Whitney presented the museum in 1932 with the world's finest private collection of birds—280,000 specimens acquired over a lifetime by Lord Rothschild. The building that houses them—the magnif-

icent Whitney Wing—had already been provided by a gift from her late husband.

The famous explorer and former Director of the museum, Dr. Roy Chapman Andrews, entitled his autobiography *Under a Lucky Star*. The phrase applies equally to the institution he served so well. Fortune *has* smiled upon it, sometimes in unexpected fashion.

Mr. Whitney, for example, presented a munificent gift—\$750,000 worth of stock—on a Friday. By Monday it was worth \$10,000 more, and was still climbing. Over groans of protest, the comptroller firmly invoked the museum's rule in such matters and converted the stock to cash. A fortnight later came the market crash of 1929.

Museum anthropologists had never heard of Frederick G. Voss, a New York insurance executive who left their department \$600,000. And Deputy Director Walter F. Meister told me of a stylish matron who walked unexpectedly into his office one day and handed him \$15,000 in securities.

Student Dreams of a Great Museum

The idea of the museum was conceived by Prof. Albert Smith Bickmore. The young Maine-reared naturalist planned "the future museum of natural history for our whole land" while a student under the great Louis Agassiz at Harvard in the 1860's.

In 1865 Bickmore sailed for the Spice Islands on a merchantman laden with ice and apples. In three years he traveled 40,000 miles through the East Indies, Asia, and Europe, collecting shells, birds, and other specimens. Two things accompanied him everywhere: a Bible and the plan for his museum.

New York was one of the few great cities of the East that had no natural-science institution worthy of the name. Moreover, Bickmore reasoned, "an institution which must depend upon the interest which rich and generous men may take in it . . . should be located in the immediate vicinity of their homes."

Bickmore found New York receptive. Charles Darwin and Thomas Huxley had

inspired millions to examine their physical world with new wonder. Within a year he had the pledged support of a notable list of "rich and generous men."

The museum's first roster of trustees included J. P. Morgan the elder; soap manufacturer Robert Colgate; publisher Charles A. Dana; mining magnate A. G. Phelps Dodge; and financier Morris K. Jesup, its third President, who eventually endowed it with \$6,000,000 and incomparable collections.

Among the first to respond to Bickmore's proposal was a wealthy importer named Theodore Roosevelt. His son, then a frail boy, was to carry an ebullient interest in the new museum into the White House and on far travels, bringing back many fine specimens.

In 1936 the State of New York completed the majestically columned Roosevelt Memorial addition to honor the Nation's nature-loving 26th President. Today, in its Man in Space exhibit (pages 224-5), it displays wonders Roosevelt could scarcely have imagined.

The museum's founders dug into their own pockets to buy the four finest collections of mammals, birds, fishes, and reptiles then available. In 1869 they persuaded New York City officials to provide quarters for the new museum, originally two floors of the Arsenal that still stands in east Central Park.

Fruitful cooperation with the city has continued ever since; the museum stands on city-owned property, and the city provides for building construction and maintenance, as well as for salaries of teachers and custodial personnel. All told, municipal aid covers more than a third of operating expenditures.

The generosity of trustees, members, and friends maintains and enlarges the collections. The museum is fortunate, as in the past, to have on its Board of Trustees men and women who are not only distinguished in public affairs and industry, but who also have a particular interest in science and education. The officers of the museum today are Alexander M. White, President; F. Trubee Davison,

(Continued on page 235)

Birds are their business. Curators Dean Amadon (left) and E. Thomas Gilliard examine a few of the museum's 800,000 avian specimens. Africa's red bishop bird, suspended by a wire, appears to perch on Dr. Amadon's shoulder. New Guinea's greater bird of paradise spreads ornate plumage. Others, clockwise from the big-beaked toco toucan of South America, are: northern South America's Cayenne cotinga, rosy-breasted bee-eater of Central Africa, eastern Asia's golden pheasant, black-throated oriole of Central and South America, New Guinea eclectus parrot, Lady Amherst's pheasant of eastern Asia, the Andes' cock-of-the-rock, and tropical South America's golden-eared tanager.





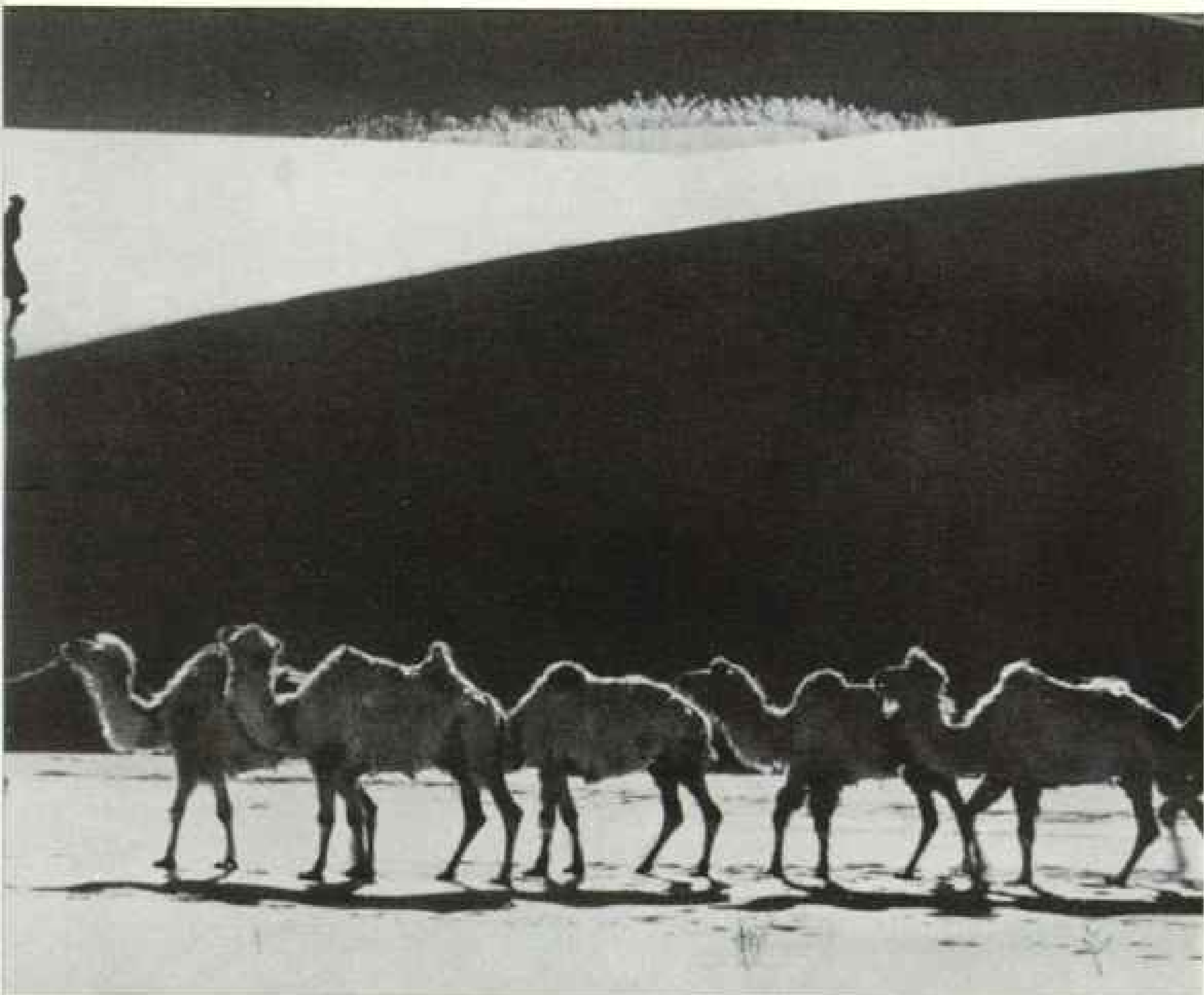
Camels plod Gobi dunes

EXPEDITION! The very word breathes adventure. Yet behind every scientific trek lie months or years of careful planning.

The American Museum dispatched its first official expedition—in 1887—to Montana for bison. Since that year more than a thousand field parties have combed the world.

None experienced more hazards or produced more spectacular finds than the Central Asiatic Expeditions of the 1920's. For eight years, begin-
228





AMERICAN MUSEUM OF NATURAL HISTORY

where museum scientists found dinosaur eggs

ning in 1922, Dr. Roy Chapman Andrews led a small army of scientists deep into Outer Mongolia, seeking evidence that it was the homeland of many mammals.

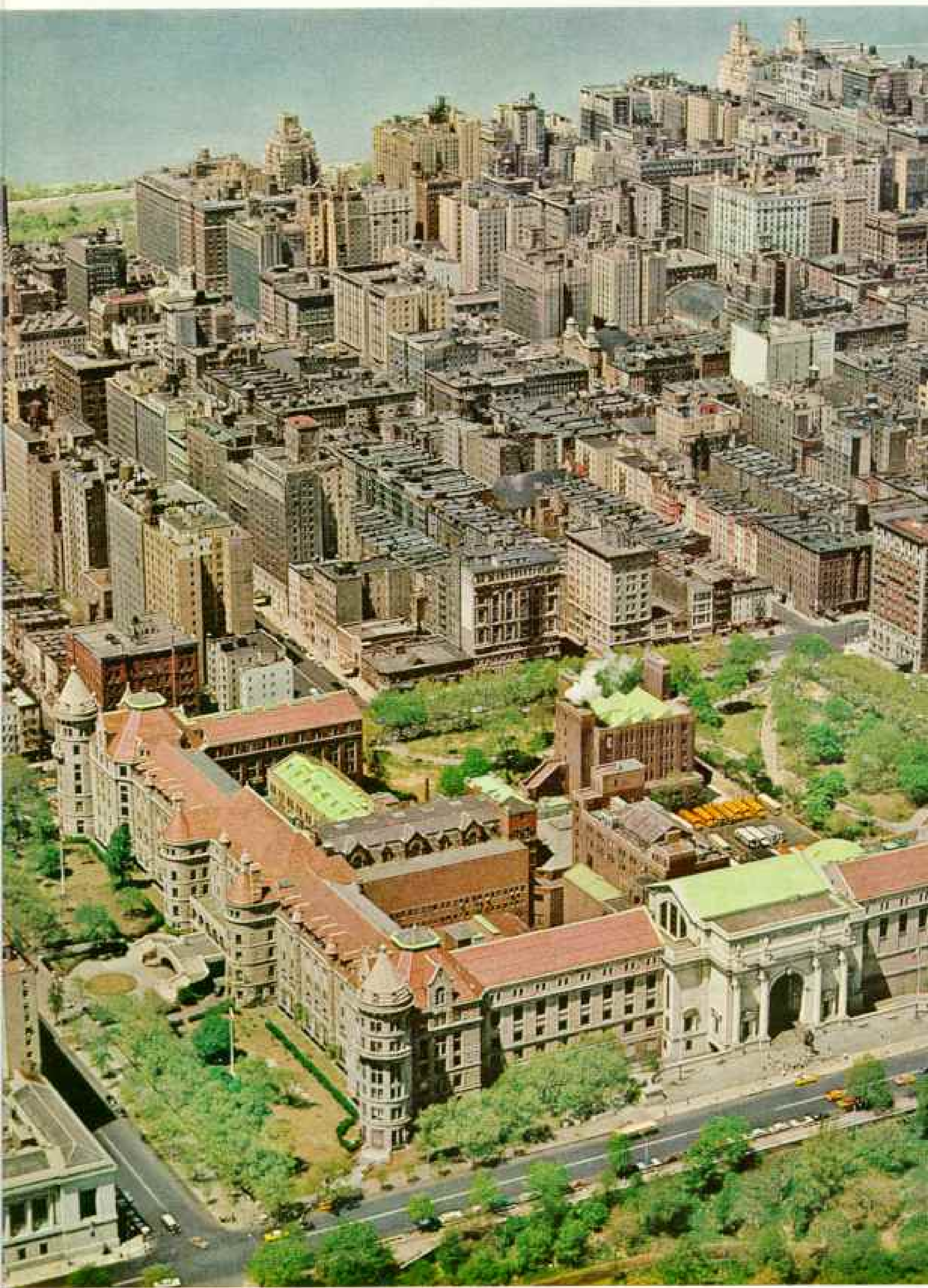
Onto the elevated basin known as the Gobi rolled a fleet of cars and trucks (below), first ever to travel those roadless wastes. Camel caravans rode out in advance to set up caches of gasoline and oil. Rendezvousing with the motorcade, they brought back items collected in the field.

And what prizes the explorers wrested from the ancient sandstones of Asia! They found bones of shovel-tusked mastodons, a giant *Baluchitherium*—world's largest known land mammal—and a clutch of beautifully preserved dinosaur eggs (left).

Dr. Andrews inspects fossil eggs uncovered in 1925 near Shabarakh Usu. Their ends pointing toward the center of the nest, they lie—metamorphosed into stone—exactly as the mother reptile left them 100 million years ago.

229







REPRODUCED BY ROBERT F. ZIEGLER © H.A.R.

Theodore Roosevelt Welcomes Visitors to the Addition Named in His Honor

This heroic equestrian bronze by James Earle Fraser depicts Roosevelt flanked by an American Indian and an African tribesman. It stands in front of the building dedicated by New York State in 1936 as a tribute to its famous son—the man who served as its Governor and later as the 26th President of the United States.

With Central Park as its front yard, the museum spreads along four blocks between New York's West 77th and 81st Streets. A complex of 19 buildings, it is one of the largest museums in the world. Facilities include four field stations—on Long Island, in Florida, Arizona, and the Bahamas.

President Ulysses S. Grant set the institution's cornerstone in 1874. So many buildings have risen on the grounds that today the cornerstone cannot be found.

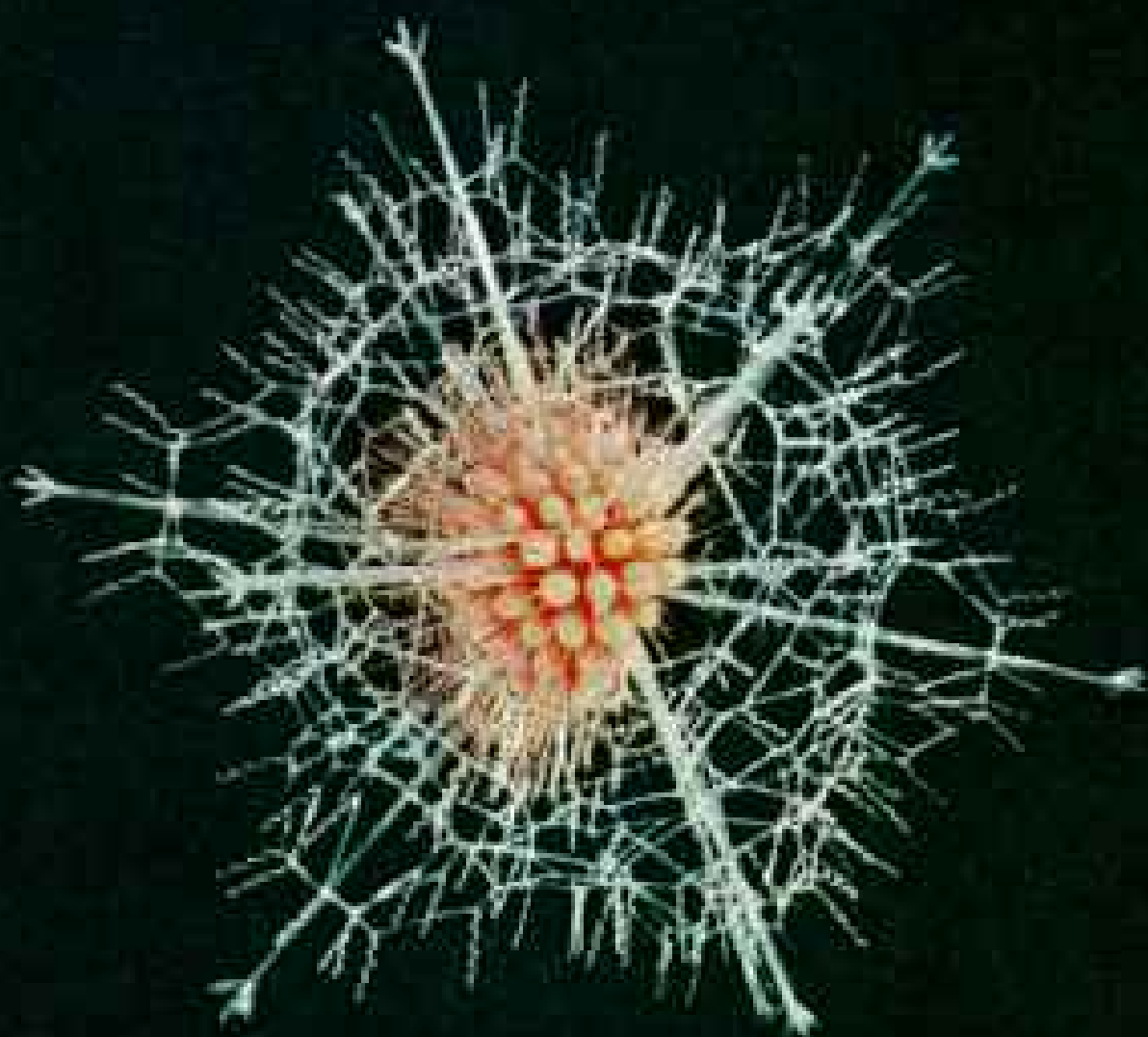
School buses park behind the museum's domed Hayden Planetarium, named for Charles Hayden, New York philanthropist (page 246). Five blocks away, the Hudson River flows past Manhattan.

**Crystal Atlas Bears a Globe With Cyrillic Lettering;
Three-inch Statuette Came From Tsarist Russia**

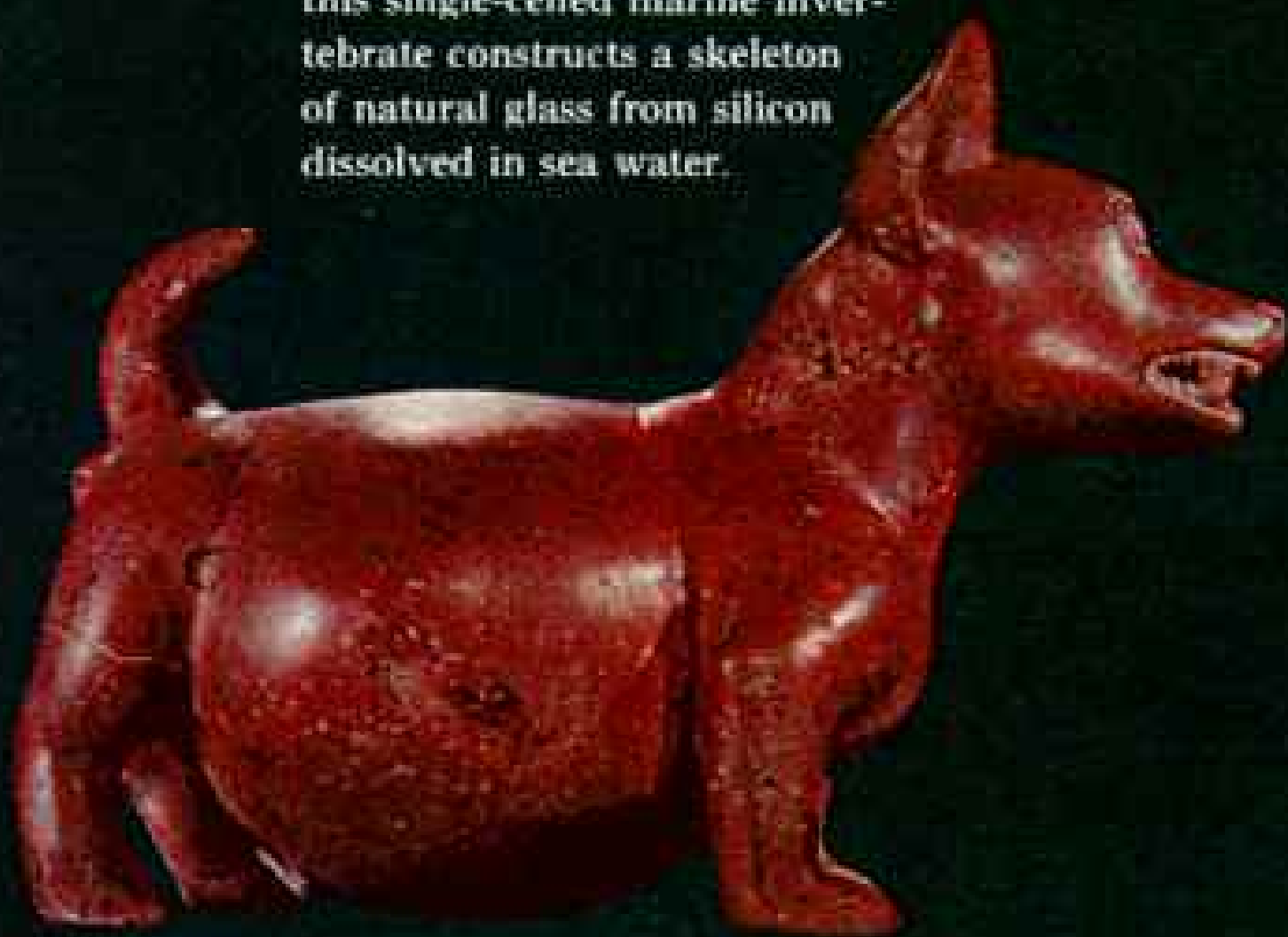
To further man's knowledge, the American Museum accents the story of the universe, the earth, and its inhabitants in 58 exhibition halls. Scientists sponsored by the museum have made expeditions to all continents and returned with superlative works of man and nature. And skilled artisans in the museum's laboratories duplicate facets of life that defy the collector—witness, for example, the snowflakelike creature on the page opposite. Atlas statuette came to the museum in 1901 with the Tiffany Collection, donated by J. P. Morgan.



Graceful ballerina, hewn from translucent chalcedony by artist Georges Tonnellier, ranks among the world's finest gem carvings. J. P. Morgan made a gift of the 8½-inch figurine to a friend, Charles Lanier, who later gave it to the museum.



Exquisite glass model of a microscopic radiolarian illustrates how this single-celled marine invertebrate constructs a skeleton of natural glass from silicon dissolved in sea water.



Ceramic dog, a Mexican hairless, came from a tomb in Colima. Pre-Columbian Indians fattened its kind for food. The figure measures 15 $\frac{3}{4}$ inches.



Golden ammonite, relative of the chambered nautilus, lived in Bavarian seas 140 million years ago.



© NATIONAL GEOGRAPHIC SOCIETY

Gold ornament, 3 inches long, adorned an Ashanti chief in Ghana a century ago.

Ceremonial headdress with mask from New Ireland in the Pacific utilizes the trapdoors of snail shells for eyes. Bark-cloth crest covered with lime and sticks towers above the fearsome wooden face.





REHARRING BY PAUL A. ZWILL, NATIONAL GEOGRAPHIC SENIOR STAFF © N.G.S.

Baby green turtle is measured by Dr. James A. Oliver, Director of the American Museum, at the Lerner Marine Laboratory on North Bimini Island in the Bahamas, one of the museum's four field stations. Scientists here hope to re-establish breeding grounds of the green turtle, decimated by centuries of hunting. This specimen will be tagged and released. Laboratory attendant Raymond Pritchard assists Dr. Oliver.

President Emeritus; Fredrick M. Eaton, Robert G. Page, and C. DeWolf Gibson, Vice Presidents; August Belmont, Treasurer; and Frederick M. Warburg, Secretary.

Within a few years of its founding, the museum bulged with so many glass cases that scant room remained for visitors. The present site, across from Central Park between West 77th and 81st Streets, was cleared of squatters' shanties and roaming goats, and the first of the present buildings opened to huge crowds on December 22, 1877.

The next day the grand halls stood all but deserted. Professor Bickmore, then Superintendent, cheerlessly surveyed the lonely corridors. He had brought his dream, the American Museum of Natural History, to the city. But it would be several years before an elevated railway brought the city to the museum.

Despite the trickle of visitors in these early years, the institution grew. Major purchases such as the Hall Geological Collection and the Cope assemblage of fossils began the museum's world-famous study collections, which today attract scientists and scholars from around the world.

In 1887 the museum's first expedition set

out for the badlands of Montana. It returned, disappointed, with a pair of shaggy bison skins, reporting that the buffalo had been "exterminated by cowboys and the Indians."

Since then more than a thousand field parties of the American Museum have combed every continent and major island area for specimens. Some have made not only scientific news, but front-page headlines.

Such were the celebrated Central Asiatic Expeditions of 1922 to 1930.

Dr. Andrews Roams the Gobi

Dr. Henry Fairfield Osborn, the museum's fourth President and one of this country's greatest zoologists, had predicted in 1900 that paleontologists would find the birthplace of many species of mammals in the little-known wastes of the Central Asian tableland.

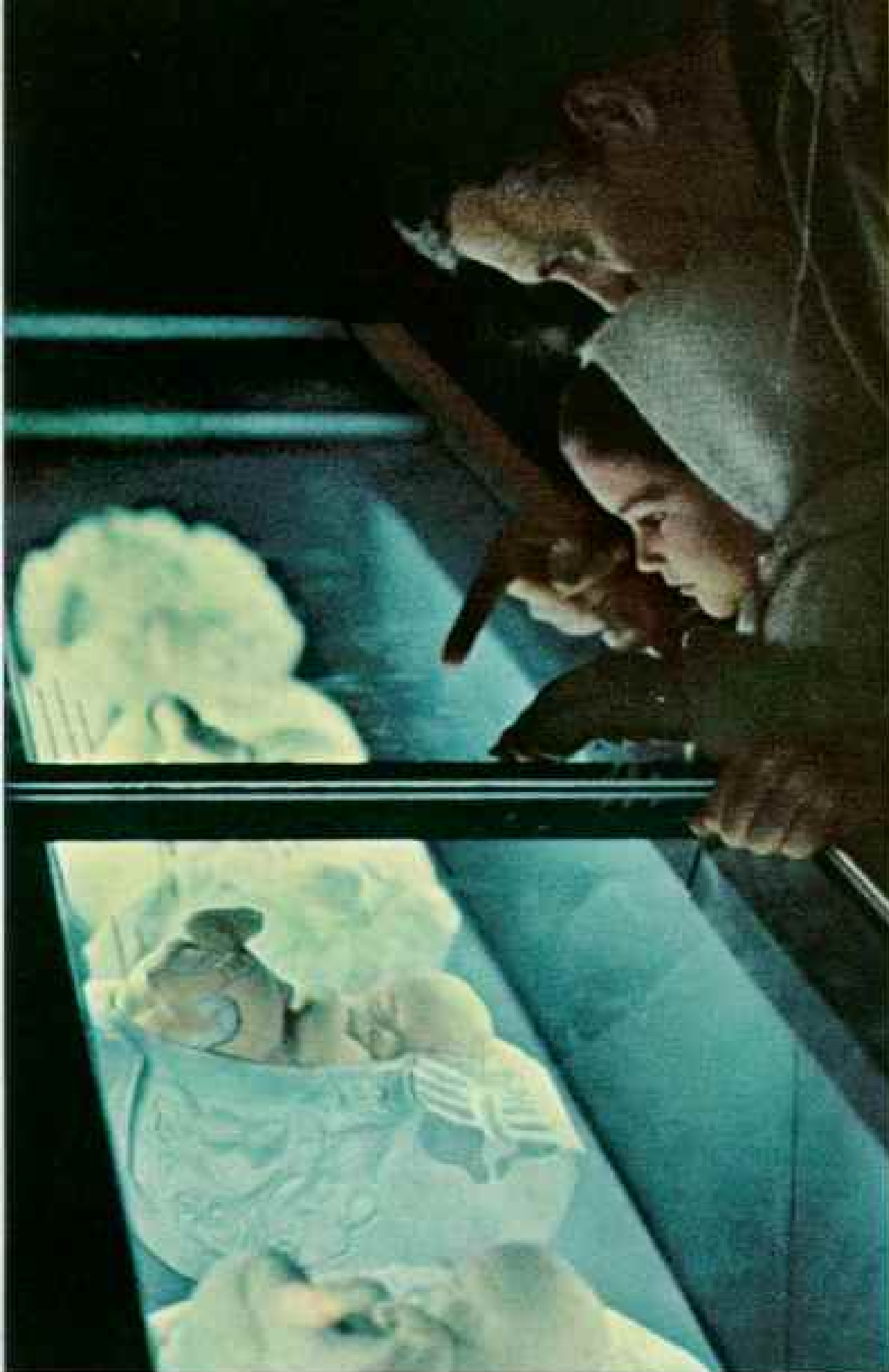
Proof of his theory awaited dependable automotive transport—by which scientists could do ten years' work in one—and a man like lean, athletic Roy Chapman Andrews. Dr. Andrews coupled a keen mind with an insatiable urge to probe the earth's hidden corners; for 25 years he did not spend 12 consecutive months in any single country.



Anesthetized bee, a yellow-faced male, sits on a thumbnail. *Pseudopanurgus*, shown four times life-size, is a subject of study at the museum's research station at Portal, Arizona (right).



Bee's burrow lies open for inspection by Dr. Jerome G. Rozen, Jr., Chairman of the museum's Entomology Department. He works at night because daytime Arizona heat might damage larvae of the female *Pseudopanurgus*. Nest contains pollen gathered for food.



Miracle of life. Father and daughter study the childbirth exhibit in the Hall of the Biology of Man. Six plaster models depict stages in the process of birth.

Six years in preparation, the hall's exhibits explain how the systems of the body function. Displays include a human cell made of illuminated plastic, plastic-preserved specimens of heart, lungs, and digestive tract, and a depiction of the nervous system containing 5,000 feet of wire.

Vital Organs Light Up in the Transparent Woman

Student nurses of Caledonian Hospital in Brooklyn ring the life-size plastic model. Kenneth A. Chambers lectures.



