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THE NATIONAL GEOGRAPHIC MAGAZINE

Because It Rains on Hawaii

BY FREDERICK SIMPICH, JR.

THE NATION starts talking when any Territory asks to join the Union as a new State. A candidate for statehood gets the same scrutiny as a would-be son-in-law might get from a girl's family.

That's how mainland Americans are looking now at Hawaii, talked of in Congress as our 49th State. If admitted, it would be the first member of the Union not a part of continental United States.

Hawaii, lying out in the warm Pacific some 2,400 miles southwest of California, is an island group long ruled by a native royal family. Liliuokalani was the last queen. After a "revolution" the islands, by treaty, were annexed to the United States in 1898.

Though the seven seas are laced by colorful archipelagoes, Americans feel there is no other group of islands quite like Hawaii. Mark Twain called them "the loveliest fleet of islands that lie anchored in any ocean" (map, page 575).

Hawaii Grows Fat on Water

The Hawaiian group *is* unique. It has no natural resources—but plenty of rain!

This rain makes Hawaiian sugar so luxuriant that it can serve the sweet tooth of some 20,000,000 Americans. Rain, transformed into Hawaiian pineapple, supplies most of the United States. And flowers and scenery, nourished by tropic rains, lure an enthusiastic tourist trade (page 596).

In this water-minded fairyland cattle swim part way to market, herded by seagoing cowboys. I know one plantation that tunneled around a volcano to move water 30 miles. Another pumps enough underground water to supply a big city.

To get the rain where it counts most, planters construct sprinkler systems, giant versions of the one in the city dweller's front yard, so big that one nozzle sends a spray over three acres.

Hawaii's dependence on water is complete. Virtually everything it eats and uses comes by water.

Islanders are never more conscious of the Pacific reaches around them than during longshore strikes. As this is written, labor troubles in both Hawaiian and mainland ports have cut off overseas supplies and markets for more than seven of the twelve months past. Such times highlight Hawaii's dependence on waterborne commerce.

Normally her supply lines run on ferryboat schedules. There are Tuesday freighters from San Francisco, and on Thursdays the Los Angeles ships come in. Every ten days brings a vessel from the east coast and Gulf ports and another fortnightly from the Pacific Northwest, supplemented by freighters handling lumber from the same region. These regular sailings operated by the Matson and Isthmian Lines are fattened by frequent calls of trans-Pacific steamers seeking bunkers and stores or discharging and loading way freight.

Foreign Flags Now Scarce

Prewar demands of the Orient-born population brought many bizarre house flags into Honolulu Harbor. Since V-J Day, with the great NYK fleet of the Japanese sunk and Dutch, Swedish, and British fleets still rebuilding, foreign flags are scarce. Rebirth of Hawaiian commerce abroad is also curbed by dollar restrictions, Australian austerity, civil war in China, and General MacArthur's limitations on foreign trade with Japan.

But the commerce remaining with the mainland United States has always bulked large. Hawaii now buys more from the 48 States

William Land from Three Lions

School Lets Out; a Library Silence Extinguishes Yells and Screams of Play

The islands' first pupils were adults who learned their letters from a Hawaiian speller devised by missionaries in the 1820's. These children, product of many races, speak English as their heritage (page 595). Their school system compares favorably with the mainland's. The bookmobile visits Oahu's rural schools twice a week.

Hawaiian Pineapple Company

From Endless Belt to Shiny Can, Peeled Pineapple Is Never Touched by Bare Hands

Automatic machinery trims off outer shells, punches out cores, and cuts slices, but judgment counts at the packing table. These women grade the fruit as they fill the cans. With syrup added, the product will be sealed, steam-cooked, and labeled. The entire process at this Oahu cannery takes 15 minutes (page 600).

than did Cuba or China, Belgium or France in days of prewar prosperity.

Mainland-bound ships carry sugar, pineapple, and tuna fish.

Big item for a time has been surplus war goods. The War Assets Administration has sold more than a quarter of a billion dollars' worth of surplus in Hawaii since V-J Day.

These rolls of barbed wire, bulldozers, jeeps, and generators have found use from California farms to eastern cities. Scrap steel, more than 50,000 tons of it, has been returned for mainland furnaces. One enterpriser tried to tow the U.S.S. *Oklahoma*, a victim of the Pearl Harbor attack, back as scrap, but she sank some 540 miles off the island of Oahu.

Inbound cargoes make up all the things men live by, from razor blades to fuel oil, chain conveyors to dairy feed.

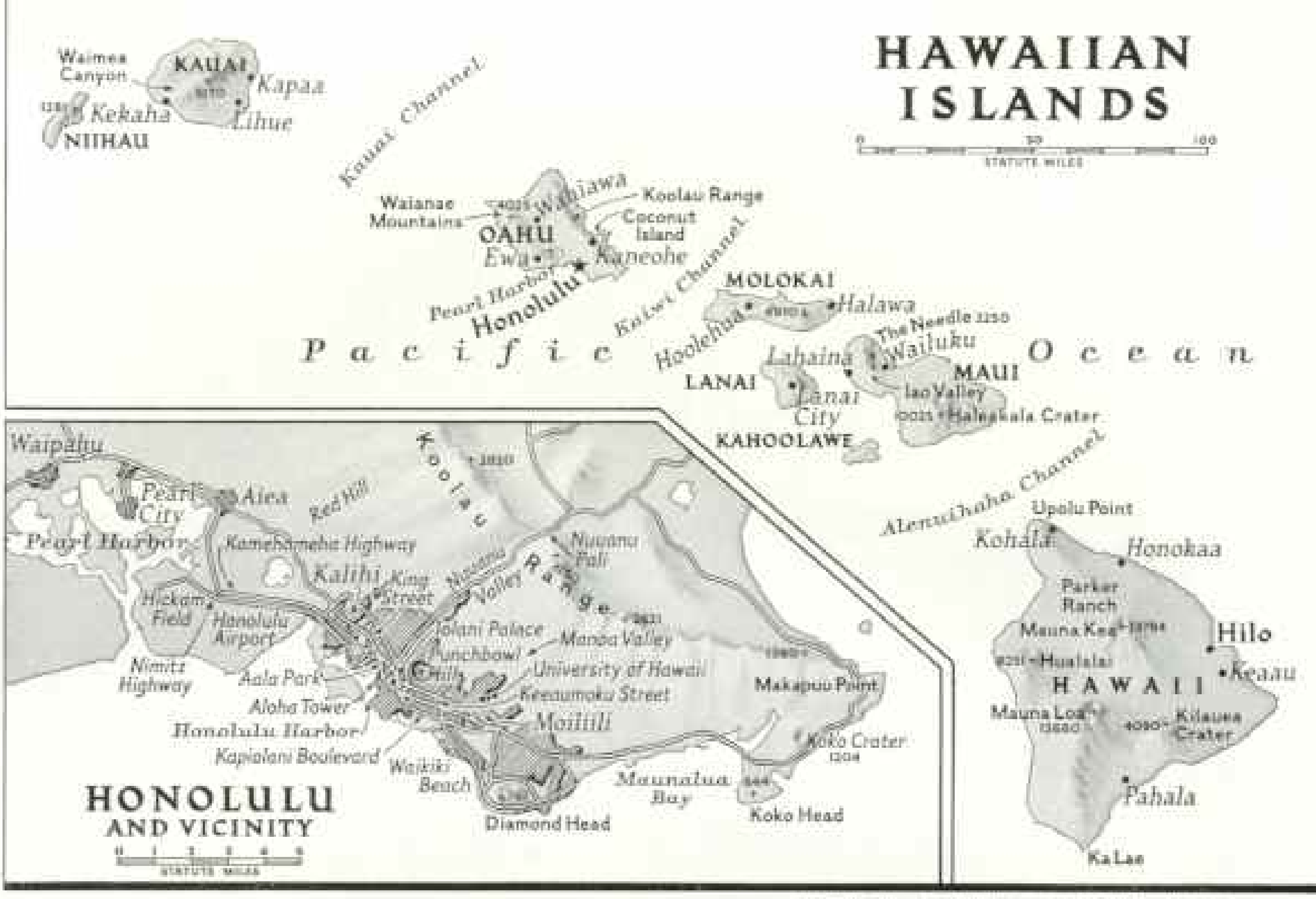
In Hawaii only the climate and the scenery are native. The Hawaiians themselves are immigrants. The decks of their double canoes brought the first domestic animals and much plant life. The sugar cane and pineapple grown now were transplanted from other tropical lands.

This elaboration on Nature is unending as men work to make Hawaii a better place to live. Roads are laid with Bitumuls from California. Reservoirs are built of Pittsburgh

Photo Haswell

A Tuna Sampan Fishes with Barbless Hooks, Free-swimming Bait, and Manufactured Foam

Japanese Americans, barefoot on a slippery, railless deck, fill the well with 18-pounders. Lunging at live bait cast into the sea, the tuna snatch at shiny hooks as readily as they do at flashing chum. Nozzles (note the spray) squirt water from the sampan's sides to imitate the froth of escaping prey (pages 596, 602).



Drawn by Theodora P. Thompson and Irvin E. Alleman

Hawaii, of New Jersey Size and New Hampshire Population, Wants To Be the 49th State

Eight main islands, stretching across 400 miles of Pacific, produce virtually all of our canned pineapple and one-quarter of our sugar. Each represents a peak thrust up out of the ocean by internal fires. Hawaii Island, where two live volcanoes spout lava, is still growing. Inset shows the Honolulu area on Oahu.

steel and California cement. The Territorial Department of Agriculture stocks streams with fish from Oregon. The Hui Manu, a women's organization, imports and frees colorful birds to brighten island gardens. Undeterred by strikes, they recently booked air freight, brought in crateloads of rainbow-colored buntings from Mexico for propagation.

Mayonnaise by the Ton

Walk the Honolulu docks after any freighter arrival and you are staggered by the intricate demands of modern life as pictured there. Mayonnaise by the ton; mountains of cigarettes; beer by the thousand caseloads; hospital-white refrigerators standing in precise rows; and mattresses, auto tires, table china, clay pipe, dynamite, herbicides, nitrates, and floor lamps.

Search the room where you read. If you lived in Hawaii, everything you see would have come by ship.

Careful use of water, among other factors, has made the limited land of the islands produce more calories to the acre than any other in the world.

From an area less than that of New York City, Hawaii grows 25 percent of all sugar produced under our flag (pages 577, 592, 593, 597). Such yields support half a million people in the American way of juke boxes and traffic jams. Two centuries ago, half as many natives warred and practiced infanticide because this same land was not enough—by primitive methods.

To achieve such land use, the Yankees who engineered it imported everything but water. Labor was recruited from China and Scandinavia, Japan and Madeira, Puerto Rico and Portugal, Philippines and Indiana. From India and New Guinea, Louisiana and Barbados came sugar cane from which to breed new strains. Cayenne pineapple was borrowed from Jamaica (pages 588 and 600). Fertilizers were called forward from Chile, Canada, and the guano islands.

A Mid-Pacific Melting Pot

Thus grew cosmopolitan Hawaii. In my short time here I have seen its population, now 540,500, grow to exceed that of six States. Biggest elements are the 179,000 Japanese Americans, followed by 175,000 Caucasians and 82,000 Hawaiians and part Hawaiians. Filipino, Chinese, and other extractions fill up the rest of the "melting pot of the Pacific." Virtually all are U. S. citizens (pages 572, 579).

The first people to come were Polynesians, possibly a thousand years before Columbus

Punchbowl, Once a Pit of Fire, Is Now the Green Abode of War Dead

Though it was rough and barren, this extinct volcano attracted many visitors in former years because its 500-foot wall commanded a glorious view of Honolulu and the sea (page 605). Today there is more reason than ever to visit Punchbowl, for its oval has been smoothed and greened and dedicated as the new National Memorial Cemetery of the Pacific.

This monument appropriately looks out upon Pearl Harbor, the naval base (not shown), where America entered World War II on December 7, 1941. The first American lowered into a grave here was an unknown serviceman killed by the Japanese attack.

Others came from battlefields in Guadalcanal, China, Burma, Saipan, Guam, Iwo Jima, and the prison camps of Japan. Many were Hawaii's own sons; some came from other theaters of war.

Eventually the 35-acre burial area will be filled with 25,000 graves, approximately 13,000 of which will be World War II dead; the remainder will be veterans of all wars.

Soldiers, sailors, and marines are laid side by side, with no distinction as to rank. Each grave will be marked with a simple headstone.

Hawaii Press Bureau

Cane's Portable Ditch Is Taken Apart Only at Planting Time

Sugar cane, which is a grass, requires heat, rich soil, plenty of water, and diligent care. The Hawaiian Islands have no lack of sun or soil, but half the area must be watered artificially, and labor, represented by this full-time irrigator, has become expensive.

To get water and save manpower, the big plantations have invested millions in dams, wells, and machinery, and these have paid off handsomely. Scientific methods have doubled and sometimes redoubled the yield.

This Oahu plantation, for example, has an irrigation flume made up of hundreds of concrete links, each a furrow wide. Metal slides in each unit control the escape of water.

For close to two years the field will be watered at intervals of 15 to 20 days. Then it will be dried for a month, the trash burned off, and the cane cut. The flume is disassembled when the cane is again planted.

Here the field has been freshly planted with sugar cane's bamboolike joints, which, like potatoes, contain sprouting eyes. A machine has dug the furrows, dropped the joints, and applied fertilizer in a single operation.

Such a planting will suffice four to eight years. When the cane is cut, eyes below ground sprout and send up new stalks (pages 592, 593, and 597).

Photo: Hawaii

showed the egg to Isabella. They and successive Polynesian immigrants became the "native" Hawaiians discovered by Capt. James Cook in 1778. Forty-two years later New England missionaries arrived to form the first stable white colony.*

These God-fearing evangels laid the groundwork for modern Hawaii. They and their descendants built her churches, arts, and business; helped lead the revolution which overthrew the native monarchy in 1893; and influenced annexation by the United States in 1898. Today their descendants call visitors to play tennis or talk business.

Eight principal islands make up the Hawaiian group. Lying south of the Tropic of Cancer on about the same parallel with Mexico City and Hong Kong, they are five time zones behind New York. All volcanic, they angle 400 miles from northwest to southeast.

First is Niihau. Next is Kauai, with the highest annual rainfall on record (some 600 inches in late months) for any station in Hawaii. Third is Oahu, site of Honolulu and Pearl Harbor. Then comes Molokai, noted for its leper colony, now dwindling; next, Maui, Lanai, and barren Kahoolawe. This last is used only as a Navy bombing range.

At the extreme southeast is the island of Hawaii, which is still growing. Here two live volcanoes, Mauna Loa (page 604) and Kilauea, erupt with regularity and spill lava seaward to build land which may some day become a fertile plain.

Even blasé old islanders throng to Hilo when the volcanoes "go off," and proudly boast that Hawaii is the only place where people run to an eruption (map, page 575).

Honolulu, playland capital of Hawaii, is two cities. In one, more than a quarter of a million people pack pineapple, drive buses, attend church—but seldom ride a surfboard. In the other, sun-seeking tourists, shiny with coconut oil against sunburn, throng the beaches and tropic-style night clubs to nourish the island's third largest business, to the tune of about $35,000,000 in 1948.

As if dramatizing Hawaii's dependence on water, Honolulu hugs the sea. For 17 miles, from Pearl Harbor to the extinct crater at Koko Head, it pushes against the Pacific, rarely venturing up the ridges of the Koolau Range at its back.

The main streets of this long, thin city tell its story.

Every morning half of Honolulu rides to work along Kamehameha Highway, named for a native conqueror. Nimitz Highway, named for a later one, also runs in from Pearl Harbor to the city's center. These avenues to the industrial district pass acres of Government housing for defense workers, Honolulu Airport, and the Air Force's Hickam Field, where B-17's took off one day to help make history at Midway.

Honolulu Harbor Pivot Point

The city's pivot point is Honolulu Harbor. Here, amid fertilizer works, fuel storage tanks, lumber yards, and bottlers of soda pop is the plant of the Hawaiian Pineapple Company, Ltd. (Dole), largest fruit cannery in the world. Every visitor remembers its giant pineapple that serves as a water tower.

King Street passes near the harbor and carries on to Honolulu's Hyde Park, called Aala, where politicians draw crowds with hula troupes and hold them by singing "Three Blind Mice" in Hawaiian. Adjoining slum alleys mark this a seaport town and recall the roaring fifties when annual visits of the whaling fleet meant riot and rapine.

The city's shopping district was once distinctly Oriental, and goods are still offered in the wild profusion of Eastern bazaars. The shopper finds *tabi* (the glovelike Japanese socks) mixed up with nylons. Ivory back scratchers share the same shelf with electric blankets. King Street saloons sell *saimin* and *sake*, steak and Scotch.

Abruptly the visitor enters the modern downtown district of smart shops, department stores, solid-looking banks, and "factors," management firms that run the sugar plantations and much of Hawaii's basic industry.

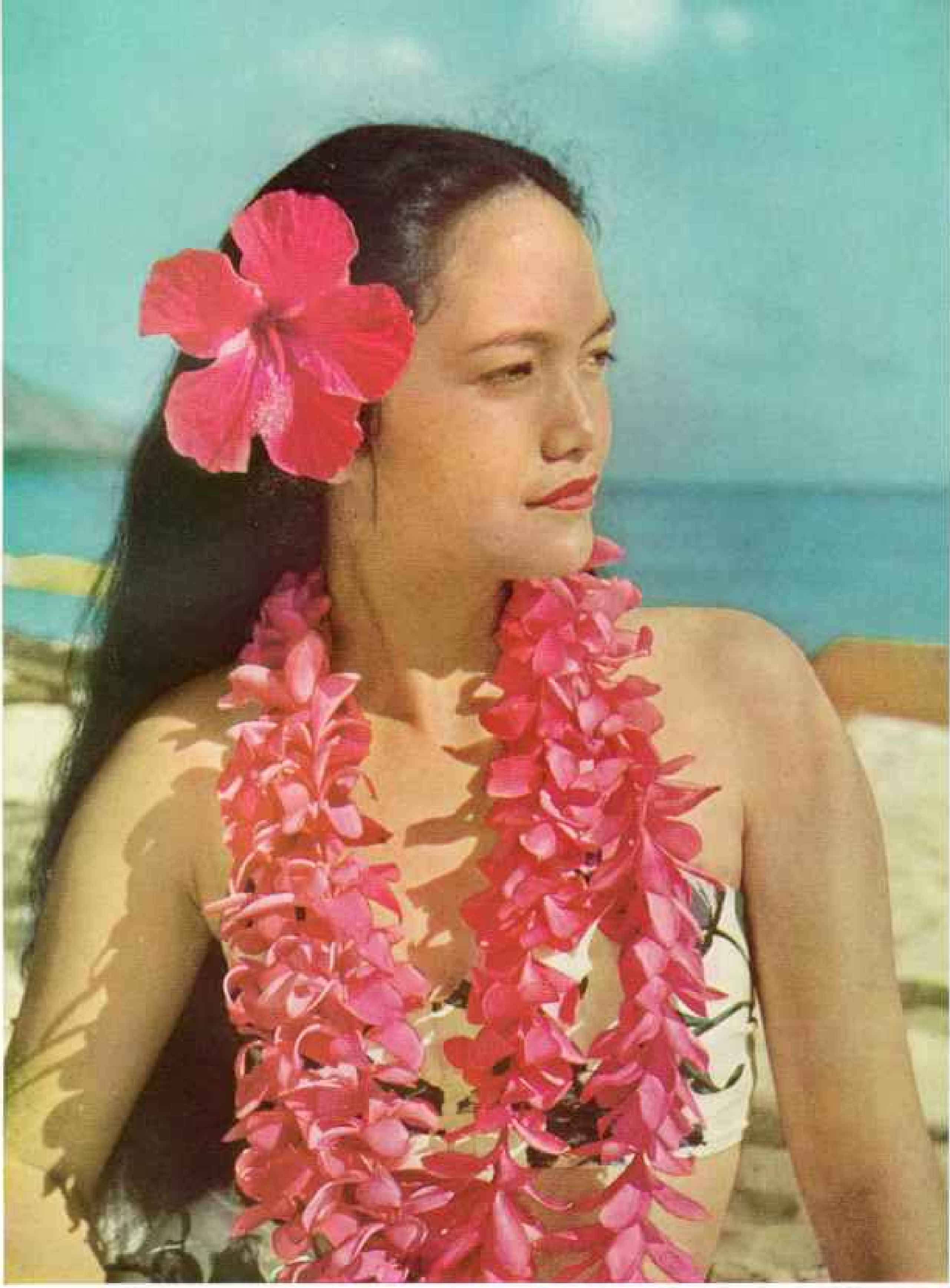
Here too are the Government buildings, grouped around the Territorial Capitol, Iolani Palace, one-time home of Hawaiian kings. These lovable south seas sovereigns copied European monarchs even to their vanity. The Capitol Building's promenades are still lined with small mirrors—just face high!