IN EXPLORATIONS © NATIONAL GEOGRAPHIC SOCIETY

In 1922 Dr. Andrews organized a scientific task force—experts in paleontology, geology, mammals, reptiles, fishes, mapping, and photography—and jumped off from Kalgan, North China, into the vast plains of Mongolia. In the next few years the expedition unearthed some of the greatest fossil fields on earth, ranging over hundreds of millions of years.*

"A world of nightmare creatures," Andrews called it. The bones of dozens of strange ancestral mammals confirmed the Osborn prophecy. There were bizarre, shovel-tusked mastodons, with lower jaws like coal scoops; chalicotheres with horselike skulls and clawed hoofs; titanotheres with massive nose bones for battering rams. An extinct, tree-browsing rhinoceros, *Baluchitherium*, stood 17 feet at the shoulder; no larger land mammal has ever been found. The wolfish skull of *Andrewsarchus* measured twice that of today's

*See "Explorations in the Gobi Desert," by Roy Chapman Andrews, NATIONAL GEOGRAPHIC, June, 1933.

Alaska brown bear, largest meat-eating land animal alive.

But deep in the Gobi, in a raw, eroded region that the party named the Flaming Cliffs, lay the most sensational discoveries of all. On a sandstone ledge near fragments of fossilized egg shell, Assistant Paleontologist George Olsen swept away overlying sediment and laid bare a 100-million-year-old drama.

Under the sediment, Olsen found the fragmentary skeleton of a small, toothless dinosaur. A chunk of the sandstone ledge, shipped to the museum for study, was found to contain 13 dinosaur eggs, of the species *Protoceratops andrewsi*. So incriminating was the evidence of intended theft against the small dinosaur that he was named *Oviraptor philoceratops*, or "ceratopsian-egg seizer."

The Flaming Cliffs had been a great reptilian breeding ground. It yielded more than 70 dinosaur eggs and the series of 13 *Protoceratops* fossil skulls now in the Hall of Late

Dinosaurs. These show a single species of dinosaur, dead some 100 million years, in every stage of growth from four-inch embryo to eight-foot adulthood.

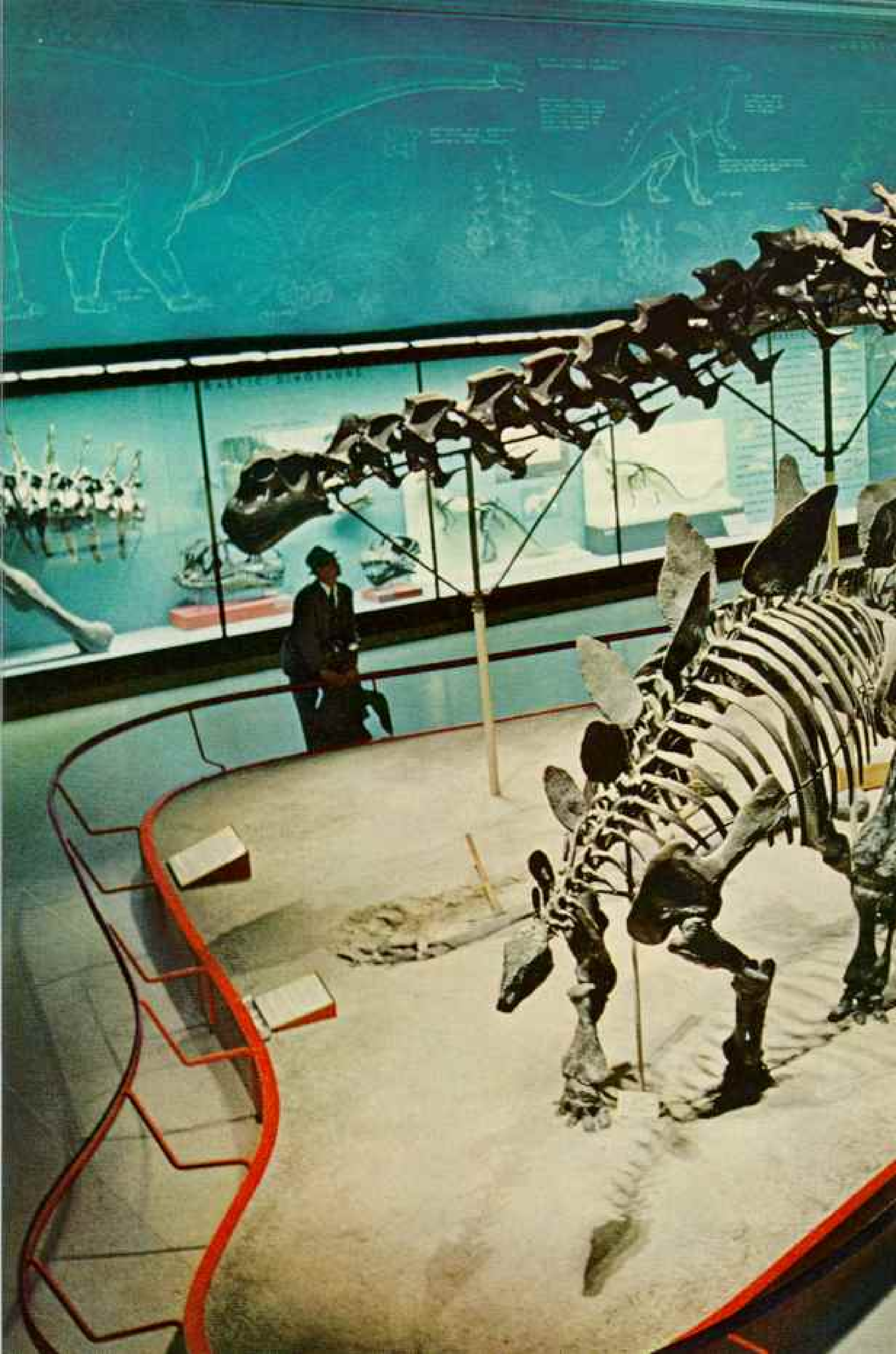
Even more significant to science was the discovery of nearly a dozen rat-size mammals amid the dinosaur remains. In paleontology's 100-year history, these were the first skulls of placental mammals from the age of dinosaurs ever found. The small creatures foreshadowed the dawn of a new era, and the still-unexplained demise of the great reptiles that formerly walked the earth.

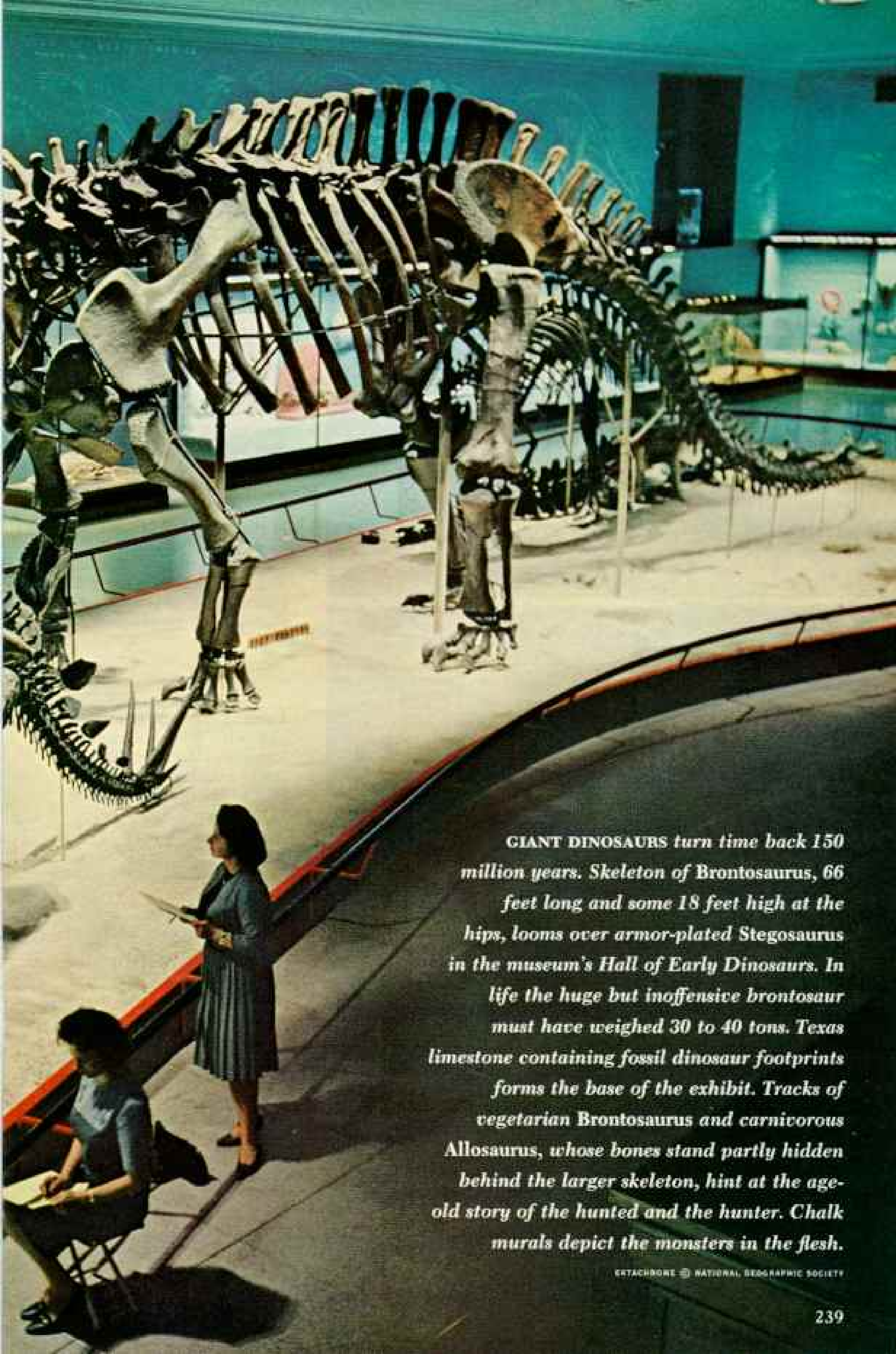
Dune Dwellers Once Inhabited Mongolia

Capping these triumphs, the expeditions dug up ample evidence of an unknown human culture—the Dune Dwellers—indicating that Mongolia probably was twice as populous 20,000 years ago as when the hordes of Genghis Khan swept over much of the world.

The American Museum has dispatched







GIANT DINOSAURS turn time back 150 million years. Skeleton of Brontosaurus, 66 feet long and some 18 feet high at the hips, looms over armor-plated Stegosaurus in the museum's Hall of Early Dinosaurs. In life the huge but inoffensive brontosaur must have weighed 30 to 40 tons. Texas limestone containing fossil dinosaur footprints forms the base of the exhibit. Tracks of vegetarian Brontosaurus and carnivorous Allosaurus, whose bones stand partly hidden behind the larger skeleton, hint at the age-old story of the hunted and the hunter. Chalk murals depict the monsters in the flesh.



King of the Dinosaurs, *Tyrannosaurus rex* Gets Its Periodic Dusting

Largest and fiercest of all flesh-eating dinosaurs, the 20-foot-tall, 45-foot-long carnivore leads the march of bones in the Hall of Late Dinosaurs. Massive skull dwarfs preparator Walter Sorensen.

Tyrannosaurs preyed on brontosaurus and other herbivorous reptiles of North America in the Upper Cretaceous Period 80 million years ago. With six-inch-long serrated teeth, the monsters slashed chunks of flesh from victims, then ripped them apart with hind legs and teeth. Scientists puzzle over the use of the kangaroo-like front legs. The little limbs may have served as hooks to help hold prey in range of the powerful jaws. Only the American Museum and the Carnegie Museum in Pittsburgh display complete skeletons of *Tyrannosaurus*.



Peering through telescope and wire grid, museum illustrator Gaetano DiPalma draws a tiger skull for a scientific article. Grid enables him to draw to accurate scale.

Giant Sea Lizard, a Mosasaur Takes Shape

As dangerous and savage as the shark, this aquatic reptile of prey rivaled the land-dwelling dinosaurs in weight and length. Mosasaur means "lizard from the Meuse," the river along whose banks it was first found. Later discoveries show the creature to have been worldwide in distribution. A broad sea that once covered the western United States swarmed with mosasaurs.

Preparator George O. Whitaker assembles the lizardlike skull and jaws from fossils found in Cretaceous deposits near Camden, New Jersey.



many other great expeditions in its 94-year history. The Jesup North Pacific Expedition explored Pacific coasts of both Asia and North America at the turn of the century, to confirm the theory that man filtered into the New World across a Siberian land bridge.

The Eastman-Pomeroy-Akeley Expedition of the 1920's brought back many of the splendid specimens that visitors see in their natural settings in Akeley Hall of African Mammals.

For ten years ornithologists on the schooner *France* collected an unrivaled assemblage of marine and island birds while with the museum's Whitney South Seas Expedition.

But I doubt that any museum-sponsored expedition has made more dramatic scientific contributions than the Andrews group. Its success owed much to the organizational skill of its leader, who led as many as 40 men, 8 vehicles, and more than 100 camels into unexplored territory without major mishap (pages 228-9).

At one point Andrews broke up an ambush by charging his sturdy touring car into a party of mounted Mongol bandits. Archeologist Nels Nelson scattered another menacing group with a feat of terrifying "magic." With a histrionic flourish, he plucked out one of his eyes—the artificial one.

Scientists struggled through mud, snow, and sandstorms that left hands and faces bleeding. In one night they killed 47 vipers that crawled into their tents for warmth. But in eight years in the field, not a man was lost.

Shipwrecks, Sharks, and Storms

In the course of more than a thousand museum expeditions, there have been inevitable moments of memorable excitement.

Dr. Robert Cushman Murphy, a seasoned ornithologist-explorer, has felt the fang of a deadly fer-de-lance on a Colombian islet. "Only *one* fang," he emphasizes, in explanation of his continued robust health.

Both Dr. Barnum Brown, one of the world's greatest dinosaur hunters, and preparator George Petersen have been shipwrecked—one off Tierra del Fuego, the other on Australia's Great Barrier Reef. Dr. Norman D. Newell, Chairman of the Department of Fossil Invertebrates, has spent some uncomfortable moments trapped by a shark in an undersea canyon while studying a coral reef.

Carl Akeley, the renowned sculptor, taxidermist, conservationist, and inventor, survived incredible adventures. An African

elephant once pinned him to earth between its tusks. Only a rock or other obstruction prevented the huge bull from driving its tusks into the ground and crushing him to pulp. He emerged fearfully mauled, but alive.*

Again, an attacking wounded leopard and an empty rifle earned him rare and unsought distinction: He strangled the beast.

Akeley did not live to see the completion of the splendid African wildlife hall he designed. He succumbed to fever and exhaustion on his 1926 Belgian Congo expedition, and lies buried on the slopes of Mount Mikeno, high in his beloved gorilla country. But millions have been moved by his monument: the teeming plains, the desert water holes, the brooding rain forests, the play of tropical sun and shadow on the matchless habitat groups of Akeley Hall (pages 222-3).

Geographic and Museum Join Forces

Museum exploration reached its golden age—an era of costly, large-scale expeditions—in the 1920's. Today's expedition is a compact affair; often it is simply a single scientist. And, unlike our Central Asiatic Expeditions of 40 years ago, he usually knows precisely what he is looking for.

The National Geographic Society and the American Museum have jointly sponsored several expeditions, most notably those of ornithologist E. Thomas Gilliard. NATIONAL GEOGRAPHIC readers are familiar with his highly successful explorations of New Guinea, New Britain, Little Tobago, and British Guiana, in search of rare birds of paradise and the colorful cock-of-the-rock.†

As I write this, a museum scientist is wading through the surf off a tropical island in the West Indies while making a geological survey. Another crawls along the floor of the Panamanian jungle to study the behavior of a poisonous frog. An ornithologist is watching the spectacular riflebird in the wilds of Australia. In a remote region of the Canadian Rockies, a paleontologist excavates the fossils of fishes that lived 200 million years ago.

The other day in a corridor I encountered Dr. Barnum Brown, the most successful dino-

*See "Elephant Hunting in Equatorial Africa With Rifle and Camera," by Carl E. Akeley, NATIONAL GEOGRAPHIC, August, 1912.

†The National Geographic Society has supported and published accounts of several of Dr. Gilliard's expeditions, among them, "To the Land of the Head-hunters," October, 1955. For others, see the Cumulative Index, Volume II, and Supplement.

saur hunter alive. (*Tyrannosaurus rex*, dominating one of our dinosaur halls, is perhaps best known of his hundreds of discoveries.)*

I listened as he enthusiastically outlined his preparations for an expedition to the Isle of Wight in the English Channel.

"They've got a little six-foot dinosaur in those seaside cliffs that we don't have in our collections," he said, eyes glowing behind steel-rimmed spectacles. "I figure to spot the bones from a helicopter, through powerful glasses."

His quarry located, the resourceful paleontologist will land and swing over the brink in a bosun's chair, some 800 feet above the beach, to pry it out.

As he strode down the hall, I found it hard to believe that Dr. Brown officially retired from the museum 20 years ago, and is approaching his ninetieth birthday.

Five Mummies Yield Six Skeletons

To the museum visitor, any of a dozen doors marked "Not Open to the Public" may suggest backstage mystery. This would be a misleading impression—though I can remember one legend of great mystery.

Our Department of Anthropology, so other departments say, decided that five Peruvian mummies were of value only for skeletal material. The mummified quintet was carted to the osteology laboratory for cleaning, and in due time the piles of polished bones returned.

Routinely, the anthropologists counted them—and counted again. Five mummies had somehow produced six adult skeletons!

An elaborate sport of solemn nose counting developed among the staff before the enigma was cleared up. An archeologist back from the field explained that he had added the remains of a middle-aged Eskimo to the laboratory-bound cart, for cleaning, just before he left.

The museum's only unsolved mysteries are those which engross the scientist. No longer can a great museum justify its existence merely by collecting and exhibiting the minutiae of man's environment. The word "museum" means a temple of the Muses—a place of study. And research constitutes the most important behind-the-scenes function.

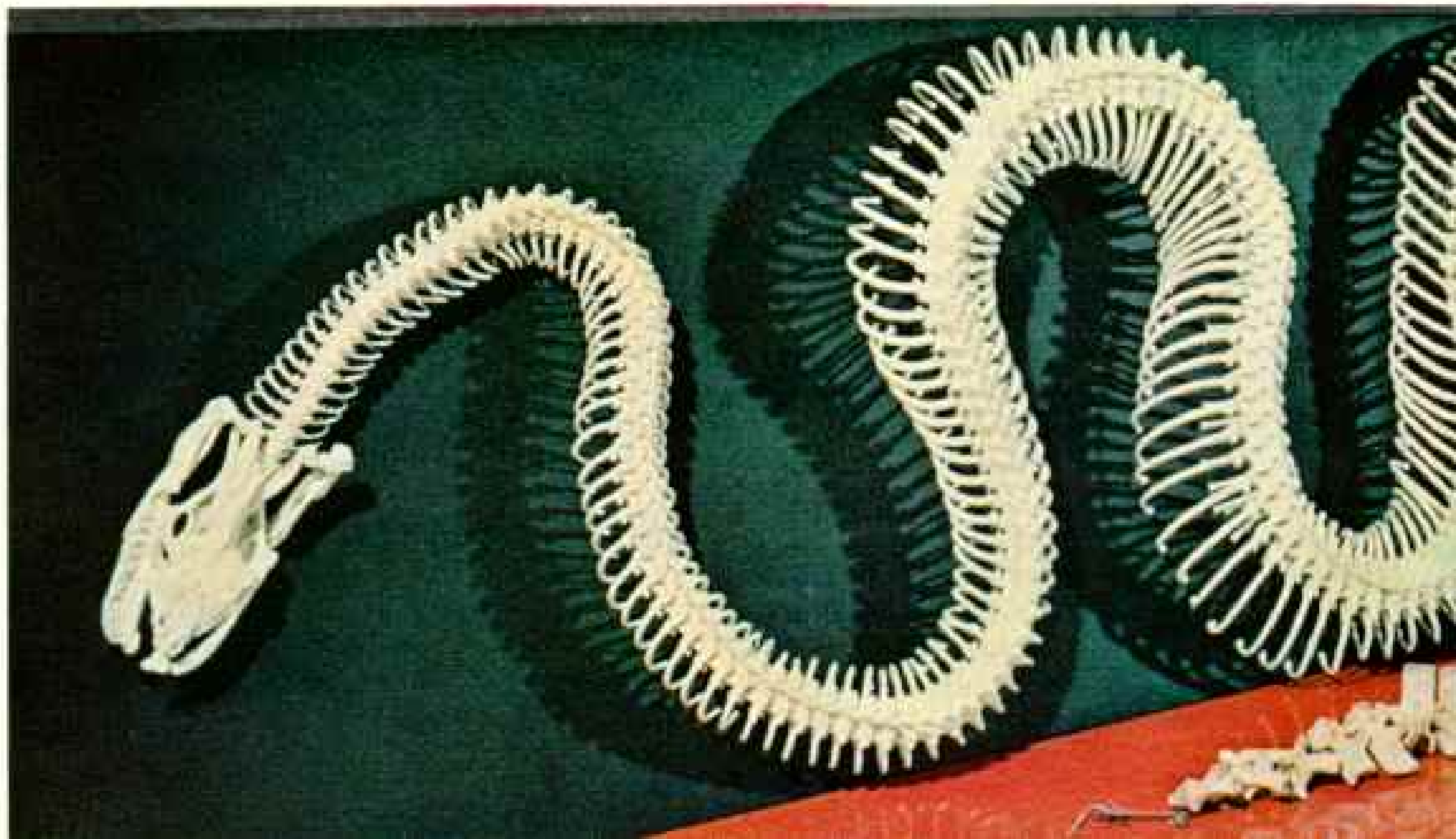
If you were to climb the spiral stairs to the top floor—the eyrie of Dr. Lester R. Aronson's Department of Animal Behavior—you might find him patiently training a small African fish, *Tilapia macrocephala*, to push a target for a morsel of food. Will its responses change after its forebrain has been excised? Dr. Aronson performs the delicate surgery. Results of such experiments are recorded on a typewriterlike device, invented in this department, which registers as many as 36 behavioral traits simultaneously.

Animal behaviorists here are chipping away at a long-standing, but not very satisfactory, concept: the overused word, "instinct."

"Instinct," says Dr. Aronson, "is merely a pattern of behavior, not an explanation for it."

How do tropical army ants form such distinctive raiding columns in hunting prey? Not instinct, but a chemical roadway laid

*See "Hunting Big Game of Other Days," by Barnum Brown, NATIONAL GEOGRAPHIC, May, 1919.



down by the leaders, says Dr. Theodore C. Schneirla, who has studied these voracious insects for 30 years.

Dr. Schneirla has also found time to trace the development of the human smile. He suspects that a baby learns to turn up the corners of its mouth even before it is born; the pout, he says, appears only after the baby has been exposed to the world for six months or so. (And there Dr. Schneirla wisely leaves his data to the philosophers.)

What happens when you fit a herring, a farsighted fish, with contact lenses to make it normal- or near-sighted? Dr. Evelyn Shaw performed the unusual experiment on a number of alewives, filmed their reactions, and is now analyzing her data. It's part of her behavioral study of how certain species of fish form schools.

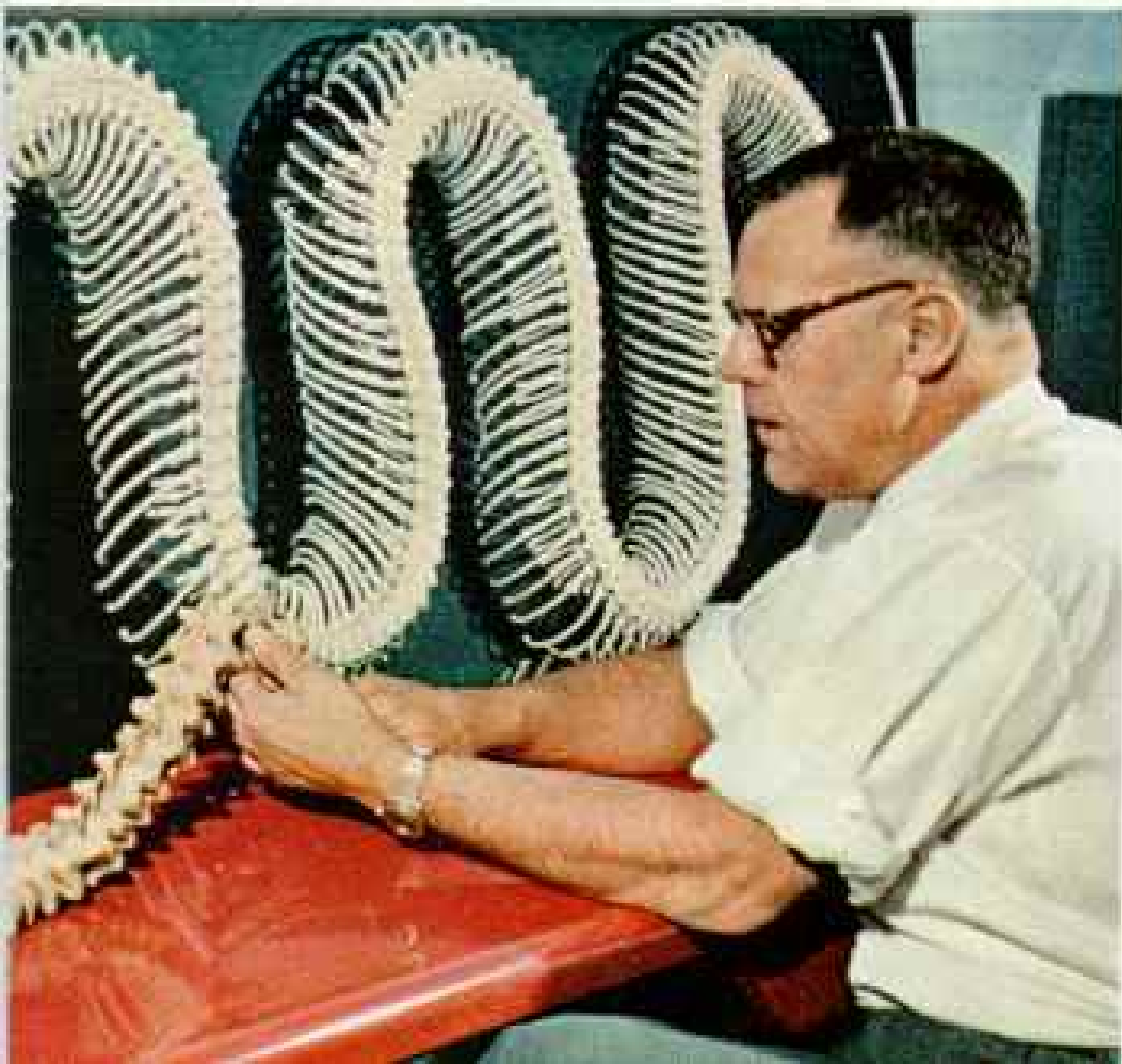
In a rooftop corner crammed with cages, gauges, wires, relays, and graphs, Dr. Helmut E. Adler is testing how well birds can see and how accurately they can tell time. Thus far he has found that the vision of starlings and robins is much poorer in twilight than that of humans; these birds can, however, estimate the time of day. Even when cut off from all natural light, the birds know within 15 minutes when to trip a time-clock-controlled feeding device for a meal.

Every scientific department of the



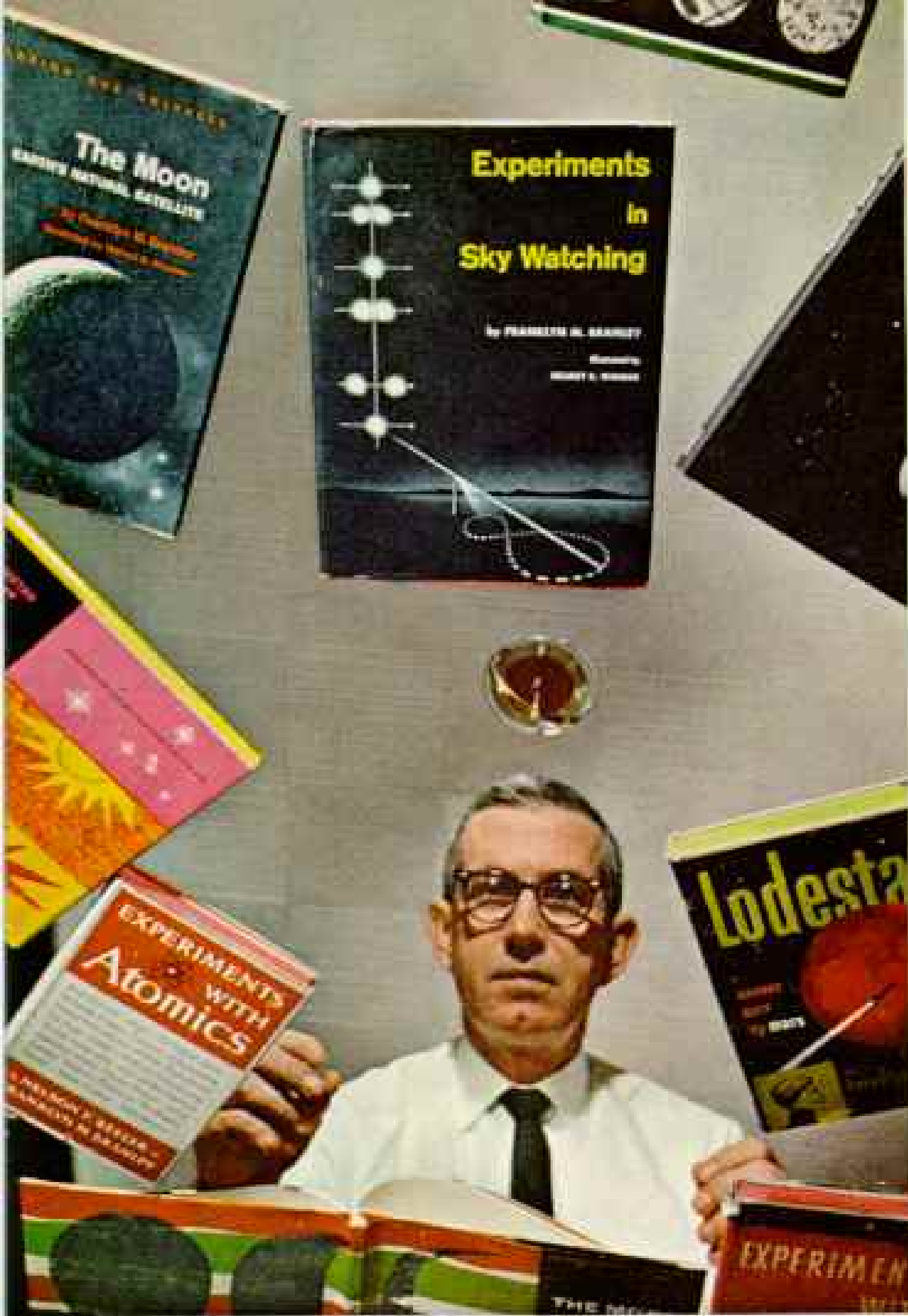
PHOTOGRAPHS BY ROBERT F. TIGHE © N.Y.Z.