From mid-town, Kapiolani Boulevard carries on toward Waikiki over land which my father remembers as swamp, good only to raise bananas and ducks. How odd that men have labored to reclaim it for secondhand dealers to hawk jalopies!

Waikiki is bare midriffs and apartment houses, sandy feet and "drive-ins."

Here stenographers and maharajas jostle for sunning space on a narrow beach, and here the amphibious, buoyed by surfboards, spend full days in the water (pages 584, 585, 594, and 598).

* See, in the National Geographic Magazine: "Hawaii, Then and Now," by William R. Castle, October, 1938; "Hawaiian Islands," by Gilbert Grosvenor, February, 1924; and "American Pathfinders in the Pacific," by William H. Nicholas, May, 1946.



A Carefree Flower of the Pacific Garlands Hair with Hibiscus and Neck with Lei of Plumeria

It's summer all the year in Hawaii, and people dress for it. Few homes have central heating systems. Because of extensive immigration, native Polynesian blood mingles with Oriental and Caucasian. Few pure Hawaiians are left.

Light Cruiser *Pasadena*, Cruising to Pearl Harbor, Comes Alongside *Iowa* To Take On Fuel

Balmy, hospitable Hawaii has been a favorite goal of sailors since the days of Capt. James Cook, who discovered the islands in 1778, and the American whalers who provisioned their ships there in the 1800's. Hundreds of thousands of American servicemen knew the islands during World War II.

Reserve midshipmen, lining the battleship's rail in the foreground, here watch a tricky refueling operation. As members of the Naval Reserve Officers Training Corps, they are taking their summer training cruise.

They come from 52 colleges and universities. In exchange for tuition, textbooks, and a living allowance paid by Uncle Sam, they are pledged to enter the Navy upon graduation. After 15 months to two years of active service as ensigns, they may accept permanent commissions in the Regular Navy or commissions in the Naval Reserve.

During a ten-day stay in Hawaii in 1948, the midshipmen were entertained at dances, feasts, swimming parties, polo matches, and sightseeing tours. Among the first to greet them were the hula dancers (page 591).

Photograph by Thomas W. McKnew

For Skipper's Inspection, Midshipmen Stand to Attention Below the *Iowa's* Guns

These Hawaii-bound reservists received their 1948 summer training aboard a champion.

The U.S.S. *Iowa* is as mighty as she is fortunate; no assignment ever daunted her.

Traveling a distance equivalent to six times around the world, the 45,000-ton battleship strafed enemy installations from New Guinea to Hokkaido, but received scarcely a scratch. Japanese gunners nicked her only once, and only one crewman suffered injury.

Iowa helped chase the enemy off Leyte; she struck against Okinawa and the Japanese home islands. Her 16-inch rifles dueled with shore batteries on Ponape, Saipan, and Tinian, and her lesser guns knocked down planes off Truk.

The 880-foot-long *Iowa* is the fourth U. S. Navy ship of her name. She was the first of four sister ships, others being *New Jersey*, *Wisconsin*, and *Missouri*. Only *Missouri* remains in service—our only active battleship.

In March, 1949, the Navy put *Iowa* in "moth balls," but, as part of the reserve fleet, she remains ever ready.

This inspection took place beneath *Iowa's* 5-inch guns, which can cover both sea and sky.

President Cleveland, Pacific's New Air-conditioned Cruise Liner, Calls at Aloha Tower, Where Honolulu Welcomes Visitors

Hawaiian Forester, a lumber vessel, reminds us that the islands have to import timber, just as they must go abroad for clothes, machinery, and much food.

Honolulu Says "Aloha" with Flowers and Guitars. Hawaiian Beauties Garland Visitors with Leis, Polynesia's Bright Necklaces

Whispering Breezes, Rustling Palms, and Murmuring Surf Sing Waikiki's Lullaby. Exhilarating Water Lures Bathers and Surfboarders

Diamond Head (left) looks down on a fashionable Honolulu residential district (page 605). A twin-hulled canoe skims the water beneath white sails.

Backs Bend, Paddles Strain, and Shouts Go Up from Shore; the Outrigger Race Begins on Waikiki Beach

Sailing huge double canoes, the pioneer Hawaiians found their star-guided way to the islands centuries ago, bringing pigs and dogs with them.

Kodachrome by John P. M. Johnston

Kodachrome by Stewart Fern

Helmeted King Kamehameha I, Hawaii's Noblest Hero, Is Smothered in Leis

With the help of firearms and the advice of two sailors, this chieftain overcame all rivals, united the islands, and founded a dynasty a century and a half ago. His bronze statue stands in front of the Judiciary Building, Honolulu.

Dressed in Royal Robes, Honolulu Celebrates Each June 11 as King Kamehameha Day

For this Territorial holiday, observed almost a century, islanders like old-time costumes. Once only the nobility could wear the capes fashioned from the gorgeous feathers of the o-o and iiwi birds. Now these birds are presumably extinct, and the making of feather capes is a lost art. A priceless heirloom is worn by the man (above), but the boy and the woman (page 586) have cloth and paper substitutes. Each group participating in the Kamehameha parade chooses its queen, who, with her garlanded courtiers, rides in state on her float (below).

Pineapple's Monster Harvester Relies on Human Eyes

Sugar, Hawaii's first industry, and pineapple, its second, form an economic team because they do not compete much for space. Sugar thrives best on the lowlands; pineapple does well in the uplands. Endless vistas once filled with cactus now yield juicy pineapples.

Old-style pineapple pickers, in addition to gathering the fruit, had to carry heavy loads in gunny sacks, transfer their burden to 40-pound lug boxes, and heave the boxes onto trucks.

This new harvester-conveyer, developed for the Hawaiian Pineapple Company, Ltd. (Dole), does away with sacks and boxes. Since the machine cannot select mature fruit, however, it requires the judgment of trained operators.

Here on the island of Oahu, a 50-foot aluminum boom, thrust into the field like a fireman's ladder, carries an endless belt at waist level. A line of workers, keeping pace with the receiving truck, picks pineapples and loads them on the belt, which dumps the fruit into the truck. When the seven-ton bin is filled, the truck moves off and another takes its place.

At the cannery the truck tilts its bin and spills the cargo into a chute.

Kodachrome courtesy
Hawaiian Pineapple Company

Oahu Grows These Bird of Paradise Flowers for Export to the Mainland (Page 603). A Japanese American Admires Her Family's Field

Japanese, buying and leasing lands, educating their children, compete with Americans in enterprise. They comprise a third of the Territory's 540,500 people.

Kodachrome by W. Robert Moore

A Breath-taking Mass of Color and Cloud Shadows Bursts into View from the Pali, Honolulu's Unique Observation Point

The winding highway from Honolulu gives no inkling of this spectacle until the road surmounts the Pali (cliff). Here in 1795 Kamehameha I (page 556), leading an invasion from Hawaii Island, drove Oahu's defenders headlong over the mountain precipice.

Barefoot Hula Girls Dance in Ti-leaf Skirts. Gesture Is Their Dramatic Shorthand . . . Curving Hands Depict the Moon

Suppressed by the early missionaries, the hula has come out of hiding but has lost most of its meaning. The standard hula for tourists is a commercialized imitation. Hawaiian politicians woo voters with hula shows, just as some mainland campaigners employ hillbilly bands. This dance was performed in front of a Waikiki hotel garden.

Sugar Cane's Juggernaut Can Haul 30 Tons at 30 Miles an Hour

Travel posters paint vacation-time Hawaii as a dreamy, lazy playground, but plantation Hawaii, a place of prodigious works, comes closer to being the real thing.

Many Hawaiians live on plantations. Eight hours of toil in the fields leaves them little time for hula dances and surfboarding.

Twenty-eight big plantations control Hawaiian sugar. They resemble giant industries more than farms. With their laboratory discoveries and mechanical improvements, the plantations have so increased productivity that they pay the highest annual wage in domestic sugar-growing areas.

Ewa Plantation, close to Pearl Harbor, illustrates the degree to which mechanization has taken over. Cane has been cut by a bulldozer rake. Now a crawler-type crane with grab attachment loads it into a Tournahauler. At the mill the entire cargo will be jerked out by means of a wire net here stretched beneath the truck's cargo.

Cane's Silvery Tassels Shine in Beauty but Make No Sugar

Hawaii requires the highest efficiency to compete with tropical sugar countries paying lower wages. The experiment station of the Hawaiian Sugar Planters' Association has led the islands to million-ton crops in some years. With improved fertilization, irrigation, pest and erosion control, it has increased the soil's productivity despite years of cropping.

One of the problems tackled by the Association's 70-odd scientists is that of tasseling. These "flowers," though beautiful, are unproductive. They absorb energies which otherwise might go into sugar.

Tasseling is effectively reduced, the station has found, by exposing the cane to floodlights a few minutes at night during the flowering season. Mobile floodlighting rigs are now being tested in the fields.

One of Hawaii's most spectacular sights is the deliberate burning of the cane fields just before the harvest. Flames consume the trash, such as leaves and tassels, so rapidly that the juicy stalk is unharmed. This process, resulting in the saving of many hours of labor, was discovered by chance.

Feet in Sand, Thoughts in the Clouds—Hawaii's Third Industry Is Recreation

Guests in swim suits are served on the terrace of the Royal Hawaiian Hotel. Beach boys daily rake and clean the sand. Waikiki's "season" goes on all year round.

Each stretch of surf has its own character. There are "Queen's Surf" and "King's Surf," once reserved for royalty, and, if wind and wave are right, "Steamer Lane" for the intrepid. From the farthermost rollers, a full mile out, a good surfer can ride all the way to shore and a rewarding bite of the beach-boy's delicacy—dried squid.*

Here my young son learned to ride in on his board—and how he misses it now, back at school in Massachusetts!

Diamond Head, beyond Waikiki, is Hawaii's tourist trade-mark. Fringed by wealthy homes such as Doris Duke's little-used "Shangri La," this aging cinder cone is pocked by strong points, vestiges of a military age when shellfire won wars (page 605).

Exotic Flowers in Every Back Yard

For each home with a view of the sea Honolulu has a thousand that look out on the neighbor's wash. Clustered about shopping districts with tongue-twisting names like Moiliili and Kalihi, each has its garden, with at least one of the 4,000 varieties of Hawaiian hibiscus. This shrub is so common now that gardeners name new strains after friends.

Many of the exotics—anthurium, orchids, gardenias, *ape*, and ginger—grow here if watered (pages 589, 603).

Scattered among the homes are Honolulu's institutions. In Manoa Valley, where early settlers built New England-style houses under an ever-present rainbow, the University of Hawaii now teaches more than 4,000 students, among them many ex-GI's, to become sugar planters and schoolteachers, industrial relations men, and veterinarians.

Cultural centers include the Honolulu Academy of Arts where Kwan Yins and Picassos vie for admiration in this cosmopolitan city. At the Bishop Museum is the world's best collection of Polynesiana—nose flutes and outriggers, fishhooks of bone, and full-length cloaks built from feathers of the o-o bird.

Games fascinate Honolulu. High school football draws sell-out crowds of 25,000. There are more than 200 pool halls, by latest count—one for every 1,300 people.

Leading U. S. swimmers, such as Duke Kahanamoku and 400-meter Olympic champion Bill Smith, paddled first in the thundering surf of Makapuu (page 608) and reached competitive perfection in the 100-meter pool of the World War I memorial at Waikiki.

No island boy has missed the pleasure of one old Hawaiian sport, ti leaf sliding. Equipment is the same for rich or poor—a bundle of these big leaves as a sled, a steep, muddy bank on a mountainside, a tolerant mother, and a pair of old trousers.

Few other cities offer so many extra days off as Honolulu. Rizal Day for the Filipinos, Kamehameha Day for the Hawaiians (pages 586, 587), Boy Day for the Japanese, and Chinese New Years only begin the list. I help celebrate the other fellow's holiday by watching him parade.

Most colorful parade is the Hawaiian, with its men in breechclouts and feathered helmets, its bearers of *kahili* (standards now made of flowers instead of feathers), and its gaily gowned horsewomen called *pa'u* riders. Japanese lantern parades have been resumed since the war, and on Boy Day each Japanese-American home lucky enough to have sons heralds its pride by flying giant pennants cut and painted to represent a carp, the fish symbol of fearless courage.

Imagine traffic having to stop to let a dragon go by!

Old-style Chinese funerals, with white-clad professional mourners and papier-mâché monsters disrupt traffic. For days after, streets are littered with perforated serpentine scattered by the procession so that evil spirits—which must find their way through each little hole—will never reach the grave.

Boat Days Always Festive Occasions

Boats mean much to these islands—mail, food, celebrities—even that long-awaited new icebox. Traditionally, boat day in Honolulu draws a crowd. Whenever Matson liners berth, thousands gather below Aloha Tower to join the Royal Hawaiian Band in a musical welcome (page 582). When they sail, an even greater crowd gathers to sing *Aloha Oe*, without a dry eye on dock or deck.

People here adopt one another's customs, and confusion sometimes results, as with shoes. A young Nisei (second-generation Japanese American) matron entering her prefab home leaves her Hollywood wedgies on the doorstep, from a traditional desire to keep floors clean. Sears Roebuck's new store boasts an escalator, policed now to see that children, invariably barefoot, don't pinch toes. Island boys of all races play fine football—yet kick better barefoot!

English is the language, but apt words have been freely borrowed from many tongues. Such include the Hawaiian *kaukau* for "food" and the Chinese *hui* for "partners."

Simplified English words and phrases serve instead of the pidgin of tropic islands farther

* See, in the National Geographic Magazine: "Waves and Thrills at Waikiki," 8 illustrations in duotone by Thomas Edward Blake, May, 1935.

Hawaiian Tuna Packers, Ltd.

When a Tuna Crew Is Not Fishing, It Is Eating; 5 Meals in 18 Hours Is Modest Fare

These Japanese Americans, some of whom fought for the United States in World War II, eat their rice and fish with chopsticks, but they are equally fond of ham and eggs, steak, chicken, and toast. As they make one-day trips, seldom venturing more than 40 miles from port, galleys, bunks, and showers are limited to make extra cargo space. Catches they share with the owners. Some 50 vessels like this power-driven sampan make up the Hawaiian tuna fleet (pages 574, 602).

south. Where a New York sign would read "Excavation," a torn-up Honolulu street is placarded "Big Hole."

Plural backgrounds produce new slang. When Hawaii-born Japanese Americans formed one of the most decorated units in American military history during World War II, so far as awards to individuals were concerned, they chose the slogan, "Go for Broke"—Hawaiian version of "Shoot the works." For "Keep your shirt on," one says, "Letta go your blouse" or "Cool head—main thing."

Vital statistics, the day I write, report the marriage of Philo Stevenson to part-Hawaiian Lillian Kuhiana Kauaka, and of Lawrence Doucette to Japanese-American Betty Mitsuko Inada. Through such events Honolulu has become a proving ground for race relations. The proof is in low crime and divorce rates, and fine standards of public health.

Boosters expect double the present total of annual visitors when more hotels are built. Combined with travel by islanders, this makes transportation big business. In 1941, some 60,000 rode the ships to or from Hawaii and only about a thousand flew.

The War Reversed Travel Habits

But the war reversed travel habits. Last year 27,000 visitors came by Matson ship, while Pan American Airways, United Air Lines, and the new Northwest Airlines brought 70,000. How new, air-conditioned ships will compete with bigger and faster planes keeps travel men up nights.

As the tourist trade grows, so grow the staggering statistics in miles of film, ukulele string, and grass skirts these visitors buy. Popular garb with Honoluluans is the open-neck, highly colored "aloha" shirt. "Ukes"

or guitars are often carried, and "coconut" hats woven from palm fronds are a fad with teen-agers. Only tourists display all three at once.

Pity the "midnight son" who comes to Hawaii expecting another Miami or Las Vegas. The gambling ban, midnight closing, and moderate tempo favor rest and romance, not racing and red dog—which pleases us who work here for a living.

Hawaii is a place for record-size marlin, golf by the sea, scenic rides, and sulphur baths drawn from the steam of live volcanoes. It is a place for experiment with foods like *poi* and *lomi-lomi* salmon (raw salmon), Bombay duck and *kakimochi*. It is a place to tan by day under a brilliant sun and sleep by night under a blanket. It is a place to dance as the trade winds blow the big South Sea moon up from behind Diamond Head and across the star-studded skies toward the Waianae Mountains. But here are no "pistol-packing mammas," no chuck-a-luck, no late-spot cabarets.

Tourist Lure Is the Weather

Principal tourist lure is the weather. Seasons are not perceptible, daily temperature at sea level averages 75° F., and rain is usually laughed off as "liquid sunshine." But freak downpours can flood streets and lawns, force tourists indoors to bridge and movies.

Much small business, particularly on outer islands, centers about the tourist trade.

To move among the islands, one may choose between weekly cattle boats or one of 60 to 70 DC-3 flights each day. Often more than a thousand people fly to other islands between dawn and dusk. Machinery, stoves, furniture, and hardware move out from Honolulu by air; vegetables come back.

On one regular business trip I fly past four islands to reach a fifth. Often the sea and shore are obscured, but towering mountains break through the cloud to appear as lesser islands in a sea of scud.

Many curios are island-made, though ukuleles are from Pennsylvania and hula skirts come from New Jersey!

Local products include subtly grained bowls tooled from iron-hard koa wood, necklaces of flower blossoms fashioned from ivory, and such sweets as mango chutney and guava jelly. There is a big trade in sports clothes. Once-fashionable "Musa-Shiya, the Shirtmaker," has forsaken custom work for assembly-line production of swim shorts.