Boldly beautiful butterflies and moths from many parts of the world make up the museum's lepidoptera collection of more than 1,250,000 specimens. Dr. Frederick H. Rindge, Curator in the Department of Entomology, makes room for a morpho newly arrived from South America.



Python's 318 Pairs of Ribs Perform an Eerie Snake Dance

The 22-foot-9-inch constrictor once slithered through Malayan jungles, and no pig or deer was safe from its crushing embrace. It died in the New York Zoological Park in 1939. Herpetologist Charles M. Bogert compares the vertebrae with those of a Komodo dragon, the world's largest lizard.



RODACHENOWES © NATIONAL GEOGRAPHIC SOCIETY

Author of three dozen books, Dr. Franklyn M. Branley supervises the planetarium's program of courses in astronomy, meteorology, and navigation. Recently he was named to head the scientific-editorial board of the new Natural History Press. A publishing division of Doubleday & Company, Inc., with offices in the museum, the Press will publish books directed toward students, teachers, and the general public.

The museum publishes the distinguished popular magazine *Natural History*, which reports on current developments and research in the life and earth sciences.

"Look at this beauty." Dr. Willis J. Gertsch of the Entomology Department shows a live California tarantula to visiting scientist Wilton Ivie. Vials hold arachnids being processed for the museum's collection of insects and spiders, which now numbers about 12 million specimens. The Hall of Insects displays the largest and most complete exhibit of its kind in the United States.



museum offers fascinating lines of inquiry. In Anthropology, for example, one may happen upon Dr. Junius Bird doing his prehistoric laundry—delicately cleaning scraps of Peruvian cloth some 4,500 years old. (A few fragments yielded the eggs of equally ancient lice.)

When Colin Turnbull is not busy planning exhibits for the new Hall of the Peoples of Africa, he is examining the relationship between magic and religion among pygmies of the Congo. When not occupied with *her* new hall—the Peoples of the Pacific—Margaret Mead ponders the cultural impact of the Space Age. Hers is a name familiar to the public for her writings on family relationships and South Sea cultures (page 250).

Two floors below the anthropologists, amid cages of live cobras and copperheads, lizards and turtles, Charles M. Bogert is studying the vocabulary of a frog.

With a tape recorder, the Chairman of the Herpetology Department has captured the croaks of scores of species of frogs and toads. Transferred to paper charts by means of a sound spectrograph, they reveal a rudimentary "language" of mating calls, warning croaks and vibrations, "rain calls," screams, and territorial calls. Mr. Bogert's frog recordings, a surprisingly brisk seller at the Museum Shop, indicate that mating calls mean far more than appearance in preventing similar species from interbreeding.

Reptiles Not Always Cold-blooded

In another unusual research project, Mr. Bogert has taken thousands of reptilian temperatures throughout the Southwest and Mexico. Reptiles are not necessarily cold-blooded. One healthy desert iguana registered 115° F.—a lethal fever for a human.

Unlike mammals, however, snakes and lizards have a far less efficient "thermostat" to regulate body temperature. Mr. Bogert's observations show that they compensate for environmental heat changes largely by their behavior. Threatened with overheating, a reptile will pant and seek shelter; to warm

up, it will stretch, flatten, or orient its body to soak up more of the sun's rays. Some species, like the Texas horned lizard, turn darker to hasten heat absorption.

As a herpetologist myself, I can confirm that a prairie rattler or Gila monster submits to a thermometer reading with notable reluctance. But Chuck Bogert, who has not been bitten in his 25-year career, has spiced a scientific quest with a touch of audacity on several occasions.

Snake Dancers' Secret Revealed

I recall his solution to the carefully guarded secret of Hopi snake dancers. Witnesses had long wondered how these Indian priests of Arizona could practice elaborate rain-making rites with live rattlesnakes draped round their necks, or even clutched in their teeth.

After watching one such ceremony from a distance through a monocular, Mr. Bogert followed an Indian who freed several of the sacred snakes in a rocky crevice near the village. Unobserved, the herpetologist reached in and hauled out a fat rattler. He dropped it into a bag and ambled off carrying the bag in his Stetson hat. Later, he examined his prize and exposed the Hopis' secret: Crude surgery had removed the fangs.

Other floors, other departments disclose museum scientists deep in less picturesque, but no less important, taxonomic research.

Amid the mammalogists' bones and hides, Dr. Richard G. Van Gelder cheerily displays a thick callus on his thumb, acquired while calipering more than a quarter-million measurements of the genus *Spilogale*, the spotted skunk, and *Mephitis* and *Conepatus*, the striped and hog-nosed skunks. His reclassification of the creatures has taken 12 years.

The museum's own collection of skunks numbers 600, one of the largest in the world. Why, the layman might well ask, are so many specimens needed? Of what use are 40 elephant skulls, or 26 goatlike Asiatic serows? The 19th-century museum was content, like Noah, with a pair of each species.

Dumbbell and Ring Nebulae Blaze on the Dome of Hayden Planetarium

In the center of the theater stands the Zeiss projector, a two-ton, 12-foot marvel that reproduces sun, moon (upper left), planets, and the "naked-eye" stars with amazing realism. Assistant Astronomer James S. Pickering, at the control console at right, describes the spectacle. Stars appear as they would in the early-morning hours of summer. Milky Way streaks upward from the horizon at center. Color slides flashed against the dome show the two nebulae, each a glowing envelope of gases around a star.







KOSACHOWICZ © NATIONAL GEOGRAPHIC SOCIETY



"Let me see it!" Hands serve as eyes for boys from the New York Institute for the Blind as they examine a mounted loon. For an increasing number of school children, the museum provides the link between past and future—from prehistory to space exploration.

Pilot black snake delights visitors in the museum's Natural Science Center for Young People. Other live specimens on display include a descented skunk, salamanders, fish, turtles, frogs, and lizards.

"We *could* choose the first man to step out of a subway station, measure him, write him up, and call him *Homo sapiens*," replies Dr. Van Gelder. "Then all humans might be described as five feet, four inches tall, with red hair and a nervous tic in the left eye."

To strike a reliable average, he feels, a museum needs at least thirty specimens of the same age and sex, collected from the same locality at the same time of year.

In some species this is impossible. Dr. Dean Amadon, Chairman of the Ornithology Department, feels we are lucky to have a single representative of the pink-headed duck from India, the Norfolk Island parakeet, the Australian grass parrot, or fifty other species which have become extinct or nearly so since we acquired them.

One species in our rare bird collection expired uniquely. Dr. Amadon recently showed me a small, brown, wrenlike bird named *Traversia lyalli*—one of three the museum possesses. In the 1890's the species was discovered on Stephens Island in New Zealand's Cook Strait; not by an ornithologist, but by a lighthouse keeper's cat. It brought home nearly a dozen specimens before the supply ran out. Forever.

The museum has one of the world's largest collections of birds (page 227). It grew to greatness under Dr. Frank M. Chapman, Curator from 1920 to his death in 1945. He has been called the "most influential ornithologist since Audubon," and his name still serves his science—in the museum's \$1,500,000 Chapman Fund for ornithological research.

Of What Value Is a Baby?

Even in this enlightened age, some still may question the value of fundamental research. Of what real use is it? Benjamin Franklin once replied to this kind of question with one of his own: "Of what value is a newborn child?"

Since 1948, Dr. Pedro Wygodzinsky, a recent addition to our entomology staff, has labored at the classification of the subfamily Triatominae. Of what use is it to distinguish among species of this little insect? The answer is that certain species transmit debilitating Chagas' disease, which afflicts hundreds of thousands of people in South America. Eliminating the culprit insect can control the incurable disease, but correct classification is essential before health agencies can know which species to control.

Every scrap of new information about our universe is a potential building block of knowledge for some future investigator. For this reason the museum prints some two million words of technical papers and scientific reports every year.

At the present time the National Science Foundation, the Office of Naval Research, the American Cancer Society, the National Institutes of Health, and the U. S. Army Medical Service, among others, are sponsoring more than \$250,000 worth of research at the American Museum and its four field stations.

Bimini Records the Ocean's Uproar

The United States Navy has a special interest in a project at the museum's Lerner Marine Laboratory on North Bimini in the Bahamas.* The project's scientists are eavesdropping on the sounds of the sea.

Last winter, when my wife and I were working there on a project involving the green turtle, I found myself often drawn to a small room lined with loudspeakers, electronic apparatus, and tape recorders.

Through cables from hydrophones submerged offshore, Dr. John C. Steinberg and his associates from the University of Miami—with support from the Office of Naval Research—are recording an incredible Gulf Stream chorus: sounds resembling a French taxicab horn, the cooing of a dove, the pop of a champagne cork, a pack of yelping dogs, a donkey's bray, the rumble of an earthquake. Some of these sounds are too high-pitched for the human ear to detect; the tapes, slowed eight times, reveal submarine voices reminiscent of Saint-Saëns' mirthful "Carnival of the Animals."

A few of these noisemakers have been identified, such as the bottle-nosed dolphin and several species of whale, which emit an odd variety of clicks, whistles, and squeals. But what of the others? What creature causes the "shallow-water knocks" heard chiefly between sunset and 8 p.m.? And why do "pops" occur more frequently at night?

Soon we may have answers, for scientists at the Lerner Marine Laboratory have added electronic eyes to their ears: the world's first permanent underwater TV camera.

On a wooden dock a team from Scripps Institution of Oceanography, led by Dr. Per

* The Lerner Laboratory is described in "Man-of-War Fleet Attacks Bimini," by Paul A. Zahl, NATIONAL GEOGRAPHIC, February, 1957.



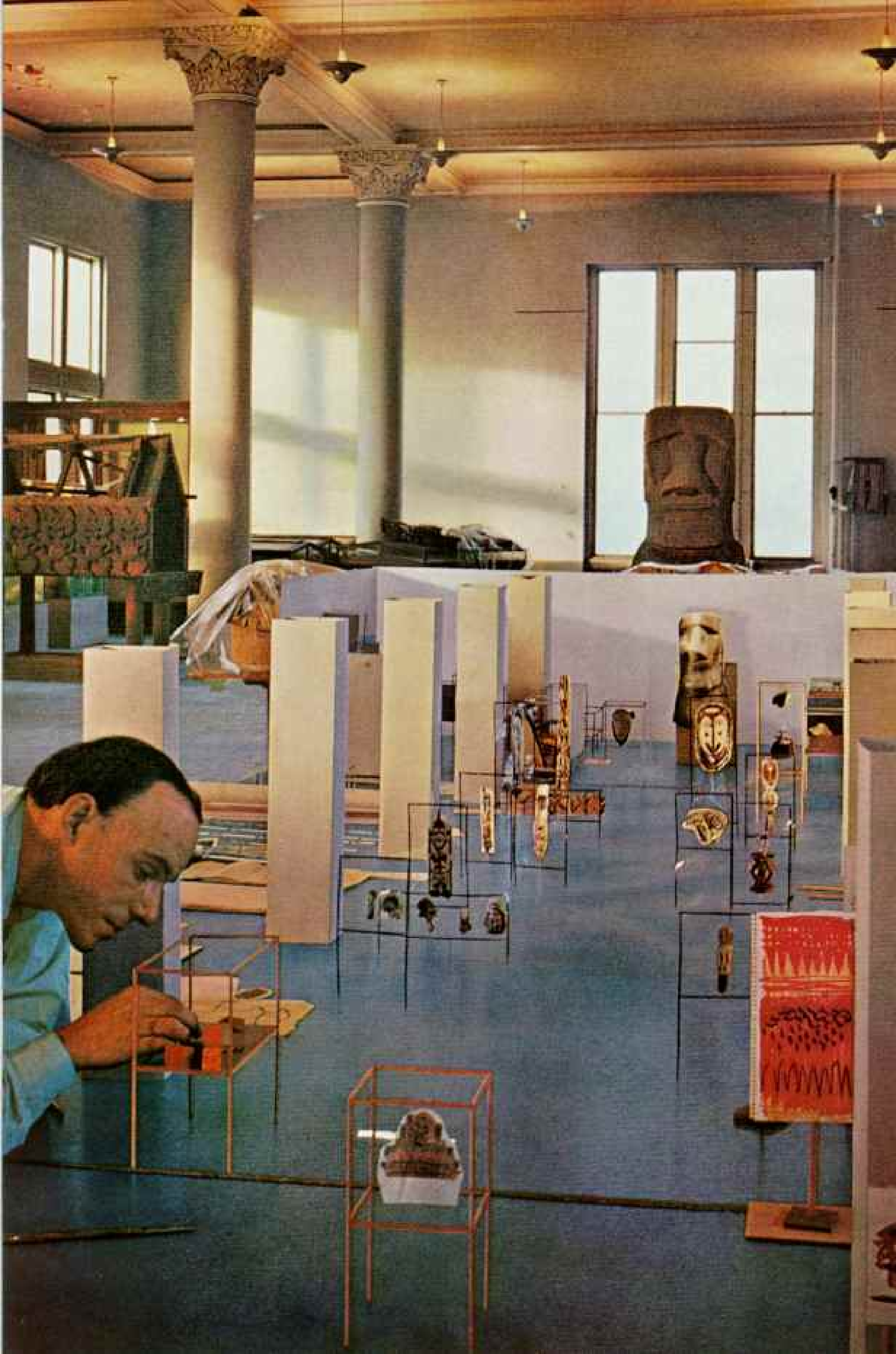
Tattooed heads from the old Pacific Islands Hall attest the skill of Maori artists a century ago. Using chisel-like tools, the New Zealand Polynesians etched soot and dog fat into the skin. To preserve the heads of chiefs, wives, children, and enemy warriors, they extracted the brains, wrapped the skulls in leaves, steamed them over fire, then smoked them. Flax and shredded bark stuffed into the heads restored the original contours.

Model showcases assist P. M. McClanahan in designing a new hall, the Peoples of the Pacific.

Renowned anthropologist Margaret Mead makes a floor-level survey of the new Pacific hall in miniature.



KOHAHOREA (ABOVE), HE KATAHIHIA (RIGHT), AND KATAHIHIA (OPPOSITE) BY NATIONAL GEOGRAPHIC PHOTOGRAPHER ROBERT J. SLOAN © N.G.S.





Scholander, seeks a precise physiological answer to a grim puzzle: How do people drown?

Alongside a raft a volunteer struggles to keep afloat as lead weights gradually are added to his belt. His breath funnels through a plastic hood for measurement and analysis. Instruments record heartbeat, respiration rate, and temperature. Thus researchers calculate the energy that varying individuals expend to stay alive in water.

Airlift Takes Turtles Far From Home

The green turtle was to early inhabitants of the Caribbean area what the buffalo was to the Plains Indian. Centuries of hunting have decimated this handsome species. In an effort to re-establish former breeding grounds around Bimini, the museum arranged a Navy airlift of 12,000 newly hatched green turtles from Central America. At the Lerner Laboratory I clipped an identifying notch in the left rear flippers of 400, then measured and released them (page 234). Several hundred more were pen-raised until a year old, then tagged and set free.

Recapture of marked specimens will, I hope, teach us much about the green turtle's growth and habits. Ultimately we may learn something about its astonishing navigational skill. These seagoing reptiles somehow are able to return to the same strip of Tortuguero Beach, in Costa Rica, after a three-year journey of as much as 1,600 miles.

Near Lake Placid in central Florida, amid saw palmetto and scrub pine, the museum's Archbold Biological Station has played host to scientists studying everything from cultural changes of the Seminole Indians to the life history of the beach mouse.

The Southwestern Research Station, near Portal, Arizona, offers researchers a remarkable variety of plant, insect, and animal life (page 235). It covers, in the heights of the Chiricahua range, five of the six biological "life zones" found in the western United States.

At the museum's "backyard laboratory"—the 94-acre Kalbfleisch Field Research Station near Huntington, Long Island—Dr. Donn E. Rosen is studying the survival characteristics and population genetics of the mosquito fish, *Gambusia affinis*. (This species is probably the world's champion mosquito-eater among

fish. One hungry two-and-a-third-inch female devoured 225 larvae in an hour.) Nearby, in a laboratory packed with radio apparatus, Dr. Kenneth L. Franklin, Associate Astronomer of the American Museum-Hayden Planetarium, tries to pick up natural radiation from Jupiter.

Back at the museum, the show goes on. From terse written instructions, a skilled technician and a planetarium lecturer at a knob-studded console begin a cosmic duet—the universe at their fingertips.

As 800 awed spectators gaze upward, a multi-eyed metal monster in the theater does the astronomer's bidding, showering the darkened dome with stars (pages 246-7). Around the rim, concealed projectors blaze a comet across the sky, eclipse the moon or sun, move galaxies through space, or paint a rainbow, a swirling blizzard, or northern lights across the heavens.

More than half a million persons every year, including 150,000 school children, attend the planetarium's sky shows. Most leave reflectively, in deeper accord with words on the wall of the entrance foyer: "...there must be a very much greater Power than man responsible for the wonderful things which are daily occurring in the universe."

The man who said that was Charles Hayden, who donated the Zeiss projector, heart of the planetarium. This fantastic instrument faithfully reproduces the heavens as seen from any point on the globe. Each star appears in precise position, with precise intensity.

Southern Cross Shines on New York

Under best conditions the naked eye sees fewer than 4,000 stars over New York State. The Zeiss projector can show nearly 9,000. It changes latitude in seconds, whisking the observer to the South Pole on June 21, or to Bethlehem on Christmas Eve. Within a minute it can roll the heavens back 5,000 years, when Thuban was the North Star, or 12,000 years ahead, when the Southern Cross will be a nightly phenomenon in New York skies. These leaps in time demonstrate the effects of earth's precession—how the slow wobble of its axis seems to alter the heavens.

Is there anything planetarium scientists *can't* do with Zeiss-projected stars?

Fanged Brown Bear (left) and Grizzly Snarl at Each Other in a Storeroom

In the loft, Dr. Richard G. Van Gelder examines the head of a roebuck, one of 200,000 animal skins kept in light-proof, insect-proof vaults. As Chairman of the Department of Mammalogy, he supervises displays and research in mammals. The vast collection of skins provides research material for the museum's work in mammal classification.

"Well, we can't make them twinkle," says Dr. Joseph M. Chamberlain, Planetarium Chairman, "but no one seems to notice."

The Hayden Planetarium—the museum's Department of Astronomy—is a museum in itself. In its circular halls the visitor finds a weather station recording data from rooftop instruments; a 45½-foot Viking rocket; and "blacklight" murals depicting sunspots, spiral nebulae, and other celestial phenomena.

Children Try to Budge a Meteorite

Among the most popular exhibits are five scales that register "Your Weight on Other Worlds." A dieter steps off Mars with a satisfied smile, having dwindled effortlessly from 160 to 60 pounds. Children bounce resolutely on the steel platform of another scale, their insignificant weight ignored by a needle that stands at 34 tons, 85 pounds. The platform supports the dense, black mass of Ahnighito, largest meteorite "in captivity."

Ahnighito—"The Tent" to Eskimos—came to the museum in 1897, drawn by 30 horses. Robert E. Peary spent three Arctic seasons wrestling this mass of nickel-iron and two

smaller fragments from the shores of Cape York in northwestern Greenland.

The lifeless lump from space gives visitors little hint of the toil and peril it cost to bring it here. In the hold of Peary's ship *Hope*, it rendered compasses useless amid hazardous straits and a fierce Arctic storm.

Museum specimens seldom disclose the exciting, the poignant, the humorous tales behind them. That massive elephant skeleton in the Hall of the Biology of Mammals, for example: In life, an estimated million youngsters rode on its broad back. Jumbo, the largest elephant ever brought to the United States alive, earned its owner, P. T. Barnum, nearly \$2,000,000 before an unscheduled freight train ended its circus career in 1885 in Ontario, Canada. Jumbo lives on as mascot of Tufts University in Medford, Massachusetts, where the stuffed skin, a gift of Barnum himself, is in the school's museum.

Or the thoughtful-looking chimpanzee in the Hall of the Biology of Primates. Her name was Meshie (page 256). Dr. Harry D. Raven, an anatomist, brought her from Africa as an infant and raised her with his own children.



Meshie often accompanied her owner to the museum; occasionally she lunched with the staff, displaying impeccable table manners. Visitors to the fifth floor sometimes rubbed their eyes in amazement at the vision of a chimpanzee bearing down on them, full tilt, aboard a tricycle.

As Meshie matured, however, she grew jealous and unmanageable. Reluctantly Dr. Raven found her a new home at the Brookfield Zoo in Chicago. Years later he passed through the city and stopped in to see his former pet. Although warned that she had become "a vicious, dangerous ape," he stepped into her cage. Meshie uttered a piercing scream and leaped at her former master. But instead of sharp teeth at his throat, Dr. Raven found furry arms about his neck. Meshie wept, in unashamed anthropoid joy.

The chimpanzee died at the zoo a short time later. It seems fitting that she has come home to the museum.

A museum director is not immune to the drama that surrounds him. Occasionally, after closing time, I make a point of passing by the great Hall of Early Dinosaurs for a

glimpse of the fantastic creatures inside (pages 238-9). In the dim stillness the awesome effect of *Brontosaurus*, *Allosaurus*, and *Stegosaurus* is intensified.

In 1953, Dr. Edwin H. Colbert, Chairman of the Vertebrate Paleontology Department, assembled these Mesozoic fossil skeletons in their present dramatic setting. They stand on blocks of solid stone impressed with huge footprints of their kind.* The remarkable prints themselves reveal a prehistoric hunt, for superimposed on the washtub-size tracks of the harmless, vegetarian brontosaurus are the sharp claw marks of its fierce contemporary, the allosaur, in obvious pursuit. It is a prodigious spectacle.

I can understand the feelings of the proud paleontologist who stood before the recently completed exhibit, eavesdropping on public reaction to this masterpiece of bone and stone. One ten-year-old spoke, and our scientist strained to catch his words.

"Why," the youngster inquired, "did they take all the skin off?"

Such wounds heal in time.

World of Sea Takes Shape

What the visitor sees at the American Museum of Natural History is the product of rare skills—the talents of artists, preparators, and other craftsmen of the Department of Exhibition and Graphic Arts, which occupies a building of its own. You reach its fourth floor by way of a monstrous freight elevator big enough to transport, as it has done, an adult giraffe with unbowed head.

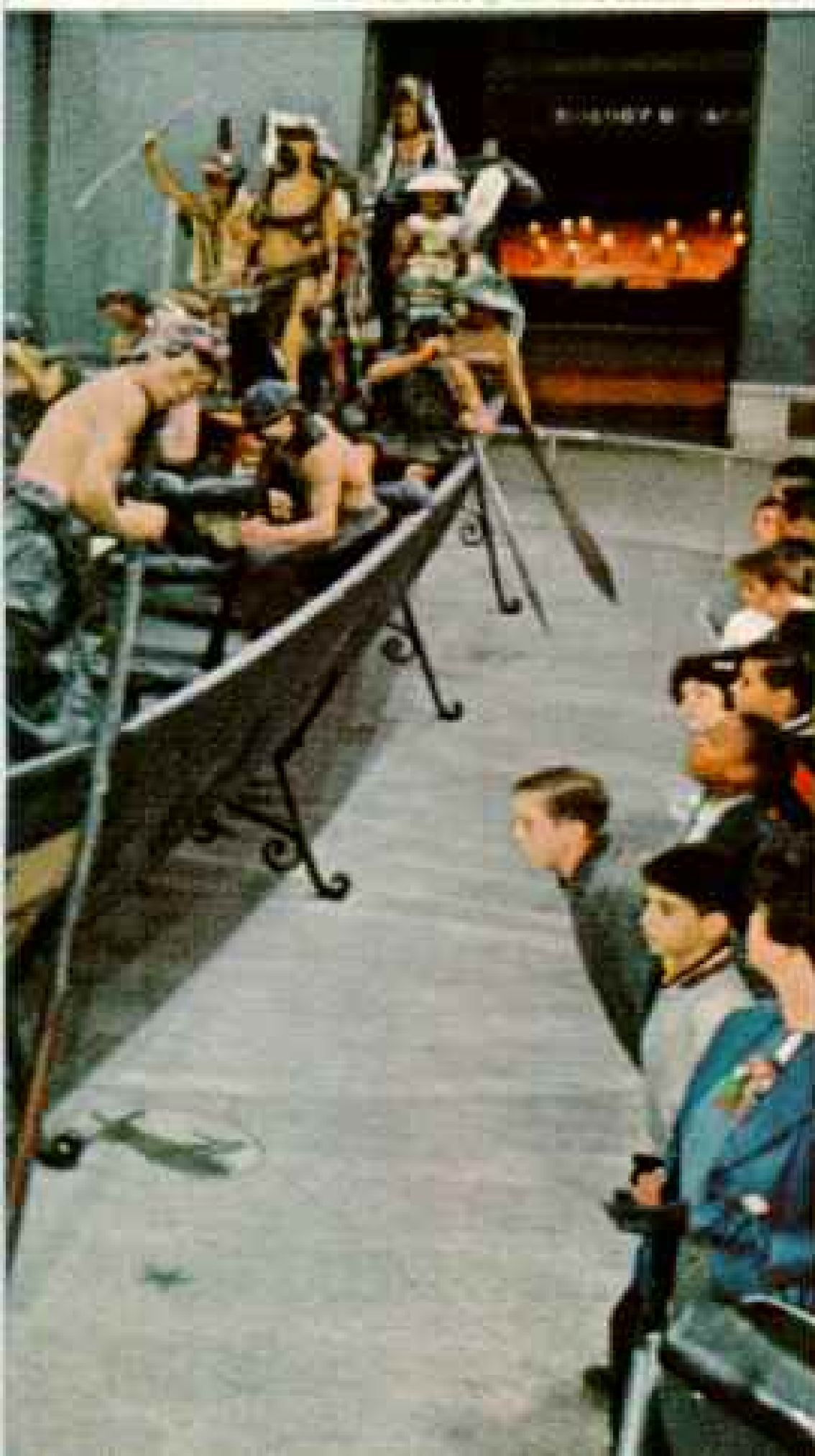
In a world of workbenches and band saws, glues and paints, a technician lays fiberglass strips into plaster molds. When the resin hardens, a porpoise will be ready for sanding, painting, and display in the Hall of Ocean Life, part of our ten-year, \$2,000,000 program of exhibit expansion.

*See "We Captured a 'Live' Brontosaurus," by Roland T. Bird, NATIONAL GEOGRAPHIC, May, 1954.

Poles and Paddles Propel a War Canoe Across the 77th Street Foyer

Haida Indians of the Queen Charlotte Islands, off British Columbia, carved the 64-foot craft from the trunk of a huge cedar. Stylized animals decorate bow and stern; plaster figures represent warriors and slaves. Haida braves paddled the canoe to Vancouver Island in 1883. The dugout rode a schooner to Panama and crossed the Isthmus by rail. Another ship carried it to New York for delivery to the museum.

BY ESTABLISHED © NATIONAL GEOGRAPHIC SOCIETY



Nearby, an artist frowns thoughtfully at a scale model of the hall as it will appear two years from now. Its centerpiece will be a 78-foot beached whale, uncannily bathed in the shifting light of sun and moon, while recorded sounds of sea birds and surf pervade the scene.

A sculptor models Australian aborigines, two inches tall; later a scientist will check every facial plane and feature for anthropological accuracy, before the tiny figurines appear in a diorama in the new Hall of the Peoples of the Pacific.

A preparator mends the reed walls of a miniature Ojibway wigwam. His material looks oddly familiar.