Where under the American flag but in Hawaii could anyone sell such heterogeneous wares as throw nets, a pasty food made from taro root, rice cakes lined with fish skin, service as a letter writer for illiterate Filipinos, and four-color photographs of Sun Yat-sen?

Desperately the islands seek a third money crop to supplement sugar and pineapple. I've done such scouting myself. Sisal, peanuts, potatoes, asparagus, and macadamia nuts have been tried, grow well, but lack commercial importance. Land, labor, and water are better used by cane and "pines."

Sugar—Big Business in Hawaii

Sugar is big business.

Nobody knows how cane first came here. Captain Cook found it growing as a hedge around native huts, introduced by birds or even washed ashore. Hawaiian legend tells of a Chinese junk blown off course and shipwrecked here. If so, sugar may be the legacy it left.

Production has been on a plantation scale since 1842. But the sorry stalks of a century ago were weeds beside the stands that today trace more than 200,000 acres of Hawaiian coast line. This sturdy, towering cane is the product of 50 years of research. By untiring crossbreeding, producing 500,000 new varieties a year, these qualities have been gained: It is rich in juice; has few profitless leaves; "closes in" fast to reduce weeds; is secure from plant disease; and resists drought (pages 592, 593).

To see how Hawaiian planters do it, plant geneticists from Java and India, Florida and the West Indies come to visit the cooperative experiment station on Honolulu's Keeaumoku Street.

Sugar scientists fight bugs too. They have saved the Hawaiian industry from pests by searching and finding, in far corners of the earth, parasites that prey on the destroyers. A late importation (1932) was a hundred-odd toads, *Bufo marinus*, originally from South America. They multiply like rabbits and, like goats, eat everything from cigar butts to paper napkins. These bufos, a multitude now and spread to all islands, have won housewives' favor, too, with their taste for centipedes and scorpions.

A pound of sugar needs about two tons of water to grow on. Producing a quarter of the cane and beet sugar grown under the U. S. flag, Hawaiian business has invested more than $40,000,000 in irrigation alone, probably the biggest privately financed irrigation project under our flag.

Battling always to save water, planters court new ideas. Seepage-proof concrete and aluminum sections of movable flume now replace dirt ditches (page 577).

W. J. Hull, hydraulic engineer, spotting a

Photo Hawaii

A Waikiki Outrigger Rides a Breaker with the Effortless Ease of a Toboggan Hurtling Down an Icy Slope

Beyond the canoe, two surfers, lying flat on boards, use their arms as paddles. When the wave breaks, they will rise, shifting weight from leg to leg.

Pineapples' Pattern Seems a Giant's Idle Doodling in the Soil

This geometrical field in Oahu has received careful preparation. Roads (wide dark strips) have been left some 100 feet apart for use of sprayers and long-armed harvesters (pages 588 and 600).

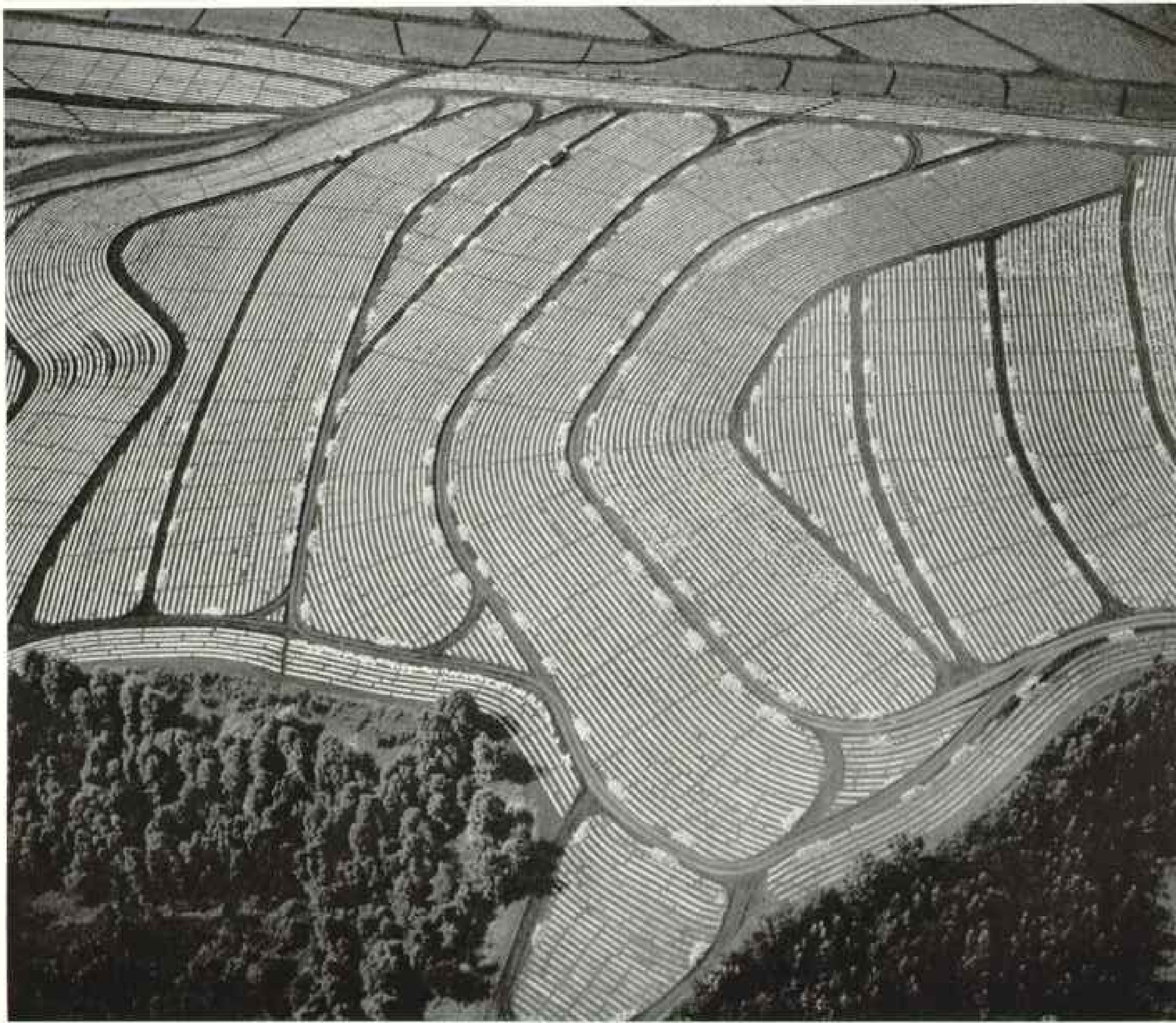
Strips of bright asphalt-impregnated mulch paper have just been laid down by machines. This paper, a Hawaiian invention, conserves moisture, prevents excessive leaching of fertilizer, keeps down weeds, activates nitrifying bacteria, and hastens plant growth by raising the temperature.

Now the field is ready for the planting of 17,500 to 20,000 slips to the acre. Piles of this planting material may be seen by the roadsides. Workers will insert them into the soil through holes gouged in the mulch paper.

Eighteen months or more are required to bring pineapple plantings to harvest. One or two succeeding crops, known as ratoons, are cut from the same planting.

Pineapple, like its air-plant cousin, Spanish moss, belongs to the botanical family called Bromeliaceae. The plant's drought-resisting ability has enabled growers on Kauai, Lanai, Maui, Molokai, and Oahu to reclaim thousands of acres of semiarid land. Pineapples are not grown commercially on the "Big Island" (Hawaii).

Hawaiian Pineapple Company



NATIONAL GEOGRAPHIC MAGAZINE illustration of overhead irrigation as used on Costa Rican bananas,* caught a plane for United Fruit Company's Boston headquarters and received permission to buy some of its nozzles and make extensive tests with them in Hawaii.

Plantations in rainy belts need no irrigation. Some of them float cut cane to mills down steep wooden troughs. It's great sport to ride a bundle of this cane as a raft, pell-mell down a mountainside (page 610). Old-timers tell of a wooden-legged manager who customarily got around his fields on horseback; then, at quitting time, unstrapped his leg, threw it into such a trough, and, hopping a bundle of cane, raced his leg home!

Waste Mud Saved To Build New Land

There are no dust bowls in Hawaii—the scarce land is guarded as is water. One plantation saves the mud that clings to cane, pipes it off to barren coral areas, and so builds 10 acres of new land each year.

Moist soils trampled by heavy equipment lose oxygen and turn sour. Planters worry now that, in their rush to mechanize, heavy tractors, cranes, and trucks will compact soils and impair their fertility. "But mechanize we must," says Hawaiian Sugar Planters' Association president, Richard G. Bell. "Paying the highest agricultural wages in the world, about $8 a day, we can compete only by practicing scientific, industrialized agriculture."

One current experiment, if successful, will revolutionize world sugar processes. By ion exchange, chemicals get more sucrose from cane juice and convert it into white sugar at the mill, and thus it may eventually replace today's refining process. I tried ion-exchange sugar. It was every bit as good as the sugar on the table at home, but not yet so pretty. Last year sugar and its by-products brought Hawaii an income of $101,000,000.

Pineapple is the flamboyant, widely advertised younger brother of sugar. Of age now, it competes for labor and some land and brings in about a fourth less income (page 588). There is a family fight whenever sugar planters "seed" clouds for rain and so rob thirsty pineapple fields; or spray 2, 4-D by plane to kill weeds and carelessly let chemicals drift onto the delicate "pines."

Pineapples Don't Grow on Trees

But pineapple growers have borrowed freely from sugar experience. With the same emphasis on science, they spray iron sulphate over deficient plants, use hormones to spread the ripening season, and even try to grow fruit to fit the can!

Asked what interests tourists most about pineapple, Boyd MacNaughton, a Dole vice president, answered: "That they don't grow on trees."

Many Americans do not know how fresh pineapple tastes and smells; canning changes flavor. Recent fresh-freezing developments have salesmen puzzled. Will the public desert the canned, or think fresh fruit tastes all wrong?

As yet, only the human eye and hand can select fruit when exactly ripe, but canneries are a maze of machines so intricate that they might well be making telephones. Pineapples are trimmed, sized, and cored by devices called "ginacas," about 100 to the minute. When canned, cooked, and cooled, they are labeled by other machines at 1,300 cans a minute—faster than most machine-gun fire (page 573).

Everything about a pineapple is used except the smell. Once juice pumped out as waste discolored Honolulu Harbor. Now its sale has about doubled the business. Pineapple shells are chopped up and dried to make cattle feed. Citric acid is a major by-product, and researchers strive to make mulch paper, used in planting the pines, from the leaves (page 599).

Pineapple is a fairly new business. James D. Dole, fresh out of Harvard, started it in 1903 with a pack of nearly 2,000 cases. Today his cannery turns out that much in 15 minutes.

Future growth here is limited by the scarce land. Growers, therefore, well aware that pineapple is not indigenous to Hawaii, look afield. California Packing Corporation (Del Monte) is rebuilding in the Philippines; Libby, McNeill & Libby is prospecting possibilities in Mexico; Dole announces experimental plantings in Cuba and a cannery venture in Mexico.

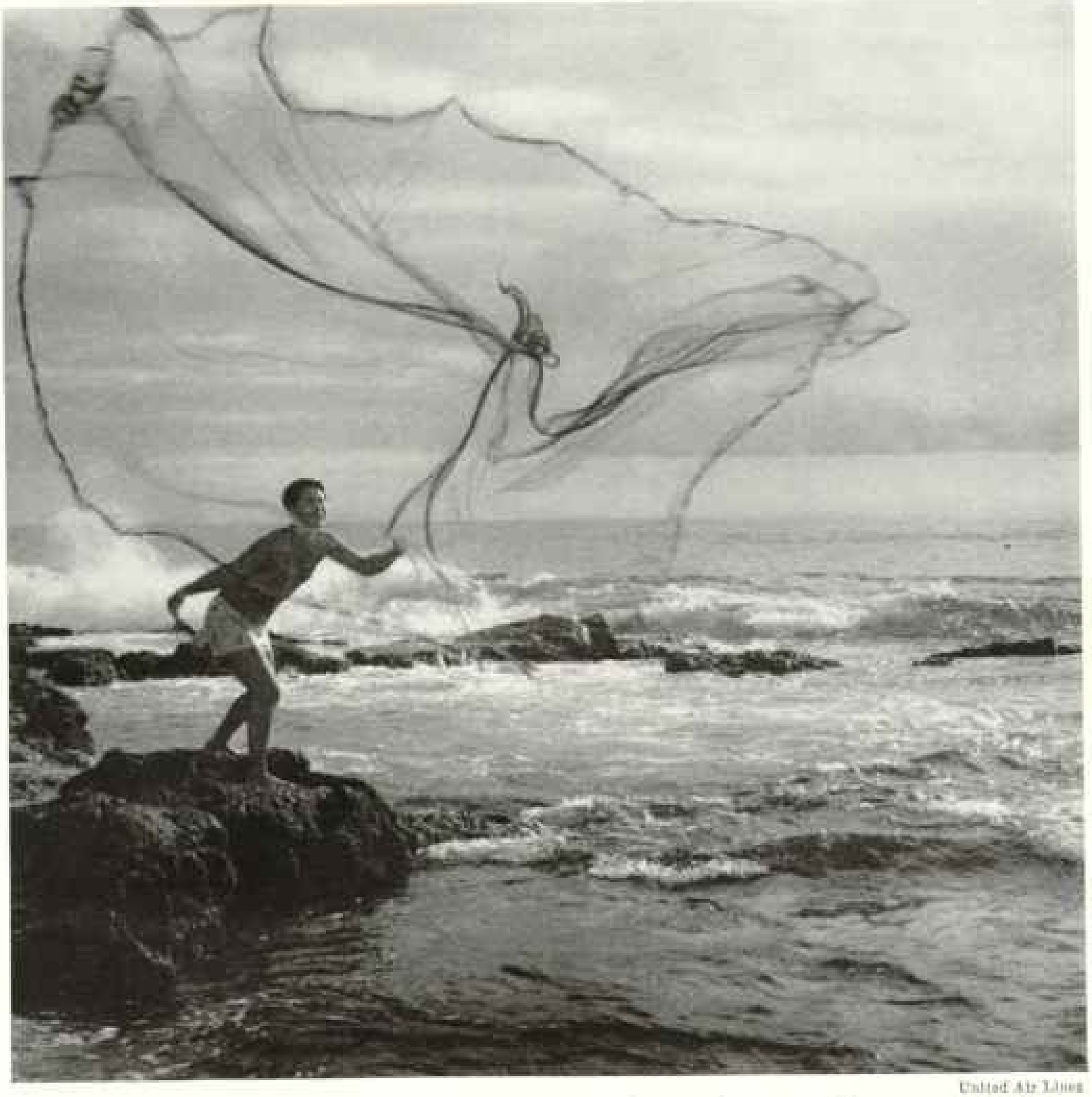
Nature Has Freakish Ways in Hawaii

The green carpet of sugar and pineapple, looking so smooth from the air, belies the rugged nature of these islands. Theirs is a turbulent geologic history. The eruptions, earthquakes, and tidal waves that have played on them since Tertiary times are recorded by sea shells 100 feet above sea level and by submerged, coral-encrusted sand dunes, distinguishable in the surf only at low tide. Only three years ago (April 1, 1946) a seismic wave inundated acres, killed 200, and destroyed millions in property.

Such violence has built much of interest.

From the Pali (Nuuanu Pali), spectacular pass between Honolulu and windward Oahu (page 590), one may look out over 30 miles

* See "Land of the Painted Oxcarts (Costa Rica)," by Luis Marden, October, 1946.



United Air Lines

A Filmy Cloud of Fiber, Cast as Expertly as a Lasso, Drops on Unsuspecting Fish

Fish-hungry natives on some Pacific islands have learned the simple art of buying a can of salmon, but this Hawaiian islander clings to his ancestors' technique. Bare feet gripping jagged lava, he makes no idle casts with weighted net but stalks his prey by eye. Hawaii's throw-net, spear, and torchlight fishing make interesting spectacles by day and night.

of tropic coast line, including Edwin W. Pauley's private resort, Coconut Island, where Cabinet members play. Winds blow so hard through this missing tooth in the Koolau Range that a would-be suicide leaping from a height of hundreds of feet ballooned gently downward. He suffered only a broken ankle!

The fact that hardened lava is porous explains fresh springs bubbling up through the ocean, and the geysers, called "blow holes," dotting the rocky coasts.

Beaches of "barking" sand that crackles underfoot fringe Kauai, northernmost island. Waimea Canyon, a gorge more than half a mile deep, is Kauai's colorful miniature of the Grand Canyon of the Colorado (page 606).

Natives once looked to Nature for their gods—and no wonder. The visitor who greets an icy sunrise at the crater of Maui's Haleakala (page 607) and then motors down its 10,000-foot slope to the towering Needle rock of Iao Valley feels at one with the Olympians.

Figures lie in describing Hawaiian mountain heights. Whitney, Rainier, and Pikes Peak all reach greater elevations, but they rise from plateaus which are themselves well above sea level. The "Big Island's" (Hawaii Island) twin volcanoes, Mauna Loa and

Mauna Kea, climb straight up from the ocean's bottom to nearly 14,000 feet above sea level (page 604).

On their slopes range the bulk of Hawaii's cattle. Parker Ranch alone operates 300,000 acres, thus forming, like Texas' King Ranch, one of the largest family land interests in our country. The heir to this principality gave up cowpunching for juvenile parts on Broadway.

On boat day Big Island cowboys, called *paniolos*, drive cattle in bellowing, unhappy herds down to the beaches, then swim them out through the surf to ship's tackle.

The saddle between the Big Island's volcanic peaks is crossed by a military road built during the war to permit rapid shifting of defenses. To drive this route is to thumb through Doré's engravings for the *Inferno*. Miles of lava, overlapping flows, though cool now, inspire awe. On such a ride I saw no living thing—only sullen black rivers of rock.

Legends spring from this Nature the natives knew to blend with early Hawaiian history. Some doubt that *menehunes*, the strange mountain dwarfs of Hawaiian legend, built a two-mile ditch on Kauai overnight. Many believe that Kamehameha I, first to conquer all the islands, was born under rare thunder and lightning and was smuggled that night to another island for safekeeping. It is fact that, in the way of Hawaiian chiefs, he lies buried now in some secret lava grotto.

One day eight years ago Jap planes roared over us, dropped bombs, and strafed. From the carefully preserved "souvenir" bullet holes in a sugar mill near Pearl Harbor to the 80 miles of airplane runways, mostly built by military engineers, the war is still in evidence.*

Tunnels leading to underground shops, hospitals, and ammunition dumps lattice the walls of Oahu gulches, and $100,000,000 worth of surplus jeeps, planes, cranes, and trucks still rust in military order on the islands.

Red Hill, a view spot northwest of Honolulu, is but a shell of earth bottling the oil needs of the Pacific Fleet at war. Costing $42,000,000 and 16 workmen's lives, this storage serviced Halsey's long-range raids, is atom bomb-proof, and its miles of galleries are serviceable as shelter for Pearl Harbor personnel.