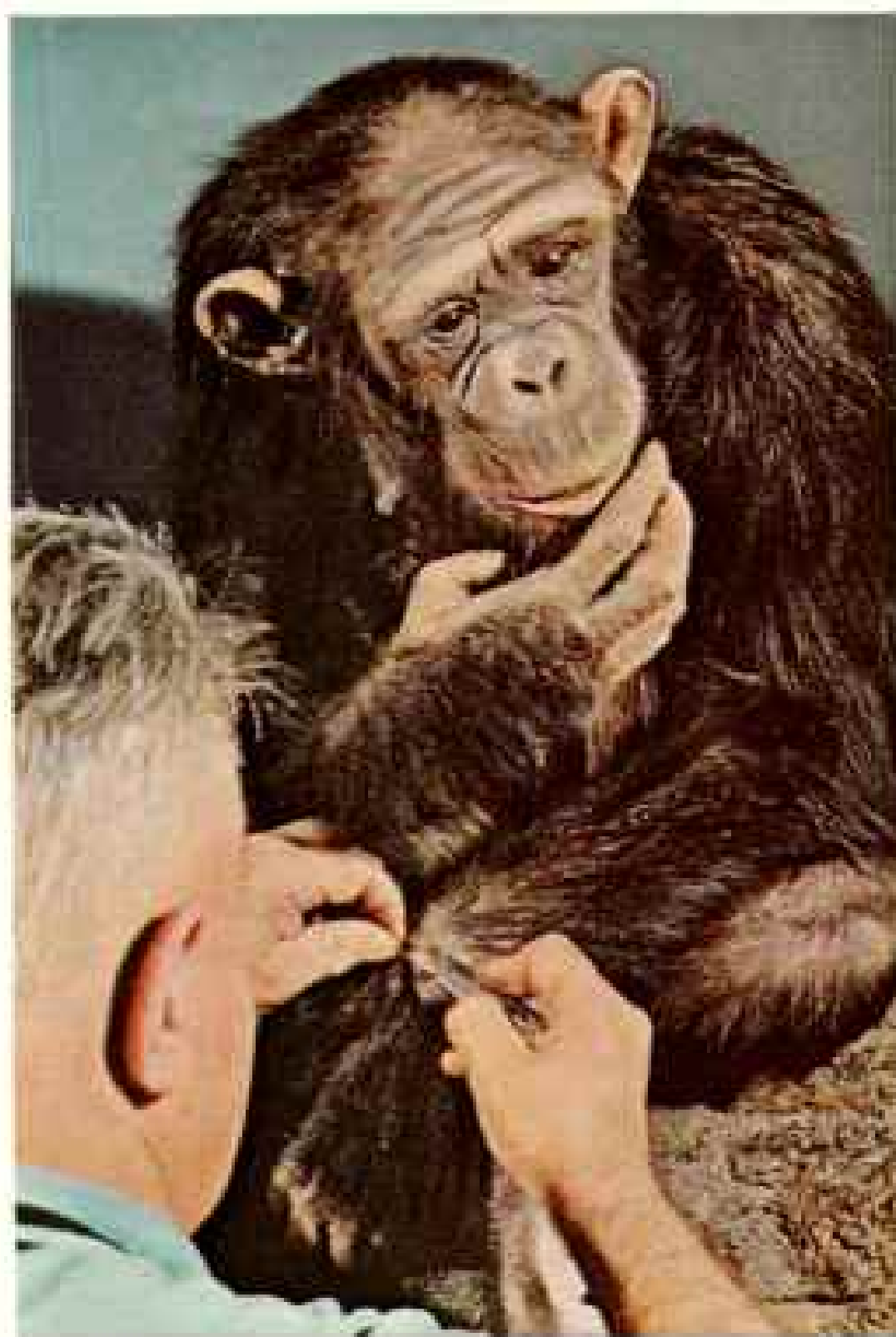
"Bamboo place mats," he grins. "Ideal for

the job. Those clumps of grass? Just snippets of frayed sisal rope."

Thus are museum illusions born—that magnified slice of forest floor, for example, in the Hall of North American Forests. Visitors marvel at the six-foot-long millipede, which in life spans a mere three inches.

"We made it from a section of big industrial vacuum-cleaner hose," our Technical Supervisor, Charles Tornell, explains.

It was he who devised a technique for spraying plastic snow on the Canada lynx group in the Hall of North American Mammals. When artificial lighting gave the snow an unrealistic yellowish cast, he tinted it purple. Now it *looks* white.



Meshie, a pet chimpanzee who rumped through museum halls on a tricycle 30 years ago, was returned home after dying in a Chicago zoo. Taxidermist Nicolas Gusakovsky cleans her fur.

Mounted Apes Appear to Tear Their Temporary Quarters Apart

The animals await renovation of the Hall of Primates. Young orangutan (right) clutches a prickly durian, an East Indian fruit. Another orangutan and a gibbon (by bookcase) hang from branches. On the floor, left to right: Hamadryas baboon, lemur, proboscis monkey, and black-masked Hanuman langur. Dr. Sydney Anderson takes a census.



The search for new exhibition techniques never ends. Museum technicians are now studying a method of freeze-drying specimens that could revolutionize modern taxidermy. So far the process has successfully preserved mammals as large as a fox without skinning or further preparation.

Nowhere can one find more advanced exhibition ideas than in the cantilevered aluminum cases of the \$450,000 Hall of the Biology of Man. Dr. Harry L. Shapiro, Chairman of Anthropology, has summarized his field's latest research findings in this unique presentation of man's evolution, structure, and organic functions (pages 236-7).

Some 5,000 feet of colored wire accurately

trace the tangled human nervous system. Transparent acrylic plastic, etched with the outlines of the circulatory system, simulates blood flow by ingenious edge-lighting. A new plastic-infiltration process preserves a digestive tract and other human organs.

Man's complex machinery takes effort to understand, and Dr. Shapiro did not oversimplify it. When the first two sections of the new hall opened, he mingled with the crowd, glancing nervously at his watch.

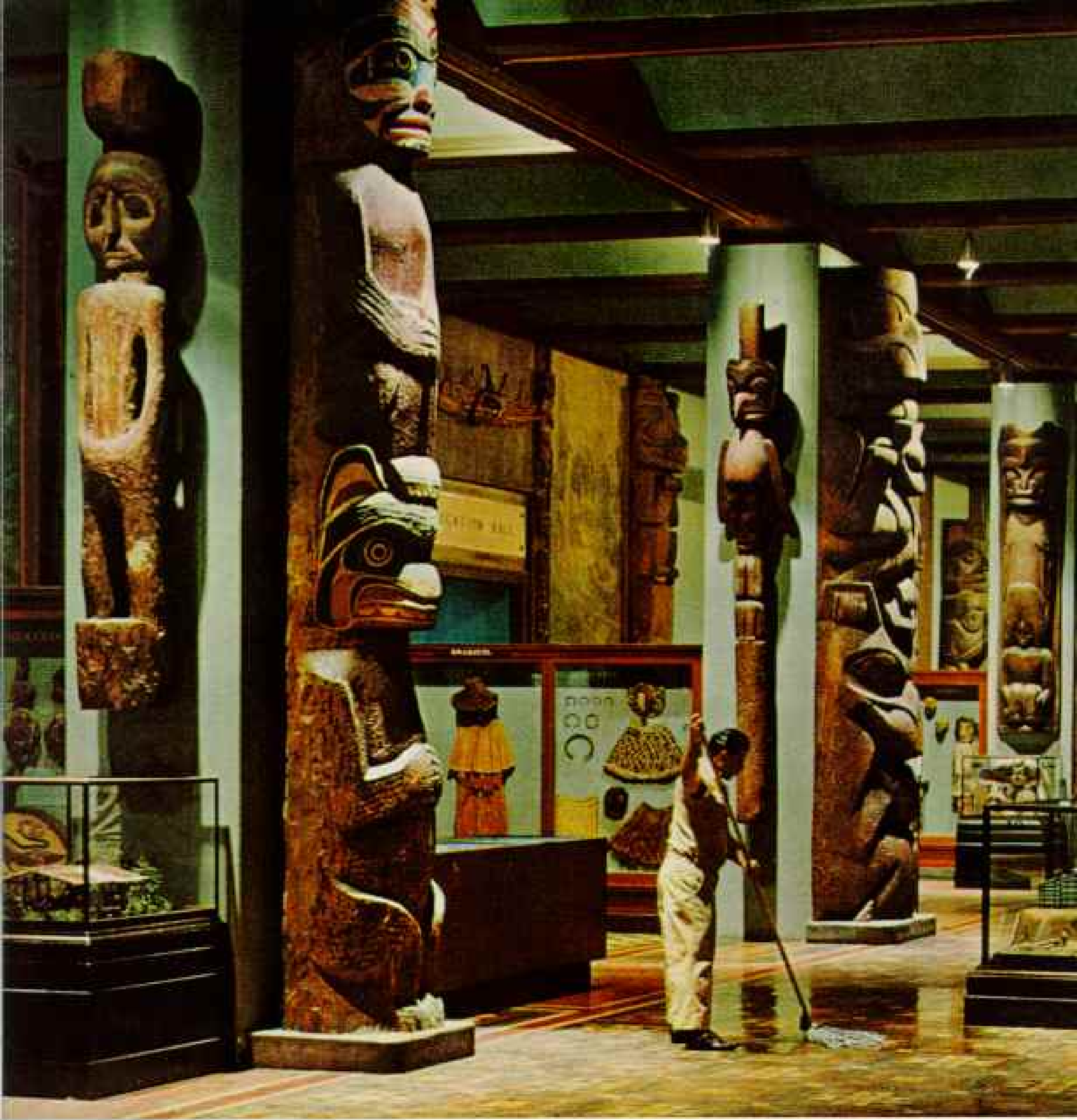
"I've seen visitors stand before one exhibit for ten minutes," he reported jubilantly. "That means we're *teaching* them something!"

I share Dr. Shapiro's satisfaction. For if a museum were to be restricted to a single

257

PHOTOGRAPHS BY NATIONAL GEOGRAPHIC PHOTOGRAPHER ROBERT F. BISHOP © 1962





Totem poles stare across the Hall of Indians of the Northwest Coast. Tribes of skilled woodworkers dwelt in the forested and mountainous coastal belt from southern Alaska to the Columbia River in Washington. They carved cedar into stylized animal and human forms for house and grave posts, ceremonial masks, and tools.

goal, it should be to pass on as widely as possible the knowledge it has accumulated.

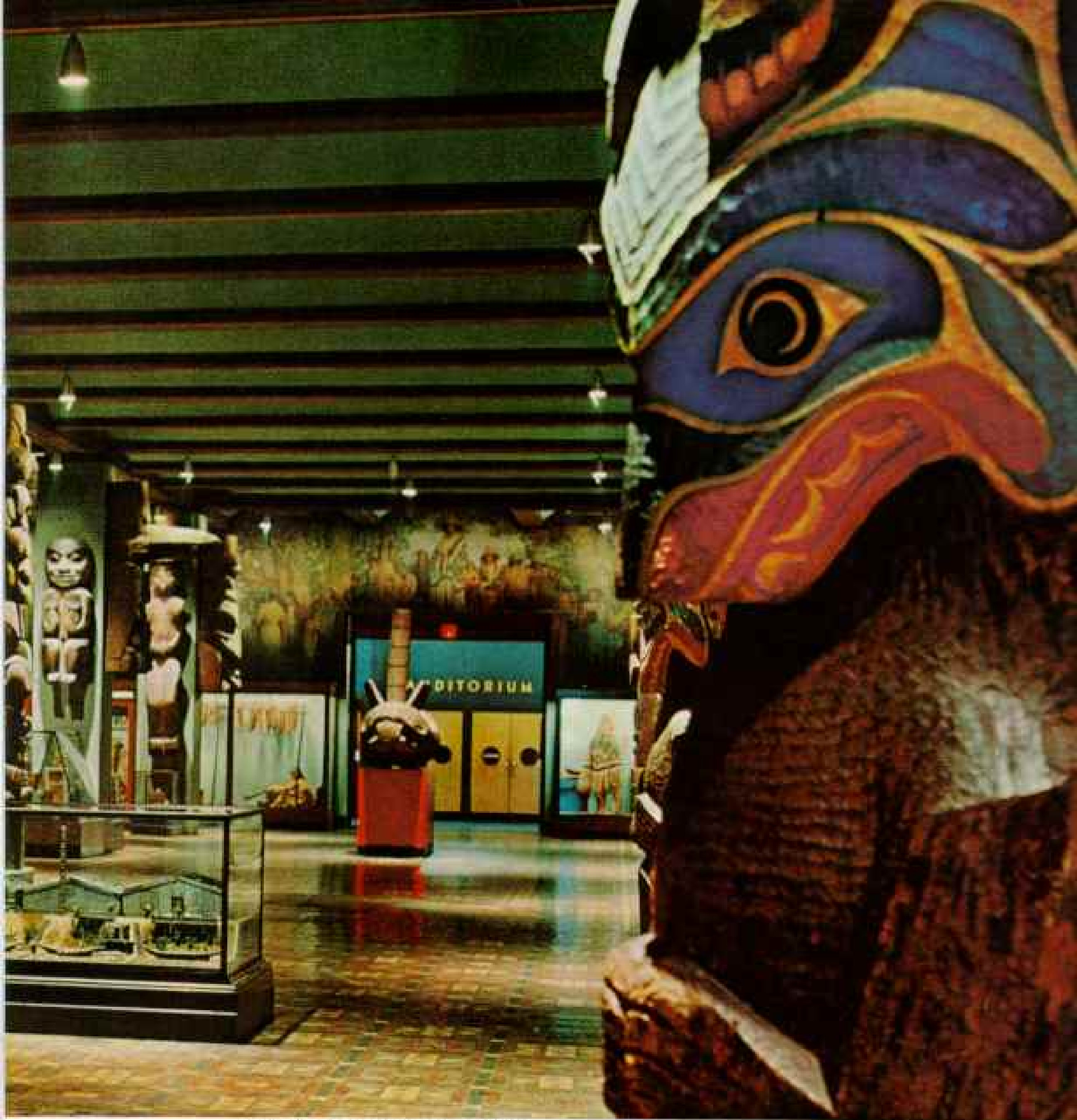
That is why our Department of Education, under John R. Saunders, numbers 18 teachers—more than the total staff of many museums. Last year they held classes for nearly 60,000 school children from the New York City area who toured the museum.

And more than once I have seen a self-conscious adult bringing up the rear of a

children's group, eavesdropping on the lecture.

He needn't; our program of adult education includes courses in everything from "The Earth's Crust" to "Patterns of Japanese Life."

Add to all this a weekly radio program, nature walks, traveling exhibits, motion pictures, a Natural Science Center for Young People, summer institutes for teachers, student nurse classes, and instruction programs for the handicapped, hospitalized, and home-



EXHIBITIONS © NATIONAL GEOGRAPHIC SOCIETY

Unusual mask of the Kwakiutl Indians has detachable lips. Its purpose was to depict a demon, its effect "to frighten people and turn their mouths several ways."

bound—and a staggering statistic emerges.

Each year the American Museum of Natural History, through all its facilities, establishes nearly 16,000,000 contacts with individuals who hunger for knowledge about the world in which they live. And that knowledge, to me, is the most precious product dispensed by the magic red box at the entrance to Roosevelt Memorial Hall, fronting on Central Park in New York City. THE END



New Era in the

Nuclear power, huge propjet cargo planes on skis, and a new-type scientific station snugly buried under the snow mark major advances in man's assault on Antarctica's mysteries

FOR NEARLY FOUR YEARS it has been my privilege to command the United States Navy's men, ships, and planes arrayed against a grim inanimate enemy—the ice, the winds, the cold, and the currents that rule Antarctica.

These forces, at the end of the earth, are always potentially hostile to man. He cannot live here for long without support from the outside world. But, steadily, technological advances have enabled us to control our environment, to expand the beachhead of science, to lift more of the mystery from the map of the loneliest conti-

nent. (See the National Geographic Society's new Atlas Series Map, *Antarctica*, a supplement to this issue.) And beneath the ever-present capacity for treachery, Antarctica has a siren's appeal.

Snow Petrel Gleams in Midnight Sun

Well do I remember my first trip "to the ice," in December, 1958, to learn at firsthand about the job I was soon to take over as Commander U. S. Naval Support Force, Antarctica. With me aboard the cargo ship U.S.S. *Wyandot* sailed Sir Raymond Priestley, who as a young geologist served

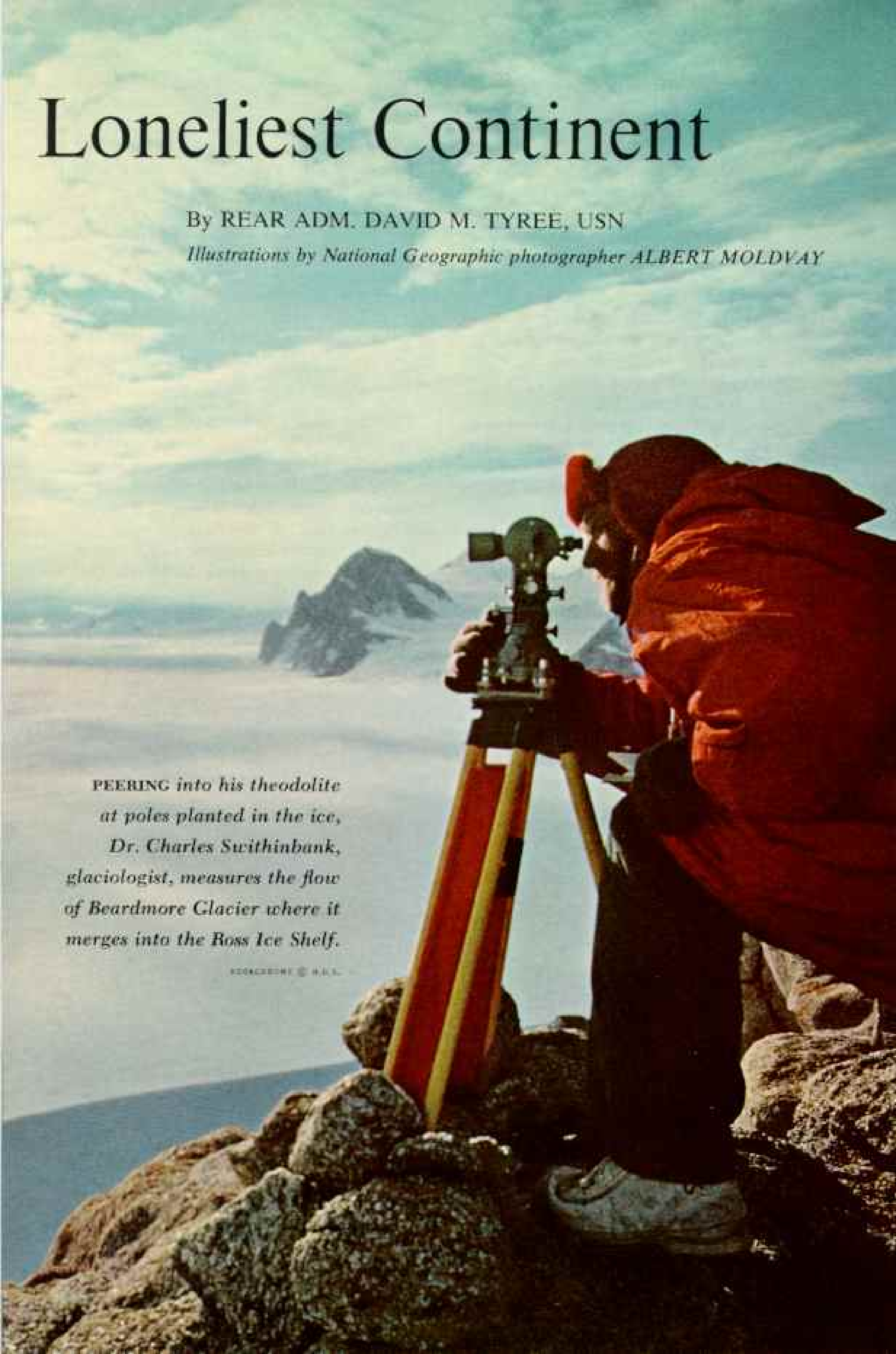
Loneliest Continent

By REAR ADM. DAVID M. TYREE, USN

Illustrations by National Geographic photographer ALBERT MOLDVAY

*PEERING into his theodolite
at poles planted in the ice,
Dr. Charles Swithinbank,
glaciologist, measures the flow
of Beardmore Glacier where it
merges into the Ross Ice Shelf.*

EDUCATION © W.A.S.



with pioneering polar expeditions led by Sir Ernest Shackleton and Robert Falcon Scott. Now a renowned scientist and explorer, he was returning to the Antarctic as United Kingdom exchange observer with the Navy's support mission, Operation Deep Freeze.

Six days out of Lyttelton, New Zealand, we were following hard on the heels of the U. S. Coast Guard icebreaker *Northwind* as she plunged through the vast belt of pack ice that guards Antarctic shores. Across the bottom of the world, the December sun hovered above the horizon, although it was midnight.

Sir Raymond, beside me on the flying bridge, touched my arm and pointed to port.

"Look, David, a snow petrel!"

I spotted it, a graceful bird, ethereal in its whiteness against the deep-blue sky. When early explorers in these waters met this first greeter of the ice, it was to them, as now to me, an omen of good fortune.

Sir Raymond's face lit up with pleasure. He was living again the voyages of *Nimrod* and of *Terra Nova*. I thought once more how fortunate I was to gain my first impressions of the Antarctic as shipmate of a man who was here fifty years ago.

As our ship thumped and crunched through the brash—bits of broken ice—we caught sight now and then of other forms of life in this seemingly lifeless world: Dark blobs that turned out to be seals sunning on the floes; penguins lurching comically along on the floating cakes of ice and vanishing in spouts of icy water; killer whales following close astern, thrusting their black muzzles above the surface.

Even the tiny plankton—so richly abundant in these frigid waters—revealed itself in the blooms of rose and brownish pink and yellow on the bottoms of upended ice blocks.

Wyandot Gets Frozen In

The day after Christmas we found ourselves stuck in McMurdo Sound off Cape Evans, almost within sight of our goal. Heavy ice floes six feet thick and as large across as several city blocks closed in around *Wyandot* and held us fast.

By now another icebreaker, U.S.S. *Staten Island*, had come out from McMurdo Station to convoy us in.

I had been working on papers in my cabin when I became aware of a new stillness. To



a sailor, silence aboard ship is a foreboding of trouble. A captain will immediately come wide awake when the engines stop in the night, or a pump throb ceases.

Stepping out to the bridge, I met a sight that would freeze the blood of any sailor new to ice seamanship. Dead ahead, *Staten Island* came charging down on *Wyandot* full speed, bows on, spewing brash to either side as she plowed the clogged path. She could not have drawn a better head.

As I involuntarily braced myself for the crash, *Staten Island's* bow veered sharply to starboard and rode high on the solid, pressing floe. She came to a grinding halt, then settled back into the sea with blocks of ice hobbing like corks around her sides. On the two fore-castles, men bantered back and forth across the few yards separating our rails.

I was still somewhat shaken when *Wyandot's* skipper turned to me and calmly remarked, "Admiral, that was a nice pass. They'll soon have us out." I knew then what the old hands in the ice meant when they talked about cutting a ship out.

The next day we stood into McMurdo Sound. *Staten Island's* helicopter took me off

RODACHENREZ © NATIONAL GEOGRAPHIC SOCIETY



The author hoists the Stars and Stripes above the South Pole, where United States scientists and Navy personnel have manned a station since 1956. Rear Adm. David M. Tyree directed Operation Deep Freeze for nearly four years.

November Springtime Brings First Supply Ships to McMurdo Sound

Because of treacherous ice between ship and shore, these tractor trains swing in a seven-mile arc to McMurdo Station, Antarctica's largest community. The base springs to life in mid-September when planes arrive with mail, replacements, supplies, and "summer tourists," the men who will not winter over. The station's population mushrooms from 200 to 1,100.

U.S.S. *Arneb* unloads beneath the slopes of Mount Erebus (page 278).



Frozen Sea Clutches the Icebreaker *Atka*; a Few Hours Later She Cut an Open Lane

Blizzards have packed drifts into Sahara-like dunes, and fierce winds have sculptured the surface into fantastic crags of hard snow. When



EVERETT COLLECTION BY CHARLES SWITHINBURG © NATIONAL GEOGRAPHIC SOCIETY

tapped by a finger, the compacted sea ice rings like crystal. Vehicles can move across the tortured surface only with the utmost difficulty. U.S.S.

Atka stands off Crater Hill on McMurdo Sound in mid-March; she kept channels open for evacuation of the last summer residents.



PHOTOGRAPHS BY ALBERT WOLFF (LEFT)
AND WALTER MARZETTA (RIGHT) © U.S.S.

Waste processing container for McMurdo's reactor sinks into rock under the skillful guidance of Seabees.

Wyandot, and from the air I could make out the crossed runways of Williams Field, our busy air terminal on the thick bay ice. Just four miles beyond, on the edge of Ross Island, I saw McMurdo's rows of huts and quonsets and fuel tanks set in a drab landscape of snow and black volcanic ash.

And then I set foot for the first time on Antarctica. I slogged through unexpected mud, and in my ears resounded the roar and clatter of tractors that never cease during the summer months at this largest of Antarctic bases.

But these routine sights and sounds meant little, for in my mind was still the awe of the views I had seen from the

Antarctica's First Atomic Reactor Transforms Life at McMurdo Station

The new power source provides four times more output for Antarctica's "metropolis" than did its diesel generators. The reactor promises to reduce drastically the costly shipment of fuel oil, and it will also run a plant that desalts sea water, ending dependence on melted snow for a drinking supply. Technicians below run a test on the fuel core, which is adequate for two years of maximum use.



helicopter: the grandeur of the Royal Society Range hanging over the Sound to the west; the silent desert of the Ross Ice Shelf sweeping to the south; volcanic Mount Erebus tossing its plume of vapor (page 278). These formidable and dramatic landmarks were to become as familiar to me as the Washington Monument at home.

More than four years have gone by, and this February, 1965, the men of Antarctica are preparing for the long winter night. They are buttoning up the continent after the eighth year of Operation Deep Freeze.

At McMurdo there is a stinging bite in the air that was not there a few days ago. At night, the sun skims lower and lower over the mountaintops to the southwest. In the early-morning hours, oily-looking patches appear in the open water where lily pads of thin ice are beginning to form.

In the field, far out on the trackless ice, scientists are breaking up their summer

camp and bringing traverse parties to their terminal points. Ski-planes and helicopters take advantage of every hour of good flying weather to bring in these scientists with their hard-won specimens and data.

Winter storms are close at hand. Forming over warmer oceans to the north, they load Antarctica's air with turbulence, often hurling down gales on her coasts. There is a feverish race against time, making February McMurdo's most hectic month.

One day soon the mess hall line will be comfortably short. The din of grinding tractors will diminish in McMurdo's streets. The last propjet's whine will fade away in the direction of New Zealand. The last cargo ship will swing in her booms, the last tanker flush out her lines preparing to leave. By mid-March a lone icebreaker will cram aboard the last of the "summer tourists," sound farewell on her whistle, and steam north.

Of approximately 1,400 Americans who



PHOTOGRAPH BY NATIONAL GEOGRAPHIC PHOTOGRAPHER ALBERT WELLS © N.G.S.

Reactor's console controls the "fire" of fissioning atoms. Dr. Ralph Bennett (left) of the Martin Marietta Corporation, which built the plant, demonstrates for blue-shirted Admiral Tyree and yellow-shirted Atomic Energy Commission official Wesley M. Johnson. Joseph F. O'Brien (right) directs Martin Marietta's power-plants department. Long-range plans call for a second nuclear reactor at McMurdo and "package" air-transportable reactors at inland stations such as the Pole.

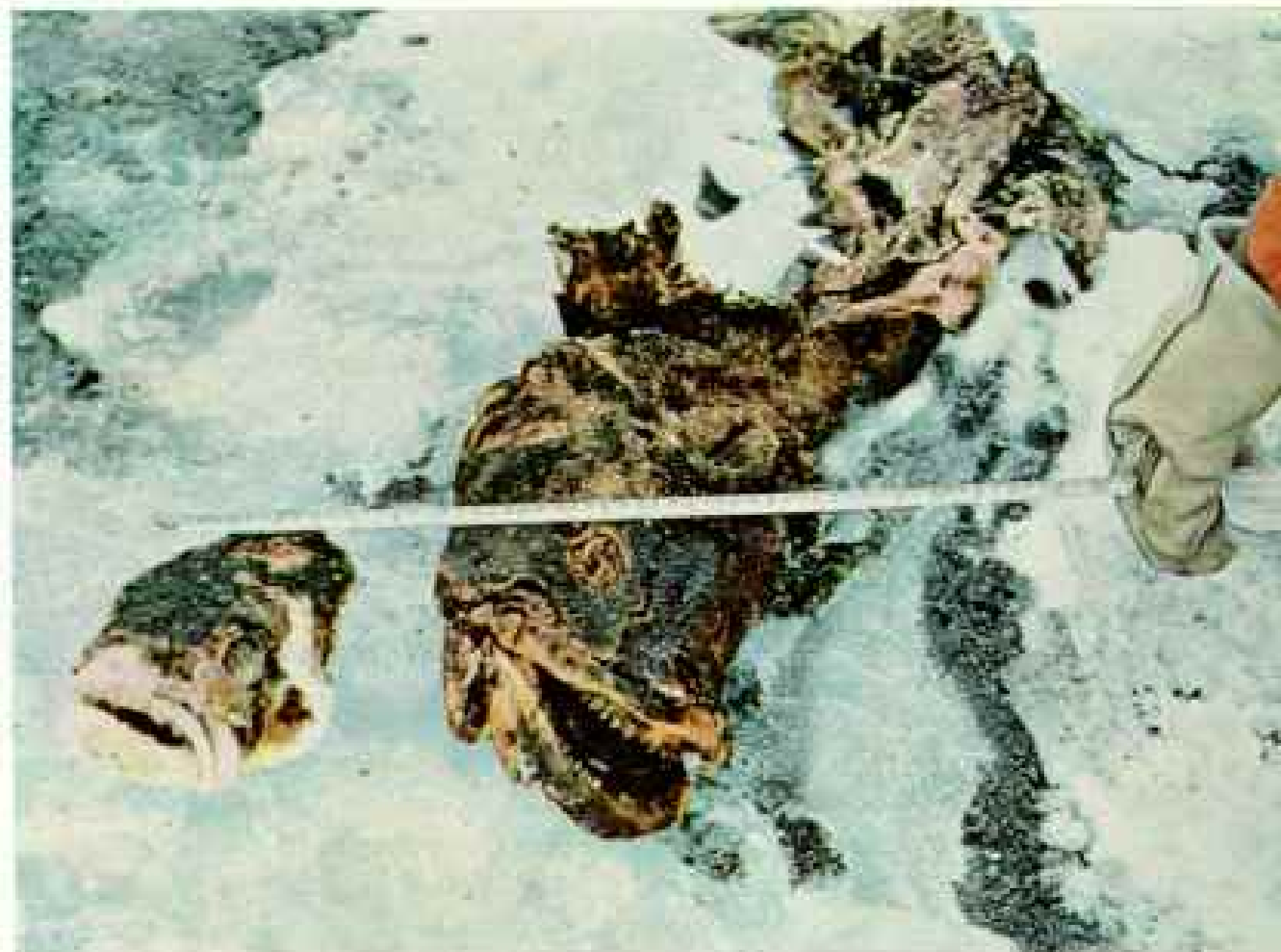
Polaris motor toboggan pulls a one-ton load across Beardmore Glacier. This revolutionary device can seat two passengers, but drivers prefer to follow on skis and steer with 60-foot reins, lest the vehicle suddenly plunge them into a snow-hidden crevasse a hundred feet deep. Polaris saves supplies: It consumes no fuel when storms halt work, while dogs must still be fed.