Above this maze of tanks wild deer scurry, and dove and pheasants rise. Hawaii has good hunting, particularly on outside islands, where wild boars course the wooded mountain slopes and herds of mountain goats range the grazing lands.

A Federal bird sanctuary extends from Niihau Island through French Frigate Shoal to Kure, or Ocean Island, 1,400 miles northwest of Honolulu.† Terns, frigate birds, albatross, boobies, and other species people these northern islands; the main group has its sparrows, hill robins, and—a recent importation—the cardinal. In the fall, migrant golden plover from Siberia and Alaska settle here by the thousands; some few fly on to winter as far south as Australia. Most common of all are mynas, native to southern Asia.

Mynas often talk. I know one canny bird named "Joe," brought up near a Marine camp. He calls the family dog by name, demands breakfast, observes that "Colonels are stupid," even whistles when girls go by!

Fishermen Hunt Prey with Submarine Lights

In surrounding waters Hawaii's fishing fleet patrols, catching nearly 5,000 tons of *aku*, Hawaiian tuna, annually (pages 574 and 596). Fishermen spend half their time looking for bait, half the remainder looking for fish. To increase the catch, Hawaiian Tuna Packers, Ltd., has developed colored underwater lights to lure bait and is equipping a boat with wartime submarine listening devices, hoping to hear schools of tuna the eye alone can't find.

This Hawaii that wants to become a State is the focal point of our western defenses and capital of the new war-won American Pacific. From here the ground and air forces scattered on the islands west to Guam are commanded, as are atom-bomb experiments at Eniwetok. Here is the Commander in Chief of the Pacific Fleet, with his civil assignment as administrator of the Pacific areas held by the U. S. as trustee for the United Nations.

Main barrier to Hawaiian statehood is her very substance, the source of her life and income—water—those 2,400 miles of water that separate her from mainland United States.

But Delegate to Congress from Hawaii, Joseph R. Farrington, says: "Distance means little today. We have instantaneous radio, teletype, and telephone service. We are less than 10 passenger hours from the west coast by plane, and there are 30 flights from Hawaii to the mainland each week.

"Our arguments for statehood are these: We pay more Federal income taxes than 12 States; we have demonstrated our capacity for self-government and our loyalty. We voluntarily joined the Union as a Territory, with statehood promised. By every standard of democracy we have earned it."

* See, in the NATIONAL GEOGRAPHIC MAGAZINE: "Life on the Hawaii 'Front,'" by Frederick Simpich, Jr., October, 1942.

† See, in the NATIONAL GEOGRAPHIC MAGAZINE: "Bird Life Among Lava Rock and Coral Sand," by Alexander Wetmore, July, 1925.

Kodachromes by W. Robert Moore

Hawaii Exports Beauty and Fragrance by Air. Flower Express Is a Million-dollar Business

At Honolulu Airport (below), where San Francisco is only 12 freight hours away and New York 36, a girl packs the showy heads of torch ginger in cellophane preservers. Its stalk grows 3 to 6 feet high and, together with the waxen cone, suggests a formalized torch. Red ginger (left, above) is often called ostrich plume ginger because of a fancied resemblance to the feather. Bird of paradise (above and page 589) resembles a gorgeous bird in flight. Ten thousand air-borne Hawaiian orchids recently went on display at Rockefeller Center, New York.

Photograph by Ansel Adams courtesy Maison Lilas

Mauna Loa's Lava Slope, Cold and Silent, Looks Out Across a River of Clouds to Snow-flecked Mauna Kea

Two of Hawaii Island's volcanic peaks are, in a sense, among earth's highest mountains, rising almost 29,000 feet from sea bottom. Two active craters still build the island.

Diamond Head, Honolulu's Volcanic Beacon, Is Known to Many, but Few Save Airmen Glimpse Its Dead Crater

Punchbowl (upper right), another extinct cone, has been laid out as a cemetery for the Pacific war dead. Correspondent Ernie Pyle was buried there last July.

Kodachrome courtesy Hoyt S. Cummings, Jr.

Kodachromes by W. Robert Moore

Waimea Canyon, with Its Castled Crags, Branching Gorges, and Desert Tones, Gives Kauai Island an Arizona Look

This "little Grand Canyon" cuts a groove a mile wide and half a mile deep into an island of only 553 square miles.

This Delicate Silversword, One of Earth's Rarest Plants, Grows Only Within Haleakala, a Crater as Weird as the Moon's

Maui Island's "House of the Sun" is dormant. The ghosts of 13 parasitic cones rise from its floor. Crater walls, 21 miles in circumference, rise 10,025 feet. Planes sometimes fly between them to give passengers a look. Other silversword species are found elsewhere in the islands. Polynesians used to make leis from their leaves.

Kodachromes by W. Robert Moore

Anscochrome by Werner Stoy-Photo Hawaii

Pacific's Roaring Surf Batters and Sprays Makapuu Beach. Body-surfers, Who Have Ridden a Wave to the Beach, Appear Lost

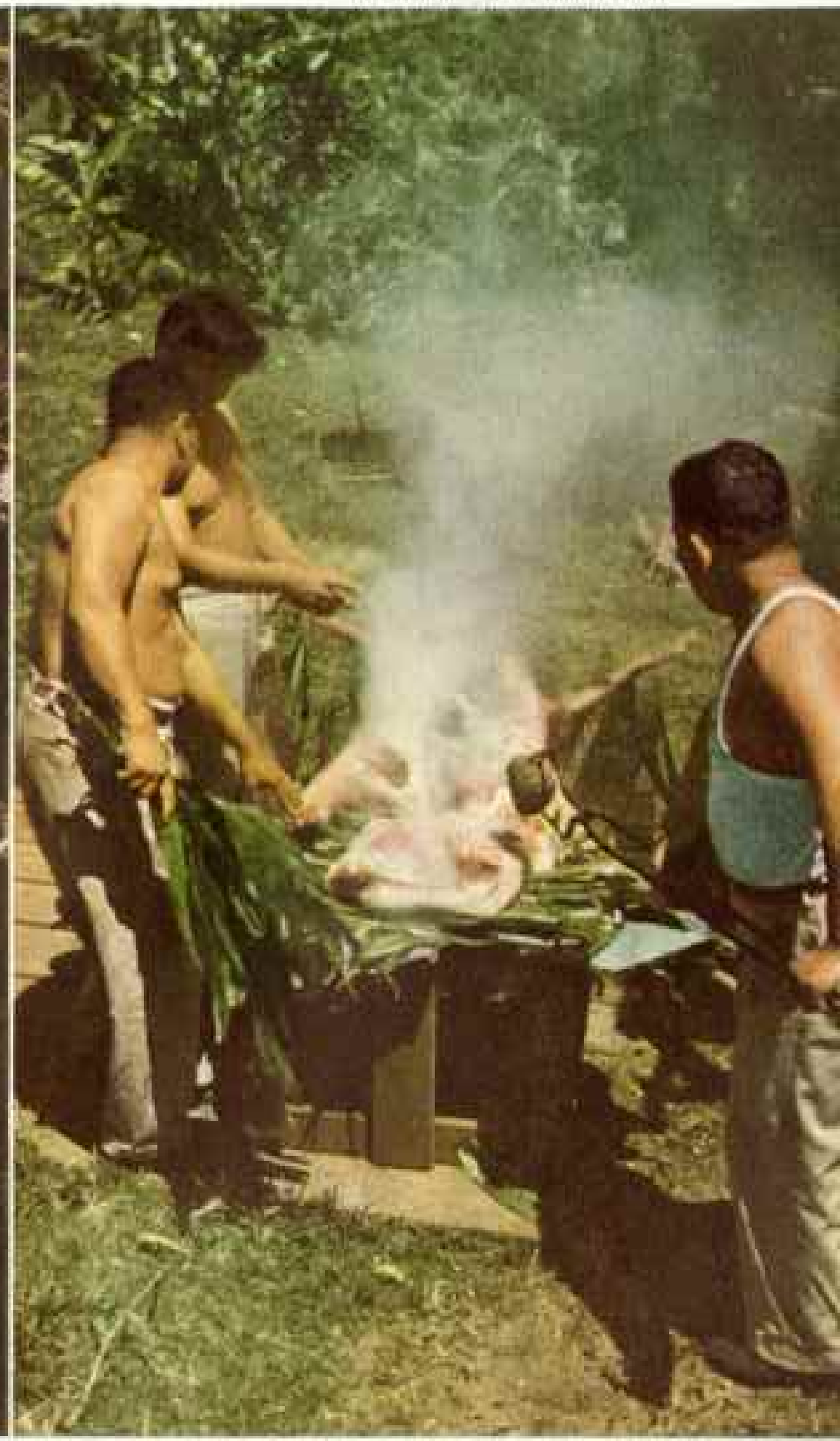
In body-surfing the experienced swimmer learns to catch a wave, hold the body rigid, and make a surfboard of himself.

A Waist-stretching *Luau*, or Native Feast, Is Hawaii's Answer to New England Clambake and Texas Barbecue

A real outdoor *luau* features pig (never called pork) from the underground oven and may include chicken, steamed and raw fish, poi, coconut, and pineapple. Feasters dressed in the colorful aloha style remove the pig from an earth oven (left). Cooks on the right stuff a fresh carcass with hot rocks and wrap it in ti leaves.

Ansel Adams by Bob Shaw

Kodachrome by W. Robert Moore



Kodachrome by Maynard Owen Williams

A Sugar-cane Flume Strides above the Palms on Spidery Wooden Legs: Island of Hawaii

Most plantations move cane by truck or rail, but where roads are impossible and water is plentiful, some use aqueducts to wash the crop from lofty fields to mills. It's a thrilling sport to ride a bundle of stalks down the flume.