Huskies face technological unemployment. Among the Americans, Polaris and other machines have displaced dogs. Here at New Zealand's Scott Station, however, the howl of the husky can still be heard.



Frozen fish found on top of the Ross Ice Shelf may have aged as long as 1,100 years, radiocarbon tests show. Clams, snails, sponges, and coral also appear on the surface, to the amazement of beholders.

Scientists theorize that the shelf froze to the bottom and trapped sea life in a deep freeze. As upper layers melted away, the lower ice slowly rose until it finally left these specimens high and dry. The fish, classified as nototheniids, appeared edible, but no one ate them.





ANTARCTICAN LABORS AND OPPOSITE, LOWER, BY CHARLEY SWITHURNE AND HIS CREWMEN; BY ALBERT WILKINSON © N.S.P.

came to the continent in mid-September, October, and November for summer work, some three hundred will remain to continue winter work at our permanent stations—at McMurdo, at the Amundsen-Scott South Pole Station, at Byrd Station in Marie Byrd Land, and at Hallett, the coastal station we operate jointly with New Zealand in the relatively warm “banana belt” near Cape Adare. This cooperation has been notable since the first Byrd expedition 35 years ago. New Zealand provides many facilities for our aircraft and ships, and a New Zealand frigate, *H.M.N.Z.S. Rotoiti*, shares the lonely watch with a U.S. Navy picket ship at the ocean station between Lyttelton and McMurdo.

In Antarctica the men of New Zealand’s Scott Station, a mile away, come to worship with us in our chapel at McMurdo and to take part in our festive occasions. And many an American boy slogs through the snow

to Scott to put in a call to his girl in New Zealand over their radiotelephone circuits.

If plans have gone well this season, eleven men will be wintering for the first time at Eights Station, our new base at the foot of the Palmer Peninsula. This portable station is made up of buildings on stilts and skis that can be moved by tractor or by plane.

Throughout the winter darkness, around the clock, the scientists who are wintering over will read their instruments and record their observations. Navy men will overhaul the hard-used equipment, man the communications network, and rebuild McMurdo’s airfield on the bay ice.

When next September comes, everything will be ready for another fast-paced austral spring and summer of activity, all for the purpose of adding to man’s stockpile of knowledge and developing a new land.

This is the way it is this February, 1963.



KODACHROME (ABOVE AND UPPER RIGHT) AND HI-ENTRAINED

But I am not there to be part of it. Last November I turned over the command of Task Force 43, the Navy's Antarctic Support Force, to Rear Adm. James R. Reedy, after almost four years at the most interesting and challenging job of my career. In these years, I feel, we have brought a new era to Antarctica, and this is what I wish to tell about.

We Are in Antarctica to Stay

When the United States built "the seven cities of Antarctica" as part of the International Geophysical Year, those stations were regarded as temporary bases for 18 months of intensive study. But by early 1959, when I took over the Antarctic command from Rear Adm. George J. Dufek, it was already abundantly clear that our scientific investigation of the White Continent must continue.*

The years since then have witnessed the transition from the IGY's program of temporary occupancy to a long-term program of

scientific effort. Without question, we are in Antarctica to stay.

In the three complete seasons the Antarctic task force was under my command—Deep Freeze '60, '61, '62—our ships steamed nearly three-quarters of a million miles. Our planes flew almost 8,000,000 miles. Scientists on their traverses and tractor trains carrying supplies and equipment slogged almost 12,000 miles, crisscrossing Antarctica's hinterland.

Nearly 4,000 men took part in last year's program alone, using 11 ships and 41 aircraft. The scientists took home nine tons of records and specimens—geological, glacial, and biological—from one summer's investigations.

These figures are startling, and I ask myself what they mean in terms of accomplishment. What is different as I leave compared to when I took over at the end of the IGY?

*See "What We've Accomplished in Antarctica," by Rear Adm. George J. Dufek, NATIONAL GEOGRAPHIC, October, 1959.



BY NATIONAL GEOGRAPHIC PHOTOGRAPHER ALBERT WILDMAN © N.G.S.

Seabees rebuild Byrd Station six miles from its former site (page 274). Here they assemble corrugated steel sections to roof the 30-foot-wide trench. Next step: to cover the steel with snow. The sunken city escapes crushing surface drifts.

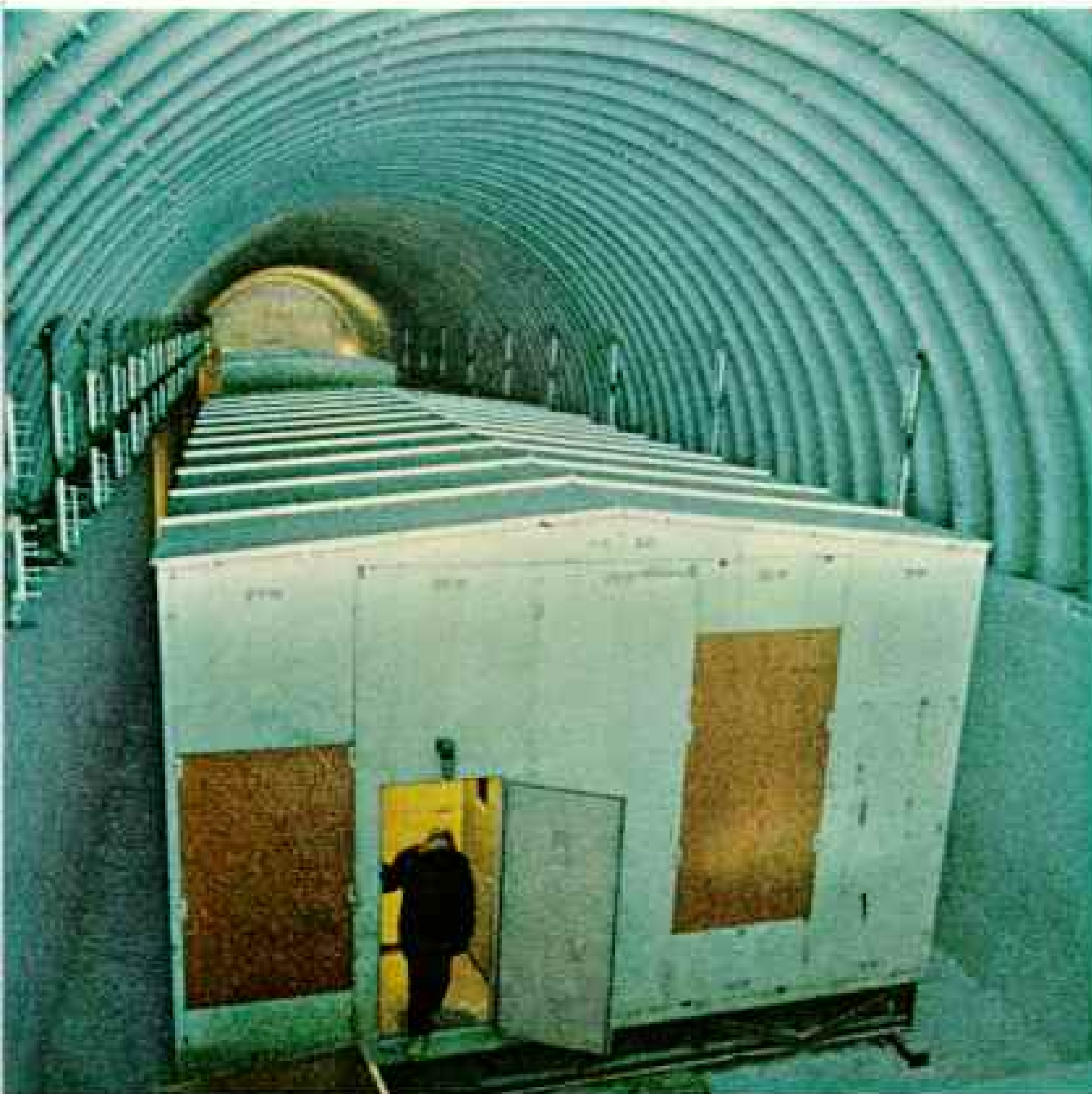
Blue light filtered through snow bathes Lt. David C. deVicq. Layers show yearly accumulations,



Seabee brushes snow from his theodolite as he surveys the site of the new Byrd Station.

Peter Snow Miller, built in Switzerland and airlifted in sections, trenches 300 feet an hour and excavates 350,000 cubic feet of snow a day. Powerful revolving blades throw white geysers as high as 50 feet in the air.





Ventilating Shaft Projects From a City Under the Snow

Byrd Station takes refuge beneath the surface so that accumulating drifts will not eventually crush it. Walls cut by the Snow Miller become so hard that they support nails and hanging objects. Tunnels will shelter 40 men in winter and 100 in summer; 15 buildings will house a hospital, laboratories, and possibly a nuclear reactor. Here two men in parkas approach an idling Sno-Cat. Distant Snow Miller turns to begin a new furrow. Guide poles help men keep bearings during whiteouts. Piles of excavated snow (upper right) were later leveled.

Building on legs, taking shape in a tunnel, has a heat-lock vestibule to keep out cold. Fans circulate cold air through the tunnels to prevent heat from melting snow walls. Repairs to shed suggest boarded windows. Poles at sides carry power and communications lines.



KOSCIUSKO (LEFT) AND AN ENTRANCE BY NATIONAL GEOGRAPHIC PHOTOGRAPHER ALBERT WOLFEY © R.G.M.

Step outside the door of my old quarters at McMurdo, and look up to Observation Hill a quarter of a mile to the south. There you will see part of the answer. On a shelf on the side of the hill stands McMurdo's new nuclear reactor, the first of several contemplated for our Antarctic stations (pages 266-7).

Nuclear Power Means Permanency

Last July, steam produced by the heat from its uranium core began turning generators to provide power. This core is good for two years' output before it will have to be replaced. The reactor will increase McMurdo's power supply about four times over that provided in Deep Freeze by conventional diesel generators.

What this can mean for the comfort, safety, and efficiency of those who work in Antarctica is not hard to imagine. It means electric heating instead of oil stoves, and a consequent reduction in the danger of fire, most feared of all Antarctic winter hazards. It means heated water distribution and sanitary lines. It means more reliable electrical energy for scientific research equipment.

It means a happy end to McMurdo's severe water shortage that last year restricted men to one shower every ten days. With nuclear

power the base can begin distilling sea water, as do our naval vessels.

Paradoxically, Antarctica is almost everywhere a waterless land. Annual precipitation on the vast interior plateau is equivalent to four inches of rain, only two inches more than that of Death Valley. The continent's potential water—equal to all the world's rivers and lakes—is locked in snow and ice, and to supply a large base, enormous amounts of snow must be melted.

The problem has been especially acute at McMurdo, where population runs above a thousand in summer, and where tractor loaders working around the clock have had to go farther and farther from camp to find uncontaminated snow for the melters. Strange as it seems, there can be a shortage of snow in snow-burdened Antarctica!

But the biggest benefit promised by nuclear power is relief from an incredibly expensive and backbreaking problem in transportation. This year, for example, Byrd Station alone will require 250,000 gallons of fuel oil costing several dollars a gallon by the time it is delivered. To get the oil to Byrd, our huge C-130 cargo planes must make more than 100 hazardous flights, 1,800 miles round trip, from



BY STANLEY D. WATSON, NATIONAL GEOGRAPHIC SOCIETY

Oil-drum pillars crumple at old Byrd Station. Roof sags under tons of crushing snow

McMurdo. Nuclear power would quickly begin paying its way at such remote outposts as Byrd and South Pole Stations.

Look now to the west of McMurdo, out to the airfield on the bay ice where a plane has just soared skyward and southward for the Pole. There, too, is evidence of the changes that have taken place.

When I first saw Williams Field, it boasted only a tiny cluster of huts for temporary shelter. Now the airfield is a complete camp for 300 people, with facilities for eating, sleeping, and maintenance, a cargo yard, and an air-operations complex with the latest in navigational aids and communications. This gateway to the Antarctic spreads its 6,000-foot runways across solid sea ice to accommodate wheeled planes; ski-planes, of course, can also land on snow runways on the Ross Ice Shelf.

Ice Breakup Threatens Airfield

Williams Field is probably the only airfield in the world that is completely dismantled late each summer and rebuilt each spring. During the summer, the fast sea ice—that is, ice frozen firmly to the shore—gradually breaks away and moves out to sea.

This "breakout" creeps steadily south until it threatens the airfield. So it is that at McMurdo a close watch must be maintained each summer, lest an unexpectedly severe breakout dump the buildings and equipment of Williams Field into the sea.

Before I had been in Antarctica long, I learned in dramatic fashion how swiftly a breakout can come.

The icebreaker *Northwind* was moored to the fast sea ice extending out from Kainan Bay, near Little America V. It was New Year's Eve, and a party was in progress on the sea ice. The sailors played baseball, using a red ball (a white ball all but vanishes against the snowy background). We cooked 20-year-old beefsteaks recovered from an old cache found at Little America III, buried far under the snow: (And how does a 20-year-old steak taste? Good.)

About 2 a.m. the party broke up—still in broad daylight, of course. I returned to camp up on the Ross Ice Shelf and turned in.

Three hours later I woke to hear an urgent voice on the announcing system: "Now all hands to muster. The ice is breaking up!"

Maj. Merle "Skip" Dawson, our trail operations officer from the U. S. Army, stuck his head in the door.

"Want to come with me, Admiral?"

I dressed quickly and joined him in a Sno-Cat.

When we arrived at the edge of the 30-foot ice cliff, where a ramp led down to the sea level, I looked with astonishment at the scene below. The baseball field of the evening before was a seething, churning mass of water and shattered ice. *Northwind* was standing off in open water.

"Suppose this had happened while we were all out there on the ice," I said to Skip.

"We've been watching for several days now," he assured me, "and we had ice patrols out walking the cracks. We would have had plenty of warning if the cracks had started to widen."

By far the most dramatic evidence of the new era in Antarctica lies hidden in the frozen wastes of Marie Byrd Land. There, at approximately 80° S. and 120° W., we have

By short wave, men in old Byrd Station's radio shack call loved ones at home. Early explorers waited a year for mail.

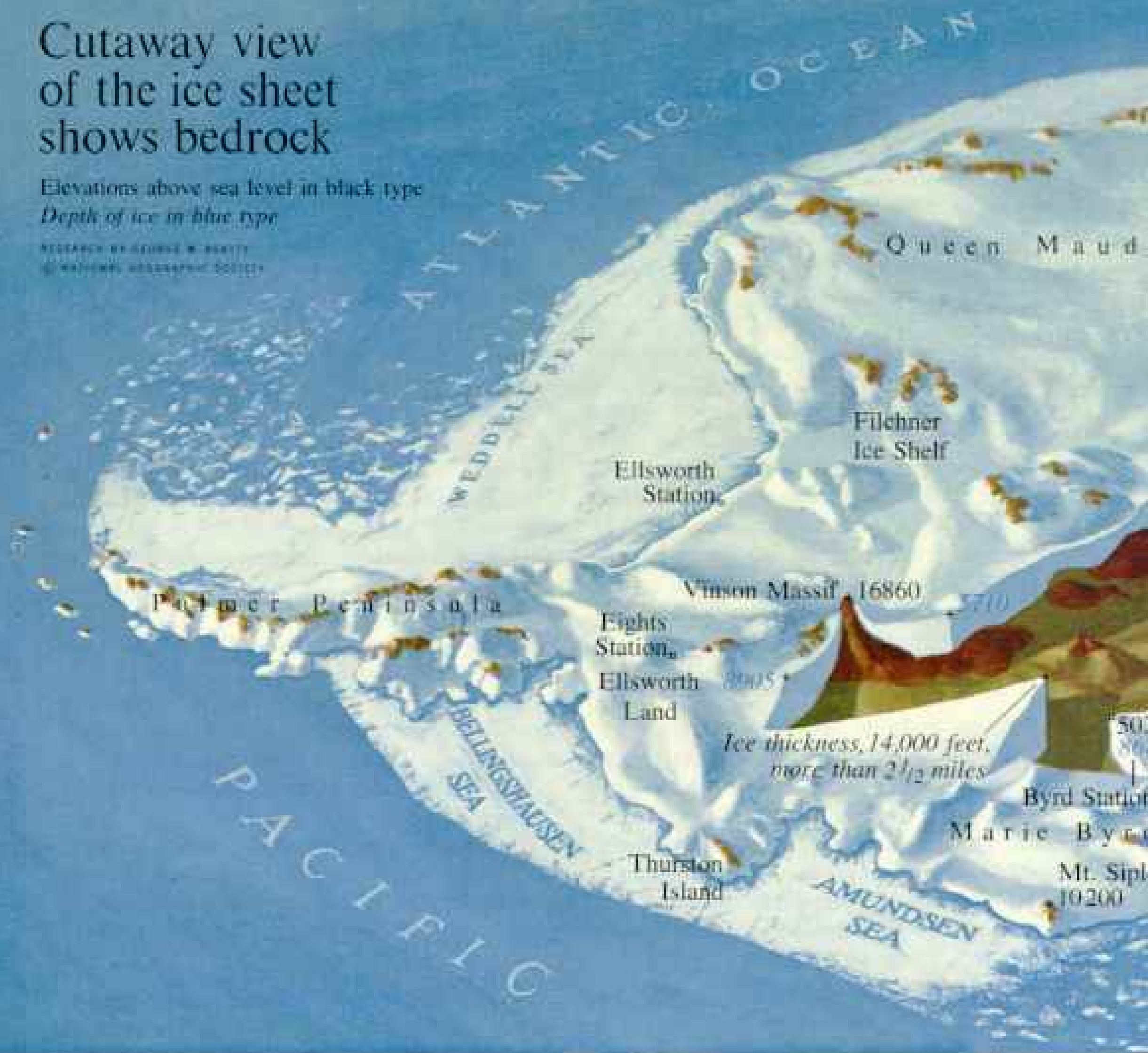
IN EXCHANGING © NATIONAL GEOGRAPHIC SOCIETY



Cutaway view of the ice sheet shows bedrock

Elevations above sea level in black type
 Depth of ice in blue type

RESEARCH BY GEORGE W. BARRETT
 NATIONAL GEOGRAPHIC SOCIETY



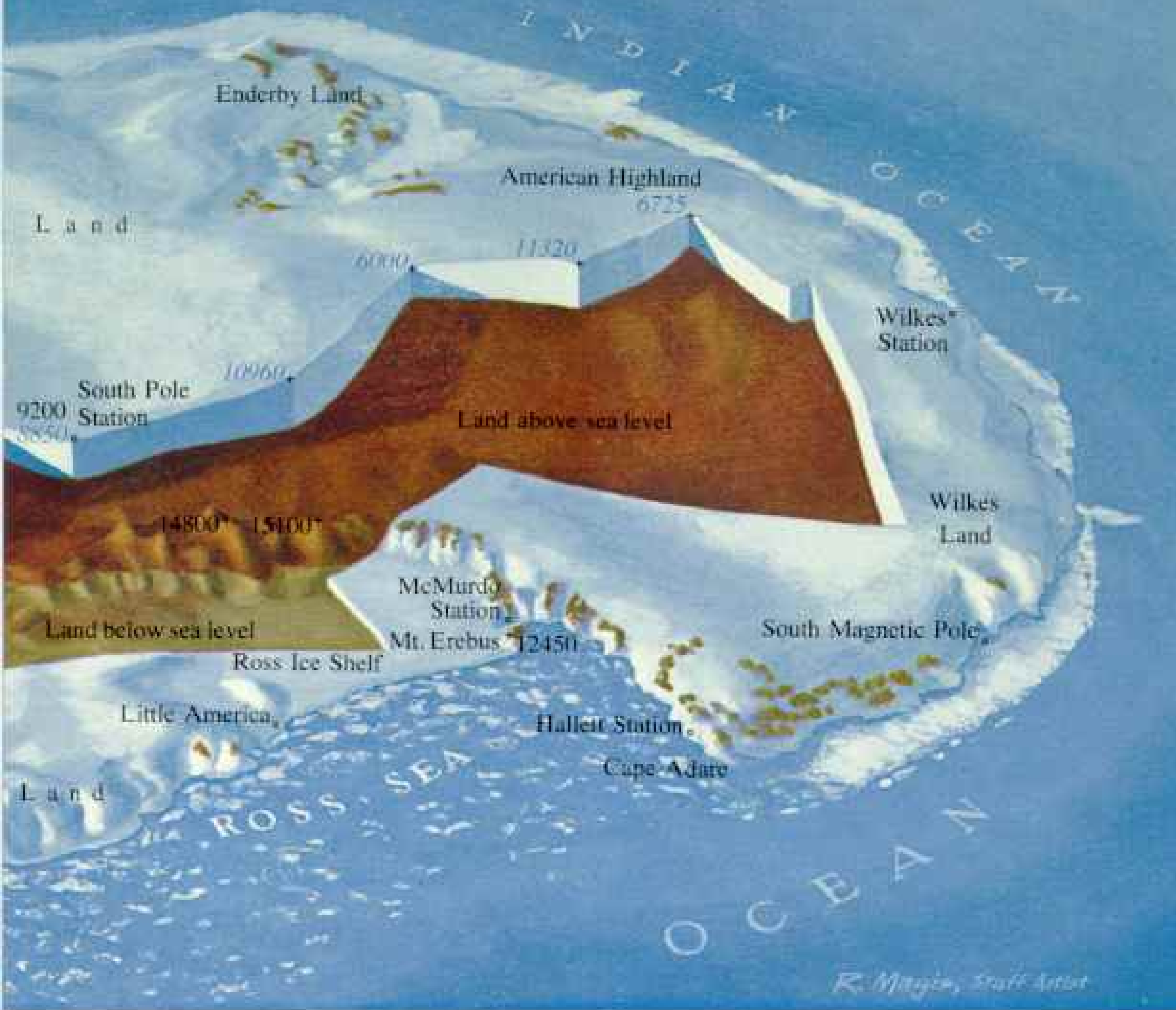
If Antarctica's ice all melted, the world's seas would rise some 250 feet, engulfing New York Harbor's Statue of Liberty to nose level.

Antarctica: New look at a continent

WHAT LIES beneath Antarctica's 7,000,000 cubic miles of ice? A decade ago, no one could have hazarded more than a guess. Now, for the first time, scientists have fathomed enough of the ice sheet and charted enough of the underlying surface to produce an astonishing picture of a rock-and-dirt continent that man has never seen.

These paintings, painstakingly prepared by National Geographic cartographic artists, coordinate what scientists have learned and what they project on the basis of their knowledge. The maps reflect surveys by men of a dozen nations, particularly some 15,500 miles of traverses by tractor train, dog sled, and foot. Scientists on these traverses have made upwards of 5,000 gravity measurements. In addition, they have plumbed the ice sheet at perhaps a thousand points by exploding charges and measuring the time sound takes to travel down to bedrock and echo back to seismometers on the surface.

These revealing views have been made possible by use of a new relief model of Antarctica prepared by the U. S. Geological Survey in cooperation with the National Science Foundation, and by the work of the University of Wisconsin, Ohio State University, and the U. S. Coast and Geodetic Survey.



Stripped of its ice sheet, Antarctica shrinks dramatically. Gravity measurements and seismic soundings reveal that much of the "land" actually is ice extending below sea level. Palmer Peninsula becomes an archipelago, according to recent findings, and Vinson Massif, pinnacle of the ice continent, stands out as an island. Only a few islands remain of Ellsworth Land and Marie Byrd Land. Evidence indicates that a channel connects the Ross and Weddell Seas. Scale: half that of the map at top.



Lonely McMurdo Station rests on black ash and lava rock from 12,450-foot Mount Erebus.



EDDACHADRE © NATIONAL GEOGRAPHIC SOCIETY

Cool air above warmer water coats sea with fog

built a city under the snow, a modern community big enough to house 100 people, a self-contained laboratory with the latest research facilities. It is new Byrd Station, dedicated and occupied just a year ago (page 272).

Nearly six miles away, shrouded in a snowy grave, lies old Byrd Station, built for the IGY. Drifts of 15 to 30 feet, piled up by the relentless wind, have crushed its walls, snapped its timbers, extinguished its life (page 274).

City Under the Snow Takes Shape

I will never forget the cold November day in 1960 when we picked the site for new Byrd. Huddled in a Sno-Cat, we lurched and crawled over the sastrugi, the waves of rock-hard snow sculptured by the wind.

The temperature stood at 30° below zero, not uncommon at a place where the warmest days barely pass the freezing point. The wind, bane of comfort in this windiest of continents, whipped powder-fine snow in our faces. The icy air slashed through our parkas, our layers of wool clothing, our waffle-weave thermal underwear, leaving us thoroughly chilled and miserable.

At length we set up a bamboo trail flag amid a cluster of fuel drums to mark the spot we had chosen, upwind from old Byrd and away from its debris.

Three weeks later, when I returned to the spot, I found the Seabees vigorously at work. For temporary shelter, they had erected the first sections of a Jamesway hut that was to lengthen to 310 feet (a Jamesway is a prefabricated insulated tent on a wooden skeleton). They were already assembling the first of two huge Peter Snow Millers, Swiss snowplows used to clear roads in the Alps. These precision machines, which are capable of carving trenches to an accuracy of half an inch, would dig the tunnels for our city under the snow. They had been proved out already in another city-in-the-snow, the Army's Camp Century in Greenland.*

On this occasion I met for the first time a 25-year-old Seabee lieutenant, David C. deVieq, who was to have more to do with the successful completion of new Byrd than any other person. In time, Dave deVieq will probably become an Antarctic legend.

Resourceful, tireless, enthusiastic, this young engineer recognizes no obstacles. If supplies fail to arrive, he creates substitutes. If a man slackens from the 12-hours-a-day,

* See "Nuclear Power for the Polar Regions," by Rear Adm. George J. Dufek, in the NATIONAL GEOGRAPHIC, May, 1962.



PH. BATES/ARND BRONKHORST

7-days-a-week pace, Dave pitches in alongside him until the man is ashamed to falter.

With Dave's natural-born leadership, the Seabees had Byrd Station ready for occupancy in the impossibly short time of 224 working days, against the odds of bitter cold and blizzard. At the end of the 1960-61 season they worked 72 hours without sleep to finish a tunnel before winter closed in.

Dave and his men dug seven trenches totaling 3,500 feet in length; roofed them with steel arches; covered them with milled snow that sets to a concretelike hardness; and filled them with prefabricated buildings and machinery and equipment (pages 270-3).

Vast Man-made Cavern Casts a Spell

After the dedication last February, Dave proudly guided us on a tour of the new station.

We filed down the entry ramp into the central service tunnel, stretching in one straight bore 600 feet long, and soaring 24 feet to its shimmering, ice-encrusted arches. The opposite entry appeared as a blinding white arch of light in the gloomy distance. One feels confined and rather insignificant in this man-made cavern, I discovered.

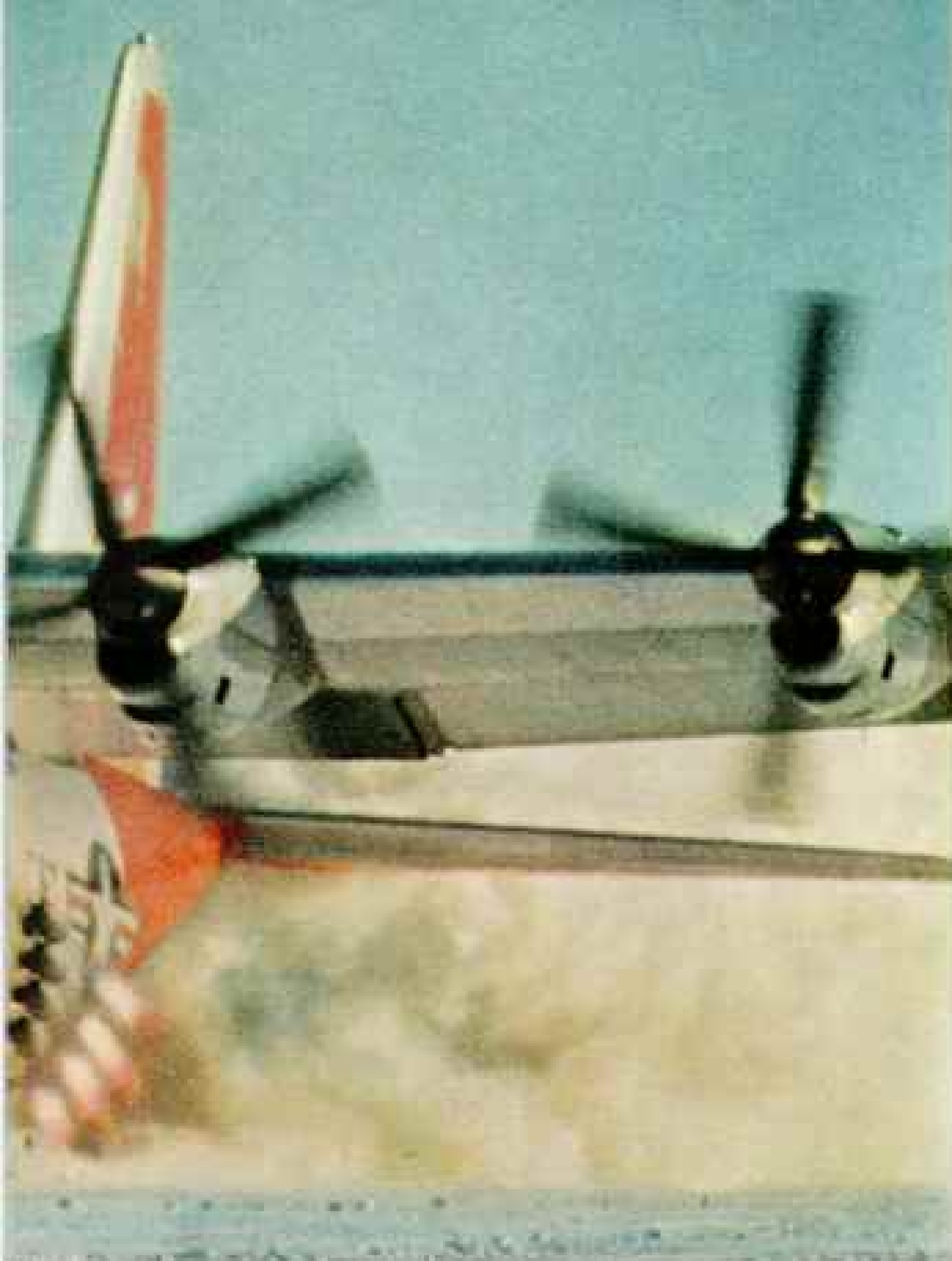
In tunnels branching off to left and right, we saw diesel generators that will provide power until the day when a nuclear plant is installed here; the latest of radio equipment, tied into our Antarctic communications network; enormous pillow tanks—actually rubber bladders—for storing fuel; row after row of neat bins for storing food and materials of all descriptions.

In the garage tunnel we inspected workshop and storage space for the weasels and Sno-Cats and Caterpillar tractors so essential to Antarctic work and travel.

Clambering up a slight incline, we turned into the 1,500-foot science tunnel. A line of buildings on legs stretched ahead, leaving passageways on either side. It was hard to distinguish between the machined snow walls of the tunnel and the white-painted walls of the buildings themselves.

"These insulated prefabs are like refrigerators," Dave pointed out, "except that they are built to keep the cold out and the heat in."

Chill currents of air at about 0° F. flowed through the tunnels, turning our breath to vapor and providing an ample safeguard against melting of the ice. Byrd's powerful



NATIONAL GEOGRAPHIC PHOTOGRAPHER ALBERT WOLFF © N.G.S.

ventilating system keeps the air fresh and cold by filtering it through the snow.

Inside the prefabs, accordion walls separated offices, but living quarters were individual rooms, painted in warm, cheerful colors to offset the coldness of the ice.

Having had more than a casual acquaintance with the sketchy plumbing of the Antarctic, I looked with appreciation at the gleaming washrooms and sanitary facilities. I thought of the hardships suffered by the men who came with Scott and Shackleton, and with Byrd in the early days. Indeed we have come a long way in Antarctica.

Walls Reveal Ice Sheet's Age

In the science tunnel Dave turned off the lights, and as our eyes adjusted to the darkness, an eerie blue glow enveloped us. It was sunlight filtered through several feet of ice, coming from an adjacent tunnel as yet uncovered.

In the blue translucent wall we saw etched lines of the many-layered snow accumulations, like tree rings, that tell the age and structure of the polar ice sheet (page 271). Dr. Carl Benson, a glaciologist from the Univer-



C-130 pilot plots his course on a navigation chart held beneath a black radar-scope. The United States is the only nation that maintains year-round stations in the interior, supplying them by air.

Roaring Engines and JATO Rockets Lift a C-130 Skyward From McMurdo

First used in Antarctica in 1960, the ski-equipped Lockheed Hercules now is the main supply vehicle for stations inland. Even when loaded with ten tons of cargo, the C-130 can leap into the air in 20 seconds, and it cruises at 25,000 feet. Jet turbines, driving four propellers, thrive on thin air that makes piston engines pant. C-130's have greatly decreased the costlier air-dropping of supplies.

Arms looped through the cargo net of a C-130, a serviceman takes a nap. A trip to the Pole from McMurdo now means less than three hours in the air, drowsing above fearsome terrain where brave explorers once struggled and died.





sity of Alaska, showed us how he was able to take his core samples directly from the wall.

Benson is one of a number of glaciologists studying the structure, growth, and movement of the 7,000,000 cubic miles of ice that cover Antarctica to a maximum depth of nearly three miles.

Vast U. S. Effort Serves Science

I felt special interest in seeing the laboratories in this tunnel, for this was the heart of the installation. The United States spends millions of dollars each year and sends hundreds of men to this inhospitable continent, not for military or economic reasons, but for scientific investigations and for development of the world's last true frontier.

The role of the Navy in this endeavor is that of support—building and maintaining the bases, and providing the housing, food, and transportation that the scientists need.

Many of the scientists are professors and graduate students from universities across the United States; others represent research institutions such as Honolulu's Bernice P. Bishop Museum, or Government agencies such as the U. S. Geological Survey and the U. S. Weather Bureau. They are financed by Federal grants from the National Science Foundation, which administers and coordinates the U. S. Antarctic Research Program.

If you were to visit Byrd Station today, you would see men of many scientific specialties at work in their new ice-locked laboratories:

- A seismologist works in his vault far removed from the vibration of the main part of the station, and records earthquakes in Antarctica and in all other parts of the Southern Hemisphere. He and others like him have made it possible to locate earthquakes previously unidentifiable. His work has also



400490000 © NATIONAL GEOGRAPHIC SOCIETY

contributed to knowledge of what underlies the vast Antarctic ice sheet (pages 276-7).

- Weather experts daily launch and track balloons to study circulation of the atmosphere, and gather voluminous information about temperatures, pressures, humidity, wind, snow drifting, and solar energy. All data from Antarctica's weather stations is radioed to the International Antarctic Analysis Center in Melbourne, Australia, to help improve Southern Hemisphere forecasts.

Upper-atmosphere physicists study phenomena like auroral displays and "whistlers." The latter are electromagnetic signals, audible on radio receivers, that are generated by lightning discharges; they bounce back and forth between the Northern and Southern Hemispheres along the earth's magnetic lines of force.

- A gravity specialist seeks among other things to learn whether the Antarctic ice sheet is

"DARBYVILLE," in 25-foot Snow Letters, Cries Out for Rescue of a Fallen Plane

Forced down on New Year's Day, 1962, by ice crystals in the fuel, crewmen of a C-130 built a den beneath the snow on an inhospitable plateau between McMurdo and Byrd Stations. Maj. Leslie L. Darbyshire, for whom the shelter was named, made the incident a survival test. NATIONAL GEOGRAPHIC photographer Albert Moldvay, who arrived with the rescuers, described the men's quarters as a "snug rathskeller."

"We were ushered down snow steps into a mess hall curtained by scarlet cloth from a survival tent," Moldvay said. "An empty fuel can converted into a stove radiated warmth and exhausted fumes through a flue of oil cans. Roller trackage from the plane's cargo deck supported a canvas roof."

Beyond the downed craft, exhaust from the rescuers' JATO bottles creates a cloud seconds after their ship took off, leaving a fresh set of ski tracks. Both the flyers and their plane returned to service.

growing or shrinking. (Many scientists think now that it is growing.)

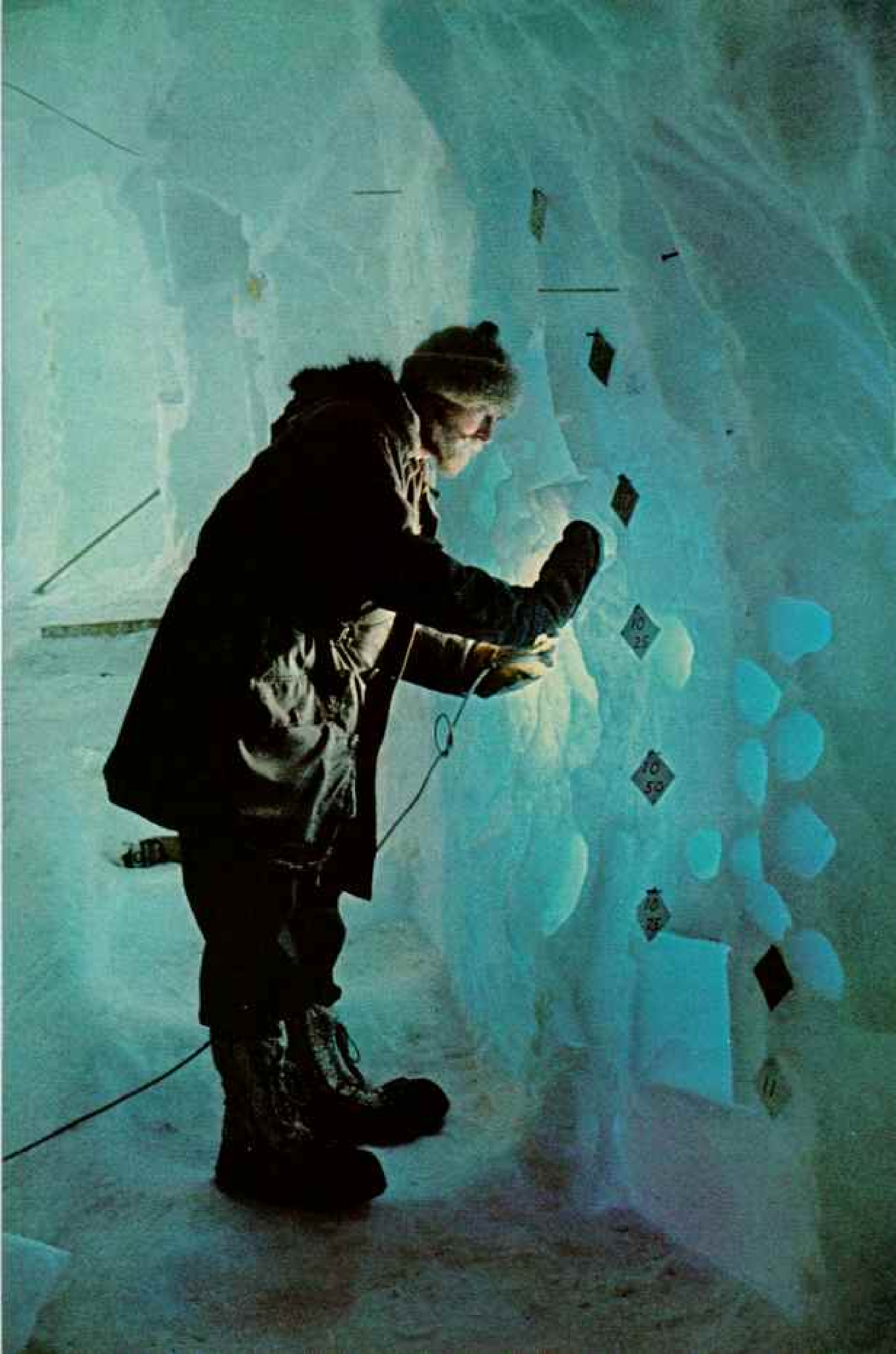
At one point in the science tunnel we found staircases and ladders rising through silo-like structures to towers mounted on stilts above the outside snow. I climbed one of these towers, designed for meteorological observations. As far as my eye could reach, in a 360° panorama, stretched the limitless white desert, desolate and empty, rippled by waves of sastrugi and broken only by the mound of snow hiding old Byrd in the distance.

The only signs of the extraordinary complex below me were the shining antennas, three other scientific towers on stilts (so that snow would blow under and not drift), the necessary vents for exhausting heat and fumes, and the escape hatches to be used in the event of fire. New Byrd lies hidden in the sea of snow like a submarine awash with only its conning tower showing.

Although our Amundsen-Scott South Pole Station is smaller than Byrd, it shows up more noticeably because it was originally built on the surface. It is, of course, now buried by drifting snow.

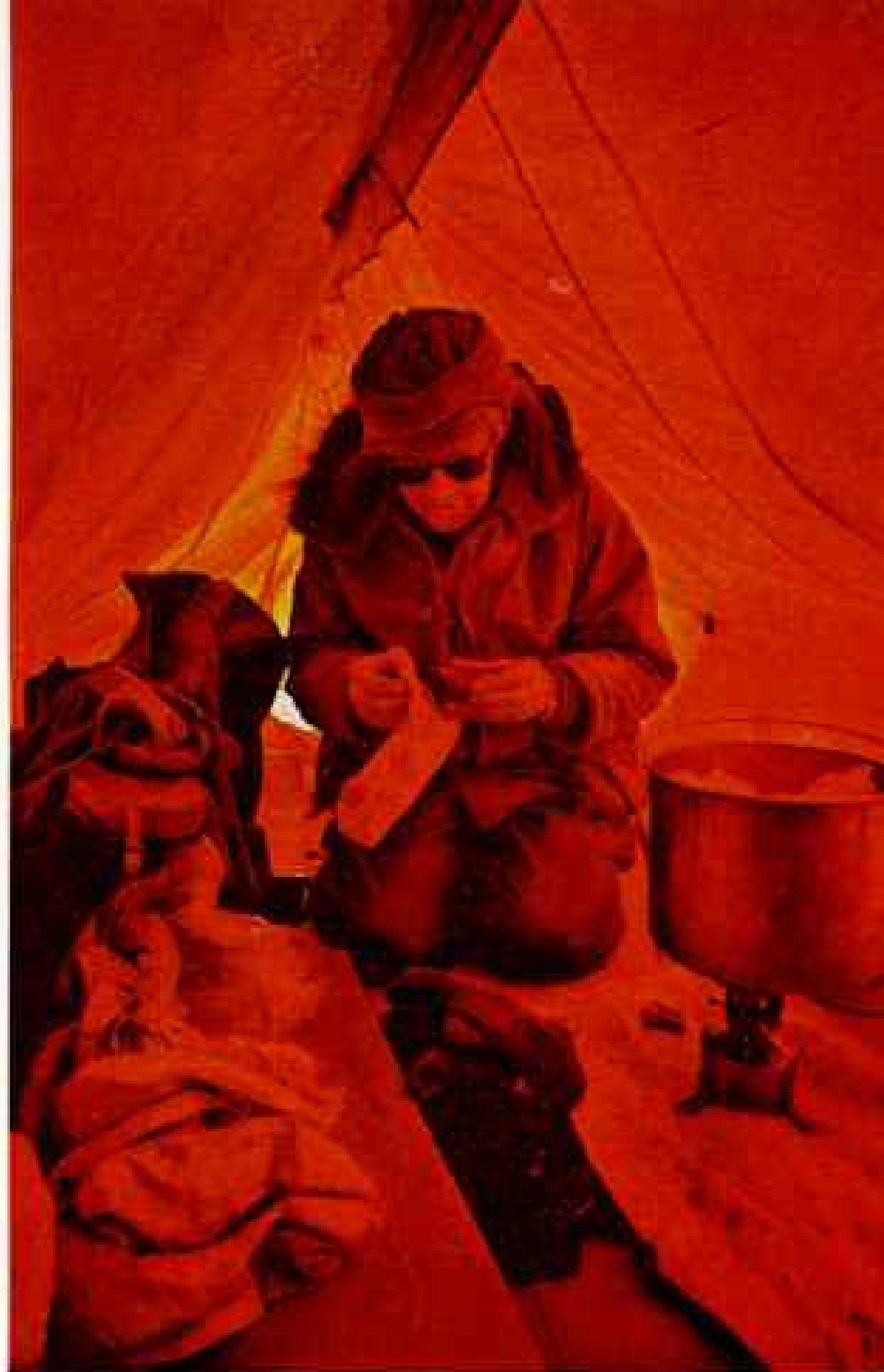
I well recall my first air view of the station: It gave the impression of a white hillock in a white desert, with a few odd pieces of pipe and boxes on stilts and curving plumes of steamy-looking smoke wafting off into the sky. Remnants of earlier airdrops lay scattered across the snow.

Whether we will replace Pole Station with



Blue grotto under the South Pole yields ice cores to be sent to the United States for analysis. In a snow mine 90 feet deep, glaciologist Edward Oliver studies snowfalls of years past. Diamond-shaped tags mark depths.

Fish in an aquatic squirrel cage provides metabolism readings for Dr. D. E. Wohlschlag at McMurdo. Rotating chamber compels fish to swim. Rate at which it consumes oxygen from the water gives metabolism data.



GEORGE HERRING FOR LIFE EXTENSION (OPPOSITE) © HILL

Red tent sheds crimson on geologist Robin Oliver, who examines a rock specimen while his primus stove melts snow for water. A visiting New Zealander, Dr. Oliver worked with the U. S. Antarctic Research Program,

a city carved in the snow like Byrd is uncertain. The Pole receives less wind and snow than Byrd, and the problem of snow accumulation is therefore less severe. We may rehabilitate the station with new surface structures built and arranged so as to minimize drifting. In any case, the plans call eventually for a nuclear reactor there.

Propjets Make New Era Possible

If I said that building Byrd Station was a labor of Hercules, I would not exaggerate. We could not have built this outpost without a propjet ski-plane known as the Hercules, the Lockheed C-130.

When I came to Antarctica, all our heavy airlifts inland were flown by the Military Air Transport Service's Douglas Globemasters, manned by Air Force crews. These wheeled planes could land only on the sea-ice runways of McMurdo. At the Pole or Byrd Station, a

Globemaster had to parachute its cargo, a dangerous and costly business.

For delivering men and delicate equipment, our "Penguin Airline," known officially as Navy Air Development Squadron Six, used ski-equipped Douglas R4D's (the DC-3 Dakota of wartime fame) or the Lockheed Neptune. But every flight in these small planes was an adventure fraught with hazard.

I remember most vividly my first flight to the Pole in an R4D, with veteran pilot Earl "Buz" Dreyfuss. Buz had painted the name "Wilsheduit" on the nose of his plane, and as I got aboard, I wondered.

We had to climb to the 9,000-foot Polar Plateau, and our route was the same one followed by the sledge parties of Scott and Shackleton in the early days—up the awesome Beardmore Glacier. Hemmed in by peaks reaching nearly 15,000 feet, this colossal river of ice drops for a span of 140 miles in magnificent



Canada Glacier Sticks Its Tongue Into Wright Valley

Three "dry" valleys—Wright, Taylor, and Victoria—all near McMurdo Sound, are almost as hostile to life as the ice that buries 98 percent of Antarctica. Thaw, evaporation, and wind erosion cut Canada Glacier short of its goal, the sea.

Mummified seal, perhaps thousands of years old, intrigues visitors to Taylor Valley. Biologists believe it wandered from the herd, died, and became mummified in dry, almost bacteria-free air.

Soviet explorers have found such seals in an Antarctic valley of death near Australia's Davis Station.

Fierce skua, a gull-like bird, mothers chicks on Cape Evans. She sometimes ranges deep into the Antarctic heartland, for reasons unknown.



ALLIENHÖRNER © NATIONAL GEOGRAPHIC SOCIETY



flowing sweeps and breathtaking icefalls.

With her twin engines laboring to gain altitude, the old R4D climbed the Beardmore, flying so low that we could easily see the 30-foot-high pressure ridges in the ice.

Buz shook his head. "I don't see how those fellows ever got up here with their sledges."

I agreed—and I wondered just how well we would fare if clouds moved in suddenly.

Such exciting flights are a thing of the past, and, I confess, I miss the thrill. Though we still use the old Dakotas and Globemasters in a more limited role, the C-130's, which thrive on cold temperatures and high altitudes, have become the backbone of our air operation. Carrying ten tons of cargo, they easily clear the mountains and climb over the weather. Day after day, from October to March, they swoop down on Byrd and Pole Stations, settling lightly on the skiways to deliver cargo and personnel (page 280).

I firmly believe that the day in May, 1959, when I finally obtained approval for outfitting our air squadron with the C-130's marked the start of the transition to an era



of permanent development in Antarctica.

Without the C-130's, we could not have airlifted the mountain of materials to build Byrd Station. Nor could we deliver the heavy nuclear reactors that have been contemplated for the inland stations.

In other ways, too, the C-130 has revolutionized work in Antarctica.

Vehicles for scientific traverses no longer need to crawl hundreds of profitless miles to reach the area in which the scientists wish to begin their studies. Last season, for example, seven scientists flew

Grotesque mask of ice coats the beard of a New Zealander just after his ascent of Mount Fridtjof Nansen (page 297).

Geologists mine coal for science in their "Dirty Diamond Mine" in the Horlick Mountains. The Ohio State University scientists found coal that dates from the Permian Period, about 250 million years ago, when Antarctica had a comparatively warm climate.

PHOTOGRAPHS BY S. F. FAIR (1967) AND WILLIAM LYNN © NATIONAL GEOGRAPHIC SOCIETY



1,500 miles east of McMurdo to Camp Minnesota. There they began the Ellsworth Land traverse, which significantly altered the map locations of many mountains and produced new discoveries about the great trench under the ice that seems to split Antarctica in two.

Only the C-130's could have delivered this expedition: seven men with supplies and equipment for a two-month, 1,000-mile traverse; eight sleds and a hutlike wanigan equipped as a galley; three Sno-Cats weighing nearly four tons apiece; and a rollitanker with four huge rubber tires used as fuel tanks and capable of holding 500 gallons each.

Perils for Penguin Airline

"Antarctic flying consists of hours of sheer boredom, interrupted by moments of stark terror."

So read a sign over the navigator's seat in one of our planes last season.

In years past this grim comment held all too much truth. The Penguin Airline has coped with some of the world's worst weather, extremely hazardous terrain, perilous take-off and landing conditions, unreliable communications, and inaccurate charts. For good reason the 2,400-mile over-water flight between New Zealand and McMurdo has been called the world's most dangerous air route.

Even when weather is perfect, sunspots sometimes set off magnetic storms that knock out our communications and isolate us completely from the rest of the world. This happened for eight straight days in November, 1960. Without the ability to notify Christchurch, New Zealand, about weather conditions, we had to suspend all operations to the continent.

Until recently we could count on no more than 50 percent reliability in communications. But Navy antenna riggers and communications workers from Hawaii (some of whom had never before seen snow) have installed gleaming 110-foot antenna towers and a new communications network. With the improved equipment, our reliability has risen to better than 90 percent.

At the same time our stations and planes are using much-improved electronic gear for guiding flight and landings. Bit by bit, in this new era,



ILLUSTRATION BY ALBERT WILSON © NATIONAL GEOGRAPHIC SOCIETY

Tellurometer on a tripod sends and receives radarlike signals that measure distances to an accuracy of two inches in 20 miles. Red screen helps operator's colleagues spot him. Hopping by helicopter from peak to peak, a U. S. Geological Survey team plotted a region as long as California.

we are reducing the moments of terror in Antarctic flying. If Adm. Richard E. Byrd could be here today he would be tremendously pleased, for it was he more than any other man who brought the Air Age to Antarctica.

We put these improvements to a crucial test late in Deep Freeze '61, when we were forced to return to the continent weeks after we had buttoned it up for the winter. Leonid Kuperov, who was wintering over at Byrd Station as a



PHOTOGRAPHS AND AN ILLUSTRATION (LOWER RIGHT) BY NATIONAL GEOGRAPHIC SOCIETY

"Hurry up and wait" is a frequent experience of Antarctic travelers. This man sleeps beside crates of supplies as U. S. Navy crew members prepare the Douglas R4D for a flight to Beardmore Glacier. Years ago he would have had to make a grueling trip by dog sled.



Peering from a plane, a member of the Ellsworth Land traverse looks for checkpoints he will spot later on the ground.

Sno-Cats of the traverse party rendezvous at Sky-Hi Station—now called Eights Station—before resuming their trek. Men work and sleep in the tractors.

Soviet exchange scientist, became seriously ill and had to be evacuated. I called two of our C-130's back from their base at Quonset Point, Rhode Island, 10,000 miles away.

Storms at Christchurch held us up for days, but on April 8, Comdr. Lloyd E. Newcomer, with Capt. William H. Munson as copilot, began a 6,500-mile rescue mission to McMurdo and Byrd and back again 48 hours later. At McMurdo, Newcomer found himself unable to take off at first attempt; even the extra thrust of auxiliary JATO (jet-assisted take-off) rockets could not overcome the drag of three feet of soft snow. The plane taxied up and down the strip to compact the snow before making the second, successful attempt.

Historic Flight Saves Russian Scientist

Kuperov survived. This mercy flight, in the face of diminishing daylight and increasingly vicious winter storms, breached the curtain of winter isolation for the first time. It will be long remembered as one of the great flights of Antarctic exploration.

Another rescue attempt after the continent had entered its winter seclusion proved far more worrisome and less successful. During a late March storm, two small decommissioned tankers used for fuel storage snapped their moorings at McMurdo and drifted away. One of these engineless derelicts held 200,000 gallons of aviation gasoline, badly needed for our flights in the next spring before the first tanker could arrive from New Zealand. We had to try to retrieve that gas.

The icebreaker U.S.S. *Edisto* had been back in New Zealand for only five days after three months in the ice. I ordered her again to the Ross Sea, later than any modern ship had ever attempted to go there.

Down she went, through the roaring '40's, the furious '50's, the screaming '60's. As she reached the Ross Sea, opposite Cape Hallett, the stormiest waters in the world proved that their reputation is well deserved.

Members of the *Edisto* crew later described their ordeal in their cruise book:

"Winds and seas picked up with the fury that a tiger unleashes when his prey has wandered too far into his territory. . . [Ice] formed as the spray fell in huge murderous sheets over the topside areas and continued to freeze, layer upon layer, until the ship staggered under the weight of it. Meanwhile winds had reached 90 knots and seas towered over the superstructure to a height of sixty

feet. *Edisto* wallowed in the swells, climbed slowly to their crests, then slid suicidally down again. The ship crashed and shuddered with such violence that light bulbs shattered in their sockets and hands were shaken loose from precarious holds on bulkheads."

For three days the fury of the storm racked the ship, snapping her forestay, demolishing 40 feet of her starboard railing, and tearing away all but one of her antennas. As the radio reports came in to me in Christchurch, I spent some of the worst moments of my life.

Finally, within 300 miles of his objective, the captain of *Edisto*, Comdr. Griffith C. Evans, reluctantly complied with my order to abandon the mission and return. By that time his ship had lost one of her propellers, and she carried a topside burden of ice that threatened to capsize her. It was estimated at 800 to 1,000 tons, some of it ten feet thick.

"As we steamed toward New Zealand," concluded the cruise book, ". . . all hands went topside to clear away the ice with pickaxes. The topside spaces resembled some weird alpine scene with the crew in full foul weather clothing scaling the mountainous ice."

Many other accomplishments rank high on the list: Capt. Edwin A. McDonald's invasion of the ice-locked Bellingshausen Sea;* the cruise of the icebreaker *Glacier* to the little-known coast of Marie Byrd Land, putting a previously uncharted island on the map and erasing two others found not to exist; the voyage of the icebreaker U.S.S. *Burton Island* into some of the windiest and trickiest of Antarctic waters, Commonwealth Bay, to locate the wandering South Magnetic Pole.

Rugged Men Assail a Rugged Land

As I reminisce about these last four years, I recall a galaxy of faces—strong, bearded faces, often framed in the wolverine-fur trim of a parka hood.

I think of the logistics officer who sang, "Oh, the life on the ice is not the life for me!"

Then there is Maj. Antero Havola, U. S. Army, Finnish-born expert on transportation who fought in the Russo-Finnish War. In Deep Freeze '61 he led a tractor train from Byrd to the Pole, over 800 miles of virgin terrain. It was the first United States party to reach the Pole overland.

There is also Chief Warrant Officer George

* See "Exploring Antarctica's Phantom Coast," by Capt. Edwin A. McDonald, NATIONAL GEOGRAPHIC, February, 1962.



Sea elephant in the South Shetlands roars defiance. A bull may grow up to 20 feet and 4 tons.

Emperor penguin warms a chick between its feet at Cape Crozier. Males incubate eggs; females do the courting. Chicks hatch on the ice in the darkness of Antarctic winters.

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Hungry leopard seal eyes Adélie penguins at

W. Fowler, U. S. Army, navigator for the Byrd-Pole traverse. They call him "Featherfoot" because of his uncanny ability to get over the most treacherous crevasse areas without falling in. Fowler rode his weasel ahead of the main party, setting up 12-foot flagged bamboo poles to mark a safe route for the 37-ton tractors.

And I recall Dr. Albert P. Crary, Chief Scientist for the U. S. Antarctic Research Program, who led an eight-man scientific traverse party on a 1,350-mile trek from McMurdo to the Pole.

Dr. Crary holds the distinction of having stood at both geographic poles.

At intervals Dr. Crary's party set off dynamite explosions in the ice. The time required for echoes to bounce back from the bedrock measured the thickness of the ice sheet.

In two months' travel Dr. Crary lost only two

Emperor chicks huddle for an exchange of heat. Born in winter, they complete their growth in time for summer's ice breakup, when they go fishing for themselves.



EDDACHROMES BY BOB LITTELL (FRONT) AND BOB LITTELL (OPPOSITE, ABOVE) © NATIONAL GEOGRAPHIC SOCIETY

Cape Crozier. Safe on the ice, the birds scurry farther from the water's edge





Capt. Robert Falcon Scott's hut on Cape Evans brimmed with ice before a New Zealand party chopped a way in and restored it. The New Zealanders visited the hut fifty years after Scott's arduous trek to the South Pole. Ten members of Sir Ernest Shackleton's 1914-17 expedition were marooned here for some 20 months.

New Zealanders atop Mount Victoria, overlooking Wellington, their capital, dedicate a memorial to Rear Adm. Richard E. Byrd. Flags of Antarctic Treaty nations surround the monument, whose design was inspired by contours of a tent in an Antarctic blizzard.

Admiral Byrd in bronze, a gift of the National Geographic Society, soon will greet visitors to McMurdo. The bust was cast from a statue commissioned by the Society and executed by sculptor Felix de Weldon. The statue, dedicated in November, 1961, flanks a roadway leading to the main entrance of Arlington National Cemetery at Washington, D.C. The Society supported Byrd's first two Antarctic expeditions and later named him to its Board of Trustees.

days—one in a blizzard on the Polar Plateau, and another during a whiteout while climbing the Skelton Glacier. In a whiteout, light bounces back and forth between the ground and a low cloud layer, engulfing the world in a uniform whiteness that destroys both shadows and horizon. Sense of depth and distance vanishes. Men suddenly feel very tall, and may experience the sensation of toppling over. Pilots liken flying in a whiteout to being inside a ping-pong ball.

Perhaps the face I recall most vividly is that of Dr. Charles W. Swithinbank, British-born glaciologist from the University of Michigan, one of the most highly respected Antarctic leaders. His face is weathered and burned by sun, wind, and frostbite (page 261).

Dr. Swithinbank has helped pioneer in the use of a remarkable motor toboggan that develops nine horsepower and can pull one-ton sledge loads.

The driver skis along 60 feet behind the toboggan, guiding it by reins attached to the controls (page 268). Thus the toboggan is also a crevasse detector; if it takes a spill, the

driver has time to stop. Says Dr. Swithinbank, "It can do everything dogs can do but wag its tail."

Once when Dr. Swithinbank was showing me his toboggan, it got away from him. Fortunately, it was set to circle, so it returned.

This scientist has earned the highest admiration from the pilots who fly his parties into the interior. He plans his logistic requirements to the last ounce and takes only the barest essentials for shelter and transport.

In his study of the giant glaciers pushing down from the Polar Plateau, Dr. Swithinbank has often used helicopters. Even so, he sometimes has had difficulty, as he relates in the University of Michigan Research News:

"The ice on these glaciers is so fast moving [about 600 yards a year] that much of its surface consists of a confusion of ridges, crevasses, séracs, and snow bridges so chaotic that not even a helicopter could find space to land. Somebody, however, had to erect survey markers strong enough to survive the extreme winds of an Antarctic winter. To do this, a man [Dr. Swithinbank himself] was



suspended from the sea rescue winch of a hovering helicopter and lowered to a relatively smooth spot on the ice. After slipping from the rescue harness, he grabbed an ice auger and a ten-foot length of four-inch aluminum pipe as they were handed down from the open door of the helicopter. The pipe was topped by a red flag. The helicopter circled within a quarter mile while a three-foot hole was drilled with the hand auger. Once the marker pipe was standing securely in its hole, the man was sedately hoisted to safety by the winch."

Among those on the home front who have backed us up, I think particularly of Dr. James E. Mooney, my associate in the Antarctic Projects Office, who has devoted many years of his life to Antarctic affairs.

Science Gains Rich Rewards

What are scientists learning from all our activity in Antarctica?

Some are collecting insects in traps on planes or in bamboo-framed nylon nets. Living specimens have been found on a glacier above 6,000 feet. The species so far discovered (including springtails and a wingless fly) are of special importance, for they are among the few forms of Antarctic animal life not dependent on the sea for food. About half are parasitic; the others live chiefly among mosses and lichens in rare ice-free areas.

Other scientists have dug what they call the "Dirty Diamond Mine" in the Horlick Mountains (page 288). Five geologists last year drilled and blasted 20 feet to bring out virtually unweathered Antarctic coal. Widespread discoveries of surface coal and petrified wood show that Antarctica had luxuriant vegetation 250 million years and more ago.

Three surveyors hopping from peak to peak with powerful new jet helicopters have charted a 1,200-mile stretch along the western margin of the Ross Sea and Ross Ice Shelf. With an electronic device called a tellurometer, they bounce signals back and forth to measure distances with the phenomenal accuracy of two inches in 20 miles. These chartings, based on brass markers fixed into the bedrock, supplement aerial photographs to produce highly accurate maps of an area larger than New England.

Some of the recent discoveries are startling. There is a shallow pond in Victoria Land that refuses to freeze in winter—perhaps because of its heavy salt content. Five miles away lies a lake that is frozen on top but registers more than 70° F. at a depth of

200 feet. No one yet knows the explanation.

There are the five penguins brought in straitjackets by plane from Wilkes Station (a U. S. IGY station now operated by Australia). The birds were banded, then released at McMurdo. Two showed up on their nests eleven months later, after waddling and swimming 2,200 miles.

The world's southernmost bird, the swift skua, has shown the same homing instinct. A year ago, six of the gull-like skuas were banded, flown to the South Pole, and released. Just ten days later, one skua had returned to his mate and chick on Cape Crozier, 825 air miles north over barren snow and mountains. Oddly enough, the skua has been known to fly inland toward the Pole hundreds of miles, far from the sea and the penguin colonies on which it preys (page 287).

Some of the scientific incidents have their humorous side. For example, near McMurdo one day, a seal appeared at a hole in the sea ice with a 52-inch live fish in its mouth. Two biologists and an engineer, who were about to pull a fish trap through the hole, recovered from their surprise in time to snatch the fish from the equally surprised seal. The catch weighed 58 pounds.

A number of similar fish had previously been found on the ice more than a mile from the sea. They were determined by radio-carbon dating to be as much as 1,100 years old. The mystery of their appearance so far inland has never been explained.

Continent Still Veils Many Secrets

The full story of what we are getting from our scientific investment in Antarctica will be years in coming. The most significant discoveries may still be hidden in columns of figures and pages of notes, to be revealed only after painstaking study. But one thing is sure—we are getting more science for our dollars each year, as we gradually extend the working season on the ice and improve the efficiency of our stations and our transportation.

I believe the time is near when women may be accommodated at McMurdo. (So far as I know, only six women have ever set foot on the continent.) I foresee also the coming of tourists to view the majestic mountains, glaciers and dry valleys, the comical penguins, and the historic huts of Scott and Shackleton.

This frontier land holds tremendous interest, for its veil of mystery has barely been lifted. It is still true, as Admiral Byrd once said, that Antarctica is "one of the great undone tasks of the world." THE END

Filling In Antarctica's Blank Spaces

AT ONE PLACE on the surface of the earth—and one only—man still has the unimaginable thrill of sighting new mountains and finding new islands, of turning blank, unexplored spaces into solid geographical facts. That place is Antarctica, last and loneliest of the seven continents.

Now, thanks to the explorations of many dedicated men, the National Geographic Society presents to its members a map of Antarctica that revolutionizes our conception of its geography. Firm orange lines today

mark coasts that wavered, white and uncertain, on the Society's previous Antarctic map (September, 1957).

An area almost as big as New Mexico, formerly shown on maps as land, is now known to be part of the Filchner Ice Shelf. In its midst rises South Carolina-size Berkner Island, named for Lloyd V. Berkner, American scientist who played a prominent part in bringing about the International Geophysical Year in 1957-58.

Much of our new geographic knowledge stems from that great international effort. For eight straight

NEW ZEALANDERS descend 13,700-foot Mount Fridtjof Nansen, scaled during a 50th-anniversary trek over part of the route Roald Amundsen followed to the Pole in 1911.

ILLUSTRATION BY P. W. STRAY © NATIONAL GEOGRAPHIC SOCIETY



Byrd's vow on a map: "I think I'll try to clear up some of these blank spaces." The admiral's promise accompanied congratulations to his friend "Bert," Dr. Gilbert H. Grosvenor, then President and Editor of the Society, for the Geographic's October, 1932, map of Antarctica. The Society's new map shows how well Byrd and his successors succeeded.

Grosvenor Trail is the route of Byrd's geological party from Little America to Axel Heiberg Glacier.

years, beginning in the 1955-56 season with preparations for the IGY, explorers and scientists have systematically attacked this last geographic frontier—first sighted only 143 years ago. Instead of little bands of bold men who probed the unknown with Scott, Shackleton, Mawson, and Byrd, hundreds sail or fly "down to the ice" each year. Even now, more than 4,000 Americans and nearly 6,000 men of eight other nationalities are bringing the 1962-63 season's work to a close; approximately 700, almost half of them Americans, will winter there.

Out of such sacrifices, then, have come the nuggets of new information recorded on this latest Atlas Series Map, *Antarctica*.^{*} Ninety-one notes—2,900 words—highlight the history of the continent from January 17, 1773, when Capt. James Cook first crossed the Antarctic Circle, to completion of the first nuclear power plant at McMurdo Station on March 4, 1962.

"Great God! this is an awful place..." wrote Robert Falcon Scott in his diary on that January day in 1912 when he reached the South Pole, only to find that Roald Amundsen had beaten him by 34 days. Scott's party perished on the return trek; he and his last two companions died just 11 miles from a supply cache. The map marks the tragic spot at 79° 38' S., 169° 15' E.

Map notes point out that Vinson Massif, at 16,860 feet, is the highest point; that in average elevation this is the highest of continents; that offshore winds reach 200 miles an hour in this windiest of lands; that Sir Hubert Wilkins was first to use planes here in 1928; that Thurston Peninsula is now Thurston Island; that Marie Byrd Land, Ellsworth Land, and the Palmer Peninsula may be islands under the ice.



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One of four insets shows subglacial Antarctica, the continent as it would appear without its ice sheet. Another locates Antarctica and its drift ice in relation to other southern continents. A third enlarges the glacier-fingered Queen Maud Range, grim hurdle for Scott by land and Byrd by air on their routes to the Pole. The fourth shows detail of the McMurdo Sound area, where planes and tractor trains head inland from the United States' McMurdo Station and New Zealand's Scott Station.

In addition to the geographic South Pole, on the axis of the earth's rotation, two other poles are shown: the geomagnetic, where magnetic lines of force would converge if the earth were a bar magnet; and the magnetic, 1,599 miles from the geographic Pole, where the lines of force actually enter the earth. This pole wanders northwest some eight miles a year.

Just as the International Geophysical Year stirred enthusiasm that carried over into several seasons of Antarctic research, a "little IGY" in 1964-65 promises to stimulate further advances. The "Year of the Quiet Sun" will focus world attention on the solar body while its magnetic storms are at minimum, and some of the most important observations will be from the vantage point of Antarctica. THE END

^{*} *Antarctica* is the 36th uniform-size map issued by the Society in the past five years; it becomes Plate 65 in the Atlas Series. A convenient Folio binds the maps; it may be ordered from the National Geographic Society, Dept. 67, Washington 6, D. C., at \$4.85. Single maps, 50 cents each; a pocket of the 35 maps issued from 1958 through 1962, \$10.50; a combination of the 35 maps and Folio, \$14.00.

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The National Geographic Society is chartered in Washington, D. C., in accordance with the laws of the United States, as a nonprofit scientific and educational organization for increasing and diffusing geographic knowledge and promoting research and exploration.

The Society has conducted more than 300 expeditions and scientific projects. It disseminates knowledge to millions through its world-famous *National Geographic*, its 23 million color maps a year, its books, monographs, bulletins for schools, its information service for press, radio, and television.

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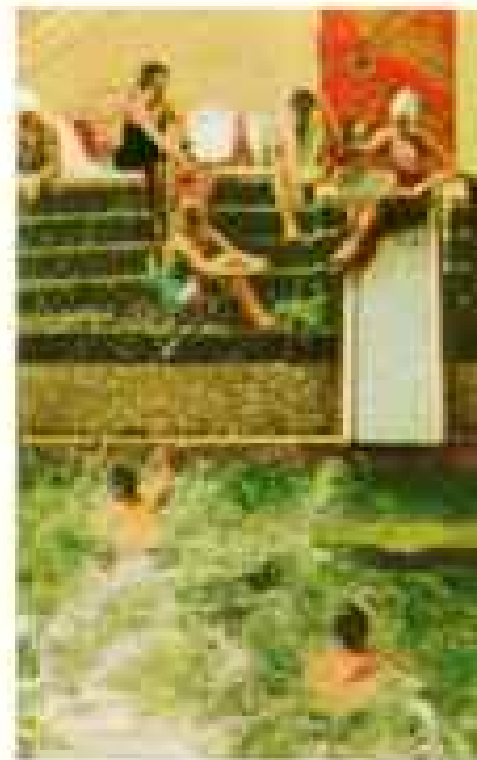
COVER: Her lithe body awlirl, a young Burmese performs a classical dance in Mandalay.

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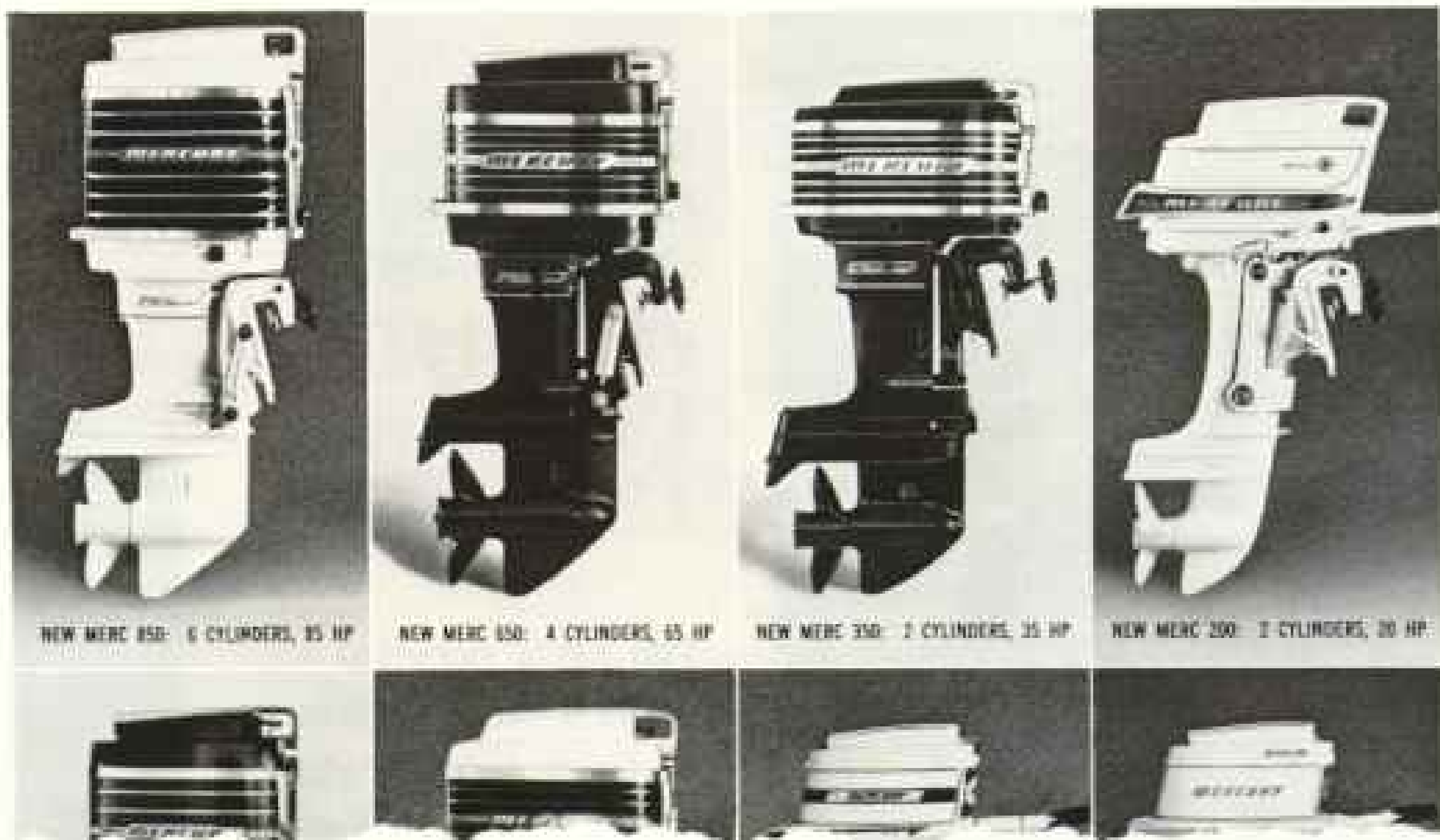
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MANY MEN have glimpsed the world's highest cataract, Angel Falls, whose maddened torrents plunge 3,212 feet into Venezuela's "lost world," the trackless Guiana Highlands. Few, however, have ventured to the base of the falls, accessible only after a dangerous canoe trip through a labyrinth of swirling jungle rivers.

But staff writer-photographer Thomas J. Abercrombie is not a man to turn away from a challenge. At a jungle outpost he hired a guide and two Indian boatmen. For four days, battling rain-swollen currents, beset by fly larvae that burrowed into their flesh, the men pushed through primeval wilderness. Finally Tom could scrawl in his damp notebook this triumphant entry:

"We cross a rushing stream, wading up to our chests, and hike up a hill. Our Indians, fearing evil spirits, refuse to go farther. In midafternoon a curtain of clouds lifts, revealing one of nature's grandest shows."

Yet Angel Falls was merely a side trip for Tom in a thorough coverage of oil-rich Venezuela. In next month's *GEOGRAPHIC* he roves this volatile Latin American republic, exploring cities and towns and joining oil workers, iron miners, and diamond seekers at work. He even shares the life of Stone Age Motilone Indians, despite a warning that it was suicidal to trust them.

Each month, through such vivid articles, you journey through a changing world. Let your friends travel too. Nominate them on the form below for membership in your Society.



In Venezuela's "lost world," a Geographic writer jots notes amid the roar of Angel Falls, highest cataract on earth

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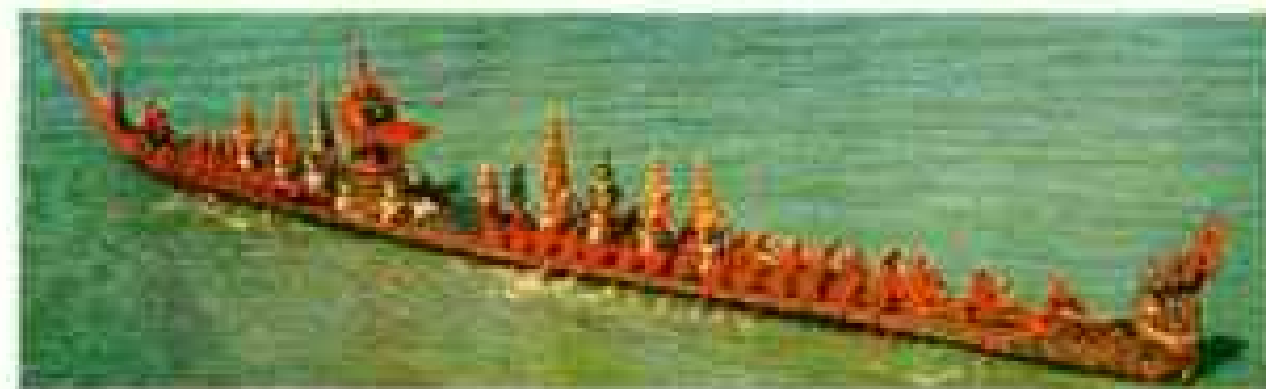
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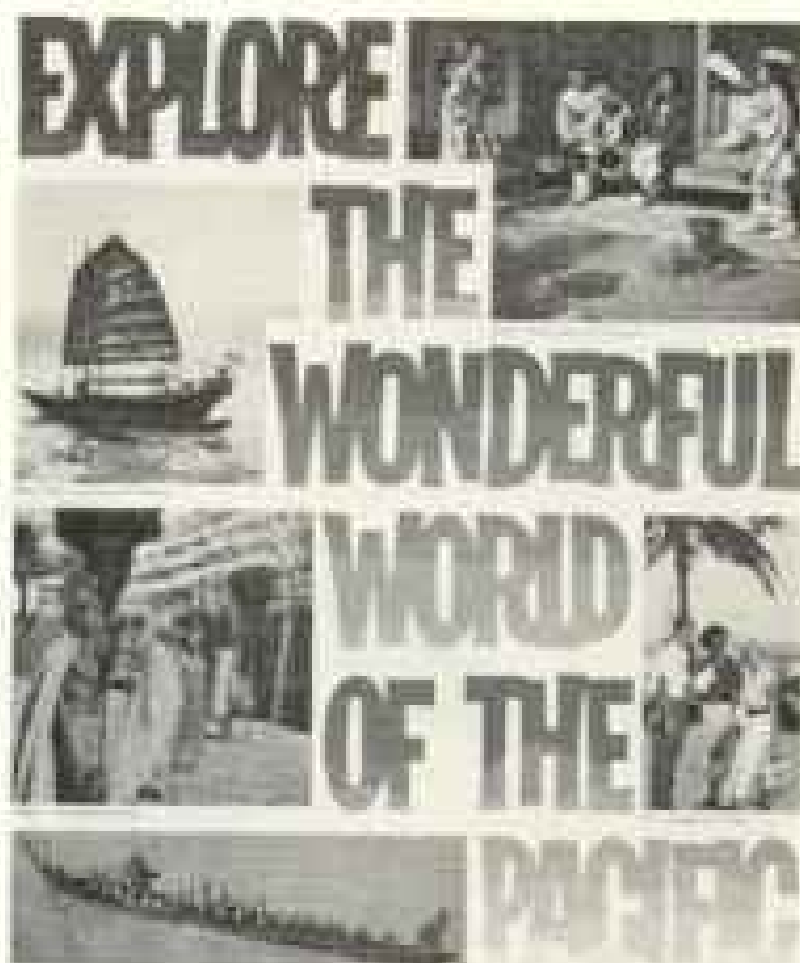
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1962



1963

The story of a classic

For a decade the Thunderbird has been, quite obviously, the car other manufacturers would have liked to create. It is one of the rarest of cars—a true classic—and that is why it is so difficult to imitate.

Yet the Thunderbird began with a very simple idea: to design a car that would crystallize all the pleasures of driving in one vehicle.

An American original. This was to be a new kind of automobile; a small, personal luxury car. It was to be a purely American car, with all the comfort, all the ease of automatic controls, all the blazing performance—and all the reliability—that American engineering skill could give it. And it was to have more; it was to express in every line and every action a unique spirit—a spirit of gaiety, of joy of living that no other car could equal.

The hope was to make the Thunderbird both individual and enduring. If you will take another look at the cars which evolved from this hope—the Thunderbirds on these pages—you will in all probability agree we were successful.

Imitated—but unmatched. Every model is being driven proudly today, and, as a matter of fact, the early ones are already collectors' items, commanding premium prices.

From the start, Thunderbird has been a trendsetter. It created a fresh new look—and inspired a good many echoes. You only have to glance at the newest cars to know that its look, its very lines, have been liberally borrowed by car after car, both here and abroad. It convinced Americans that a car could be both nimble and luxurious. Others have tried to follow that pace-making idea, too. But the whole

new Thunderbird concept has never been matched.

No untried fledgling. You can see, looking down the years, that the Thunderbird has changed—but without changing. Each model is different, but the unique look, the zest, the flair for action remain as a basic theme.


What you can't see (but what is very real indeed) is the silky silence and perfection that ten years of development and refinement have given the latest Thunderbirds. There is no substitute for this time, this testing, this refinement. No car could hope to be really "like a Thunderbird" without this decade of development—but that means a ten-year wait.

Meanwhile, hundreds of thousands of drivers have discovered what it means to possess a car built in the classic tradition.

1963: best year yet. According to sales records for the 1963 introductory period, in fact, more people have accepted the keys to new Thunderbirds than in any like period of the car's history. These Thunderbird owners have discovered how deeply satisfying a timeless look of distinction can be. They realize how reassuring it is to own an automobile that is refined and polished in every detail. Indeed, our own very deep pride in the Thunderbird stems in no small measure from the manifest loyalty and pleasure of its owners—as well as the satisfaction any manufacturer can take from creating an unduplicated triumph that has stood the test of time.

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SS Monterey	June 20	June 21
SS Mariposa	July 11	July 12
SS Monterey	Aug. 4	Aug. 5

Regularly every three weeks thereafter.

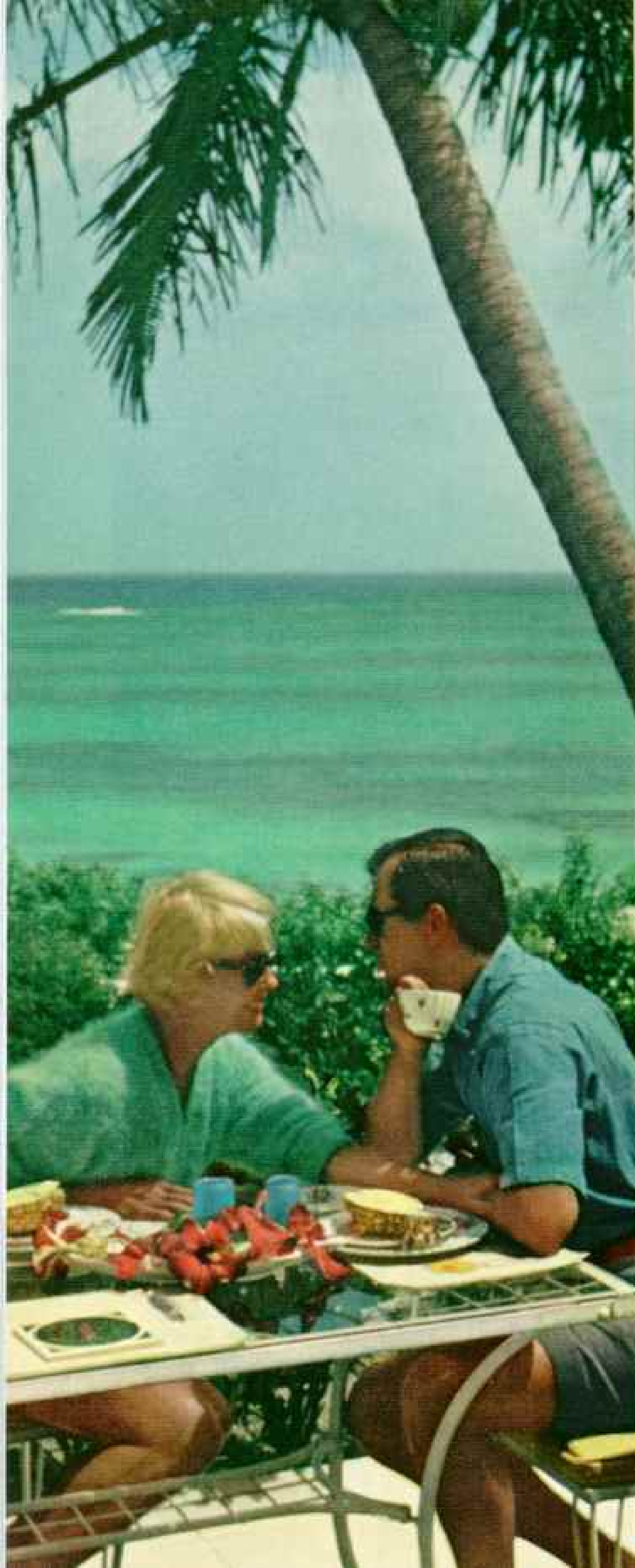
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Nassau AND THE Bahamas

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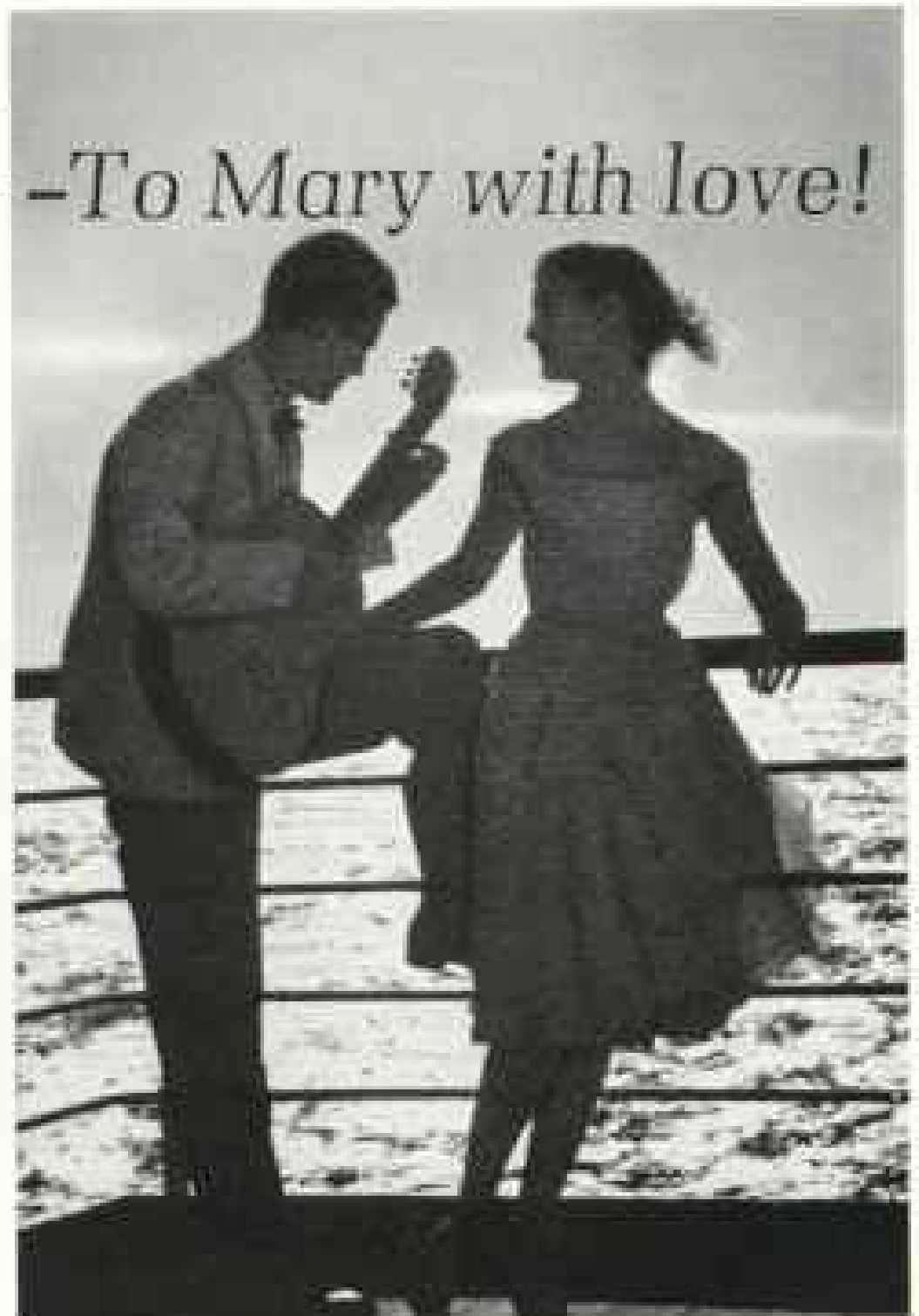
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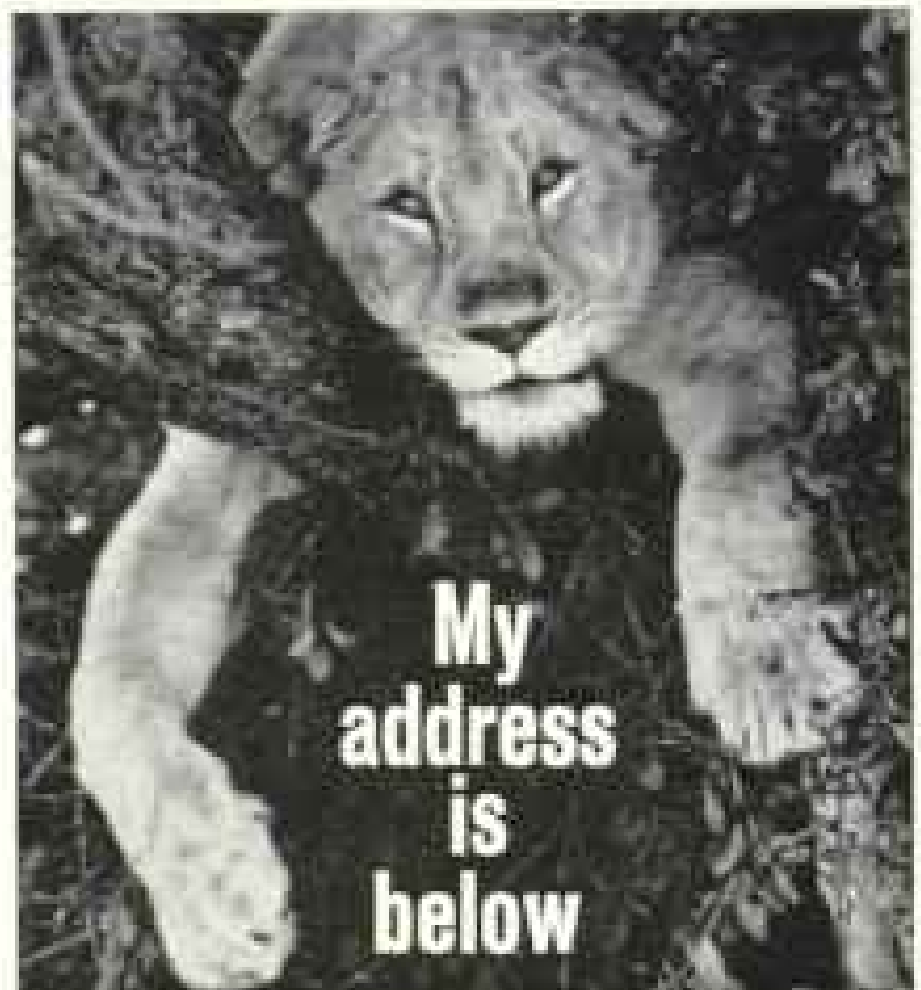
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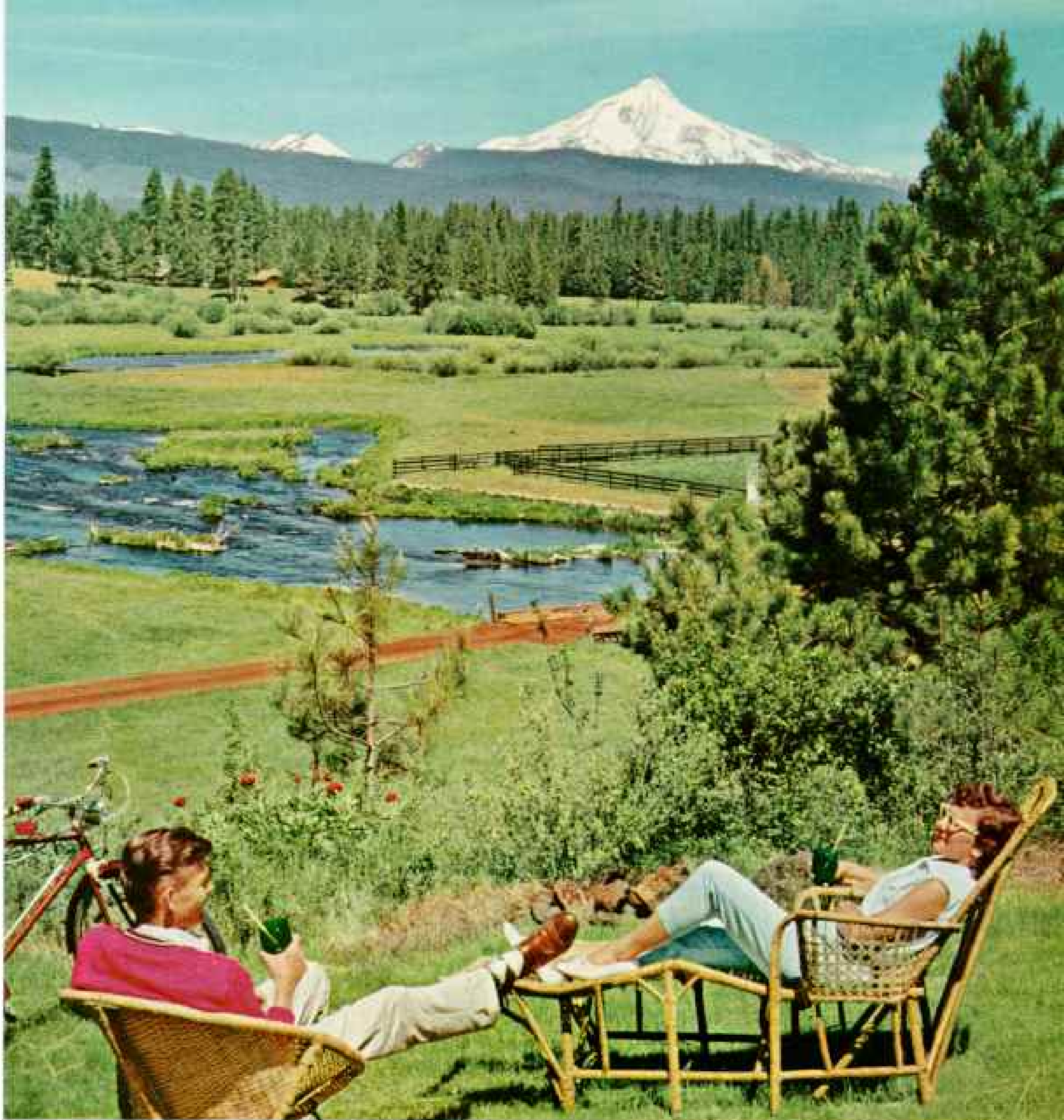
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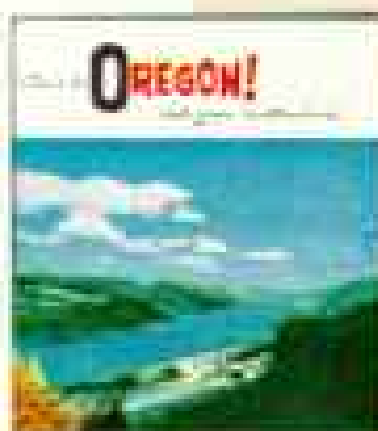


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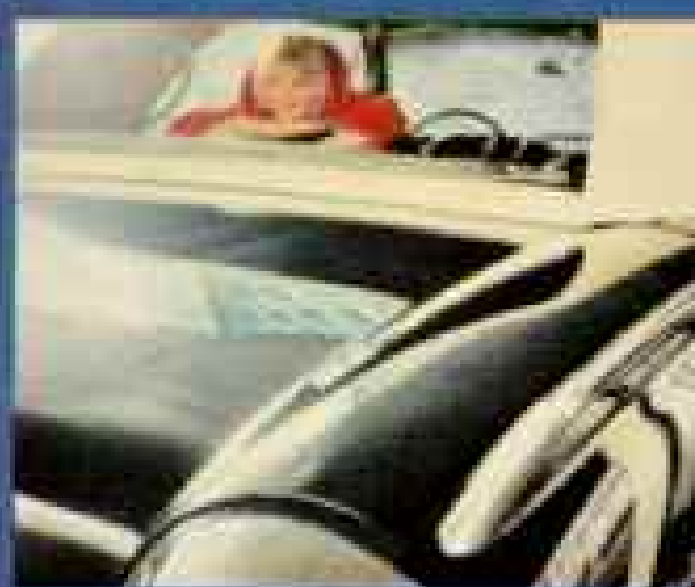
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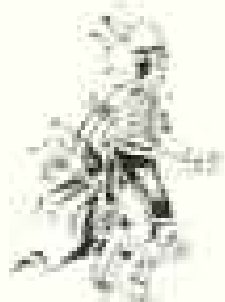


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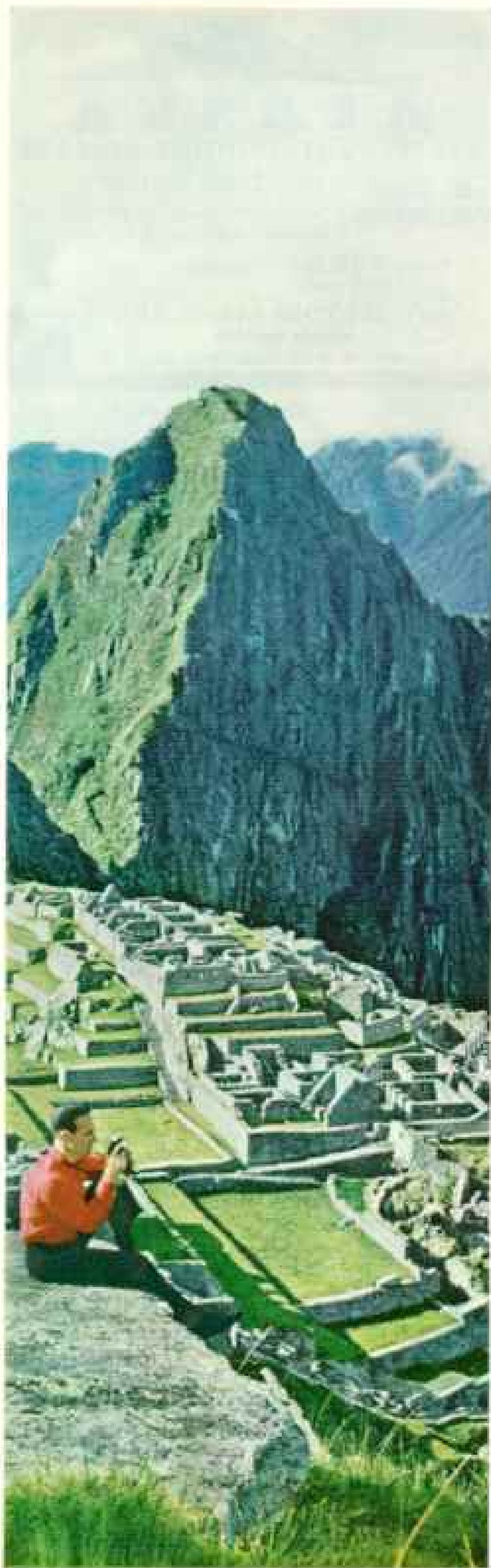
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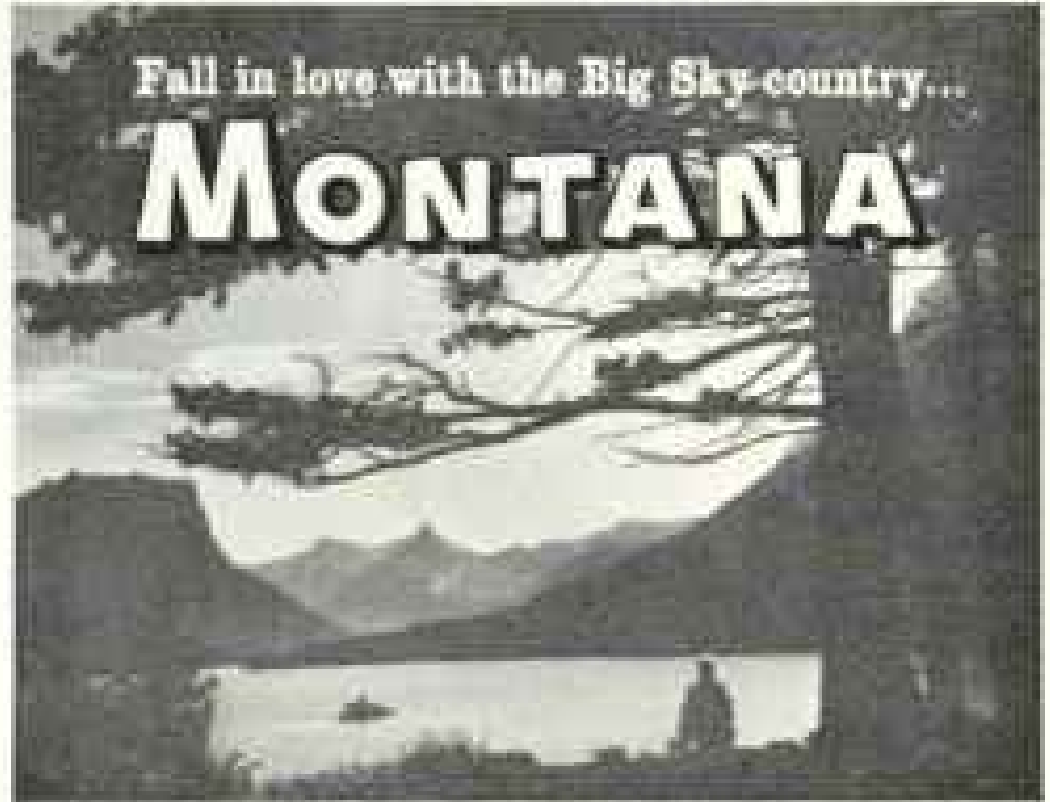
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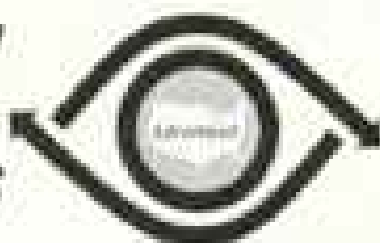
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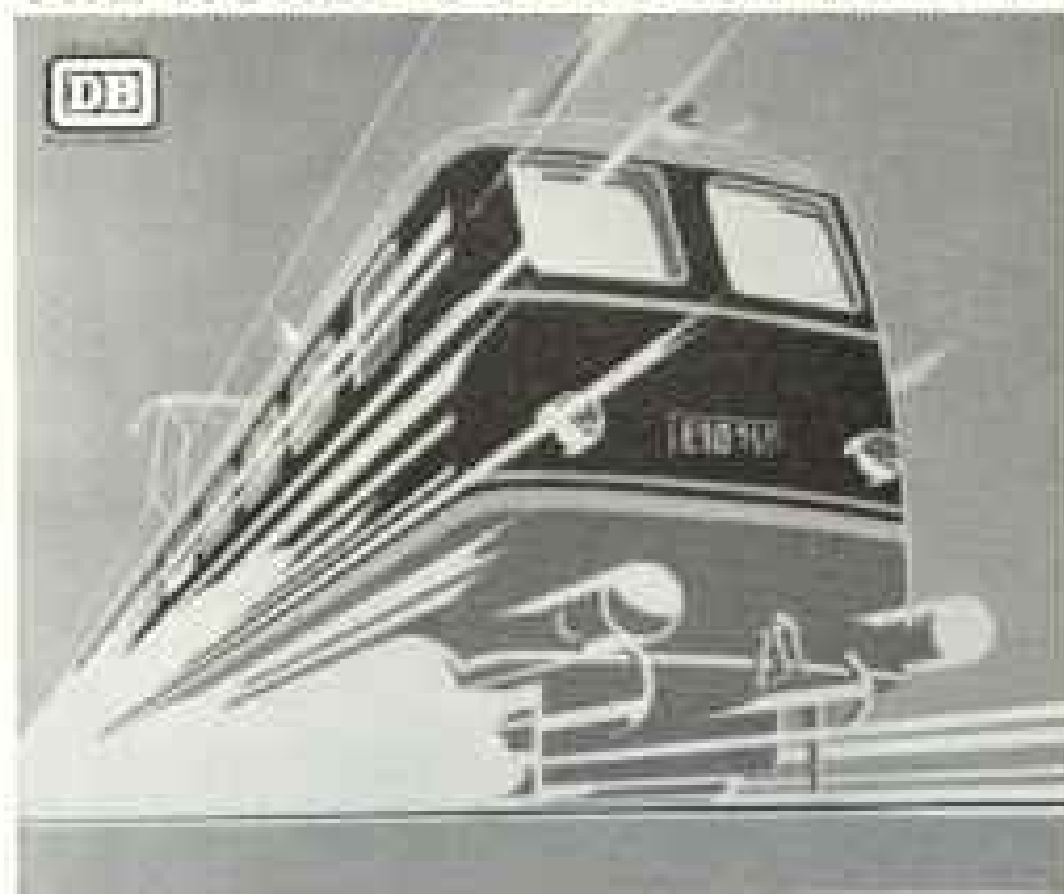
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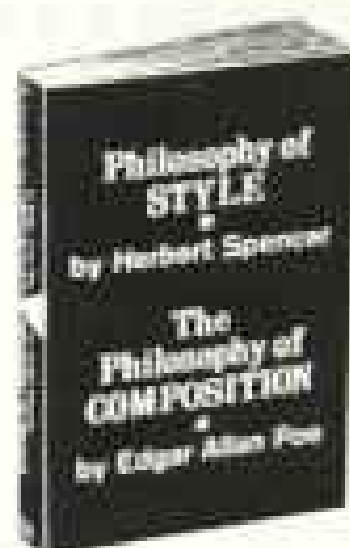
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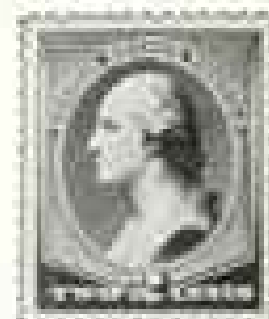
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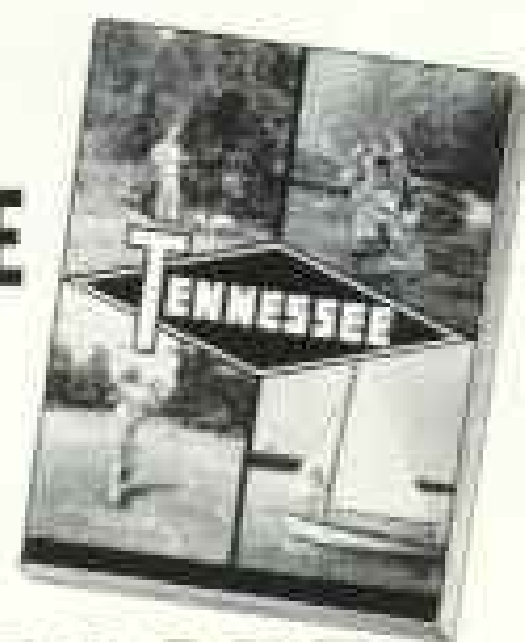


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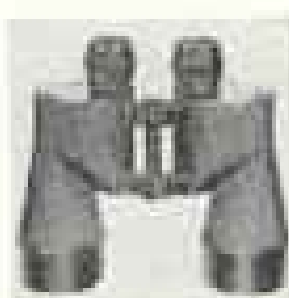
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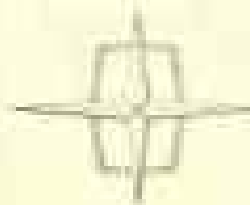
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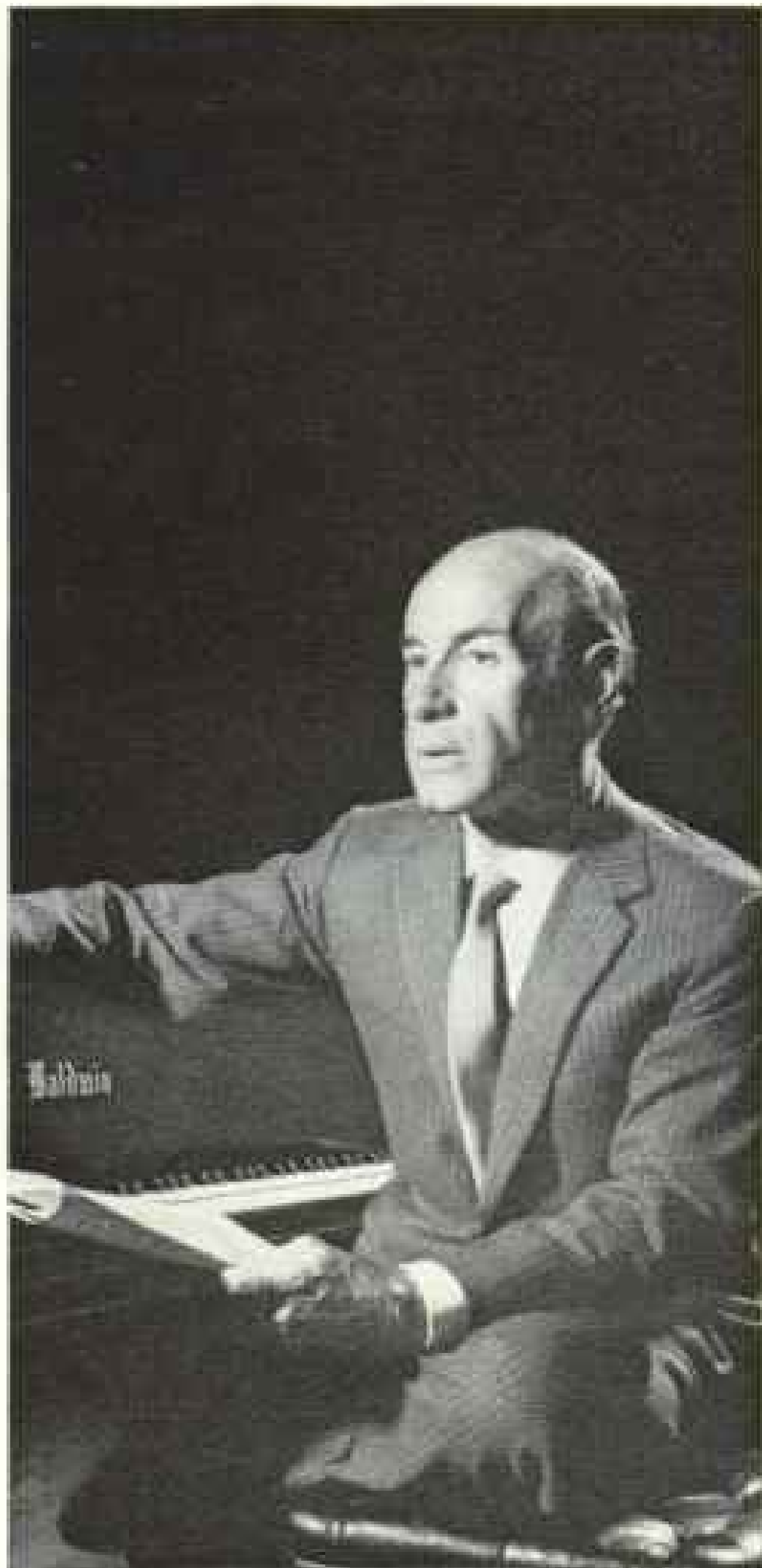
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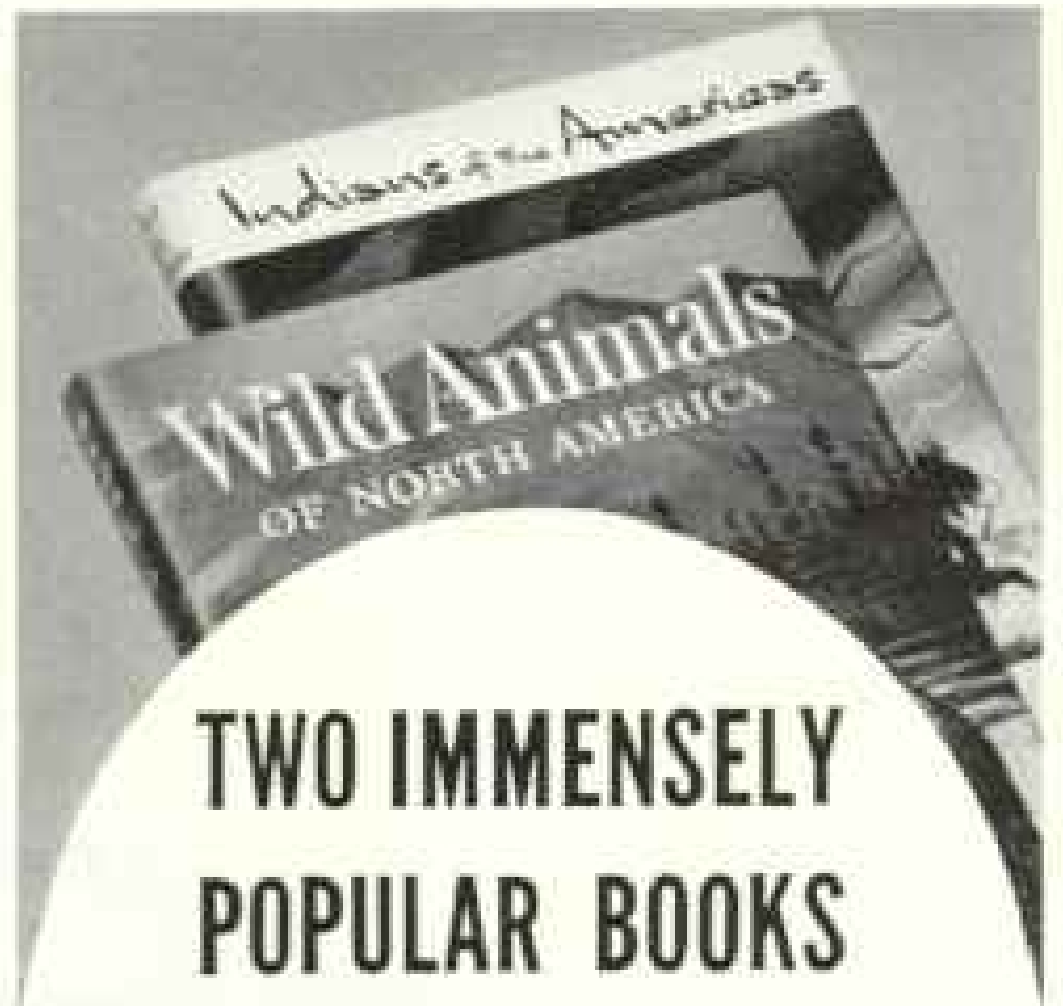
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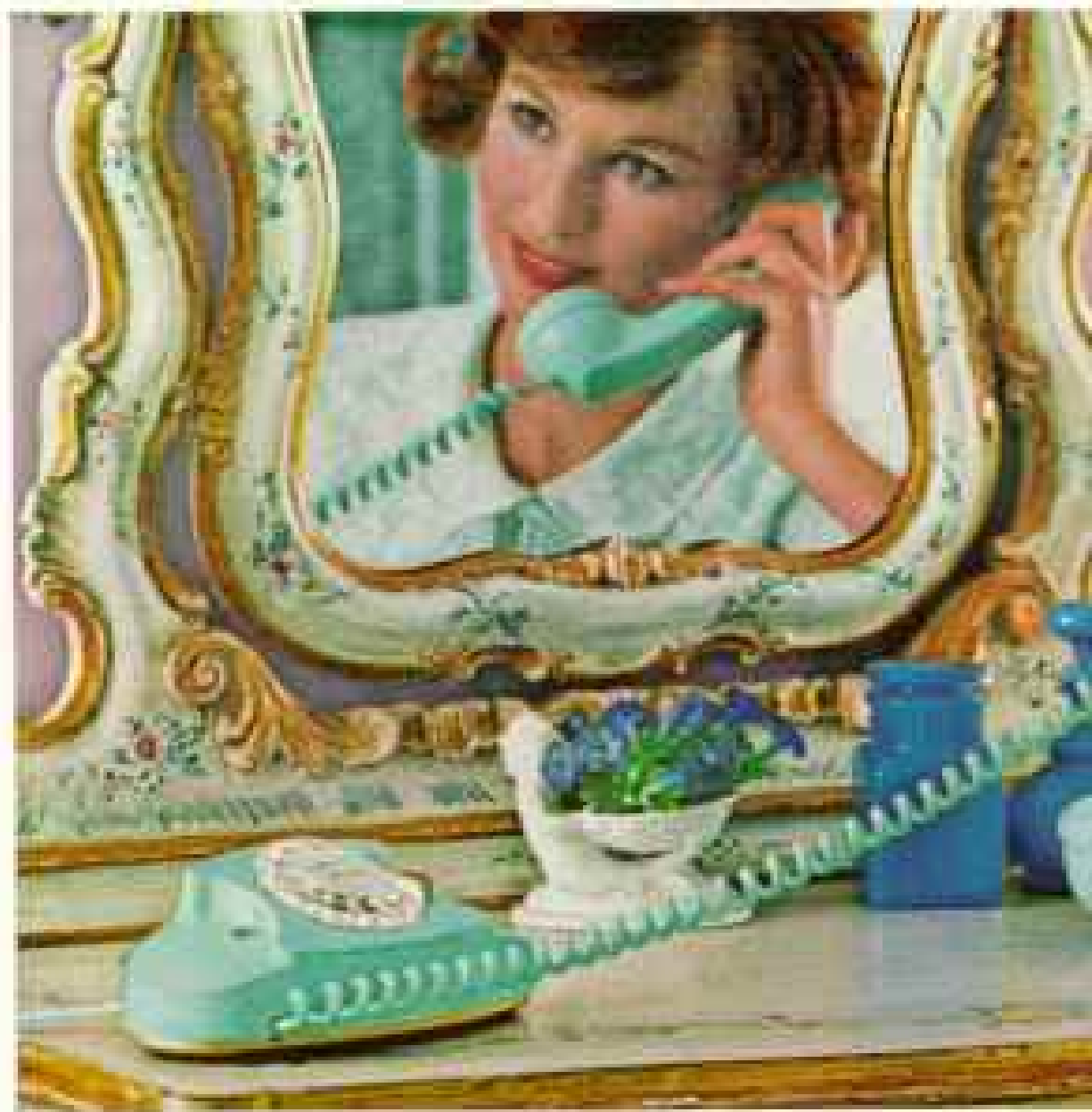
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