New Discoveries on the Mid-Atlantic Ridge

By Maurice Ewing

Professor of Geology, Columbia University

Leader, National Geographic Society-Woods Hole Oceanographic Institution-Columbia University Expeditions to the Mid-Atlantic Ridge

Illustrations by National Geographic Photographer Robert F. Sisson

"STAND by to lower away!"

As this cry sounded, all hands crowded to the rail of our little research ship *Atlantis*, rolling easily as she lay hove to on the gray midocean swells.

It was a tense but eagerly awaited moment on our second voyage of exploration of the Mid-Atlantic Ridge, the world's longest mountain range, which runs a full mile deep under almost the whole length of the Atlantic Ocean.*

We were about to probe deeper down into the mud on the Atlantic's hidden bottom than we ever had been able to penetrate before. This meant that we would be reaching far back into the ancient history of the Atlantic Ocean, and even of the earth itself, a history preserved in the sediments that had been piling up on the sea bottom for many millions of years.

Taking core samples of the ocean bottom was just one of the many scientific projects in our exploration of the Ridge under the sponsorship of the National Geographic Society, the Woods Hole (Massachusetts) Oceanographic Institution, and Columbia University, New York City.

Exploring the Undersea World

Swung out over the ship's starboard side was our new and improved coring apparatus, with which we would delve into the dark, silent undersea world.

It was a 40-foot steel tube, two and a half inches in diameter, with a sharp cutting edge on the lower end and 1,000 pounds of lead weights on top to drive it down into the mud of the ocean floor.

Double the length of tubes we had previously used, and now equipped with a piston to help pull up the mud inside, it would enable us to penetrate twice as far down into the bottom sediment as we had gone before.

We were ready now to lower this tube on the end of two to three miles of steel wire, let it drive itself deep into the bottom mud, as a corer is pushed into an apple, then pull it out and haul it back to the surface with the core of mud inside for analysis.

Mud from the Atlantic Ocean bottom is slimy, unglamorous-looking stuff, as is mud from anywhere (page 623). But in that mud we can read a chronological history of everything that has happened in and around the Atlantic Basin far back into Ice Age times—evolution of life, changes of climate, risings and sinkings of the ocean bed. We need to learn more about all these things.

Our ship lay over the western "foothills," or terraces, of the Mid-Atlantic Ridge, almost two miles straight down beneath our keel. Thick fog hemmed us in, and our foghorn was sounding a nerve-shattering "bla-a-a" at frequent intervals.

This was the first test of the improved, longer coring apparatus we had built since our last voyage. Would it work? If by mistake we hauled the corer in before it actually hit bottom, or if the trip device failed to let it fall freely the last 10 feet, it would not secure as good a sample as the old shorter tubes, and hours of work would be wasted. If the wire kinked or fouled, it might break, causing the loss of our tube and perhaps thousands of feet of valuable wire as well.

No wonder then that we all felt a little tense as Capt. Adrian K. Lane, called out, "Cast off and stand clear!"

As he pushed the control lever, a grinding roar came from the big winch down in the hold, the heavy steel wire rattling and slapping as it unreeled into the sea.

After about an hour, when we had paid out nearly three miles of wire, its tension suddenly slackened—the coring tube had hit bottom. At once the winch was reversed, the tension gauge showed the sudden strain as the tube was pulled out of the mud, and then began the long haul up.

As soon as the tube was visible under water alongside, I sang out, "In sight!" Then, as it came up and broke water, "Surface!"

This signaled the captain to slow down the winch, then stop, and the corer was hoisted aboard. A smear of mud on the outside showed that the tube had successfully penetrated 26 feet into the bottom.

We found that this 26 feet of mud repre-

* See "Exploring the Mid-Atlantic Ridge," by Maurice Ewing, National Geographic Magazine, September, 1948.

Stout Hook and Chain Bag an Angry Shark

"Tigers of the sea" sometimes fouled the hydrophone towed behind the ship (page 616). Tips of their teeth were found imbedded in the towing cable. One voracious shark got a dose of castor oil used in the sound pickup apparatus.

sented at least 250,000 years of the earth's past history. It told a story of climate changes during the Pleistocene age, when glaciers were advancing and retreating on land and the numbers and types of sea creatures varied as the ocean water warmed and cooled.

On the first voyage the summer before we had explored the vast Ridge farther south, dredging up rocks from its precipitous cliffs, taking core samples, making continuous fathometer soundings to chart the peaks, slopes, and valleys of parts of the Ridge, investigating the type of bedrock beneath the ocean floor, the thickness of sediment covering it, and capturing some of the weird deepsea fish that inhabit the waters around it.

This time we were to make two cruises, exploring the Ridge for a total of four months, from the latitude of Newfoundland almost to the bulge of South America, and charting also the great flat plains on the sea floor that flank the Ridge on either side (map, page 615).

Origin of Atlantic Basin

Facts we gathered on this second voyage will help give a better understanding of the origin, age, and history of the gigantic Atlantic Ocean basin. This great water-filled depression might have come into existence in one of three ways:

Land may once have existed where the Atlantic is now, connecting the continents on either side and later sinking to form the basin.

Or the Americas may once have been joined to Europe and Africa in one great land mass, then split apart and drifted away from one another, opening up the Atlantic Basin between, as suggested in the famous Wegener theory of continental drift.

A third possibility is that when the outer surface of the earth first took form the continents were thrust up above the general level in the same positions they occupy today, so that the Atlantic Basin has always existed.

Some of the things we found on this second cruise create new scientific puzzles. One was the discovery of prehistoric beach sand in two core samples of the bottom, brought up in

"Let's Try for Underwater Pictures Here." Dr. Ewing and His Staff Discuss Plans

On the chart spread on the *Atlantis*'s mess table, the expedition leader points to the ship's location east of the Grand Banks. Wavy lines represent ocean hills and valleys traced in profile by the fathometer (page 614). The mess table is rigged to stay level even when the ship is rolling in a heavy sea or heeled under sail.

one case from a depth of two and in the other nearly three and one-half miles, far from any place where beaches exist today.

In one core there were actually two layers of sand, one 20,000 to 100,000 years old and the other 225,000 to 325,000, these ages being calculated from the depth and the average rate at which sediment is deposited.

Two Startling Theories

Sometime in the distant past this sand found deep beneath the ocean must have been located on a beach, at or near the surface of the sea. Either the land must have sunk two to three miles, or the sea once must have been two to three miles lower than now.

Either conclusion is startling. If the sea was once two miles lower, where could all the extra water have gone?

Some sand found in other places on the Atlantic bottom undoubtedly was rafted out from shore by floating ice during past glacial periods. Such sand is well mixed with larger rock fragments.

But the grains in the sand we found are well sorted into various sizes, with no large fragments. This fact suggests that here is a real beach, unless the sand was originally picked up from a beach by the ice, which is extremely unlikely.

One of these sand deposits is 1,200 miles from land and so far south that it is improbable that ice could ever have carried sand that far before melting.

On this second expedition we secured 25 core samples of the ocean bottom, both along the Ridge and in the three-mile-deep basins on either side. Study of the material in them

will add much to our knowledge of the past history of the Atlantic.

On this second expedition, too, we made the first photographs in natural color ever secured in the sea at depths below 600 feet (100 fathoms).

Sound Echoes Measure Depths

In more than 3,000 different places over vast areas of the Atlantic we have now measured with sound echoes the depth of the sediment on top of the bedrock of the ocean floor.

These measurements clearly indicate thousands of feet of sediments on the foothills of the Ridge. Surprisingly, however, we have found that in the great flat basins on either side of the Ridge this sediment appears to be less than 100 feet thick, a fact so startling that it needs further checking.

Seeking to learn the nature of the Atlantic's bedrock, whether it is basalt or granite, we measured the speed of sound traveling through this rock. Sound travels faster through basalt than through granite, and our tests, though incomplete, indicate that these "basement" rocks are probably basalt. If this is true, it means that the Atlantic Ocean basin might be as old as the earth itself and was not formed by the sinking of an ancient land mass.

One important achievement of our expedition was the tracing of a continuous profile of the contours of the bottom over large areas of the North Atlantic. This provided for the first time a complete and accurate picture of the slopes and peaks of many parts of the Mid-Atlantic Ridge and the smooth, table-flat plains that extend for hundreds of miles on both sides of it to the continental shelves.

All this was done with our continuously recording deepsea fathometer, which measures the depth of the water by the time it takes for a high-pitched sound signal to echo back from the bottom (page 617).

An Atlas of the Ocean Floor

Our record of the topography of the Atlantic's bottom, made on these expeditions and other recent *Atlantis* cruises, covers a total of 60,000 miles and is drawn on strips of paper that if joined together would total 1,200 feet in length (page 613). It forms a priceless library of the first detailed information gathered on certain areas of the bottom of the sea.

The record shows unerringly every "pimple," every peak and cliff, every rise and dip in the sea floor. On it we discovered many new uncharted "sea mounts," confirmed the existence of others previously reported, and also proved the nonexistence of some shoal areas that had been erroneously marked on earlier charts.

An interesting recent discovery made with our fathometer was that the submerged canyon of the Hudson River, a continuation of the Hudson Valley, extends 100 miles farther out under the sea than anyone had known before.* Several years ago the Hudson Valley was charted out under water to the edge of the continental shelf, 120 miles offshore.

Tracing the Hudson Canyon

But on this trip our fathometer found a slight dip even farther out. We have now traced this canyon for another 100 miles across a lower, second slope on the edge of the continent, in water one and a half to two and a half miles deep. Here the valley is two to three miles wide and 300 to 1,800 feet below the level of the shelf through which it cuts.

If all this valley was originally carved out by the river on dry land, as seems probable, it means either that the ocean floor of the eastern seaboard of North America once must have stood about two miles above its present level and has since subsided, or else that the level of the sea was once about two miles lower than now.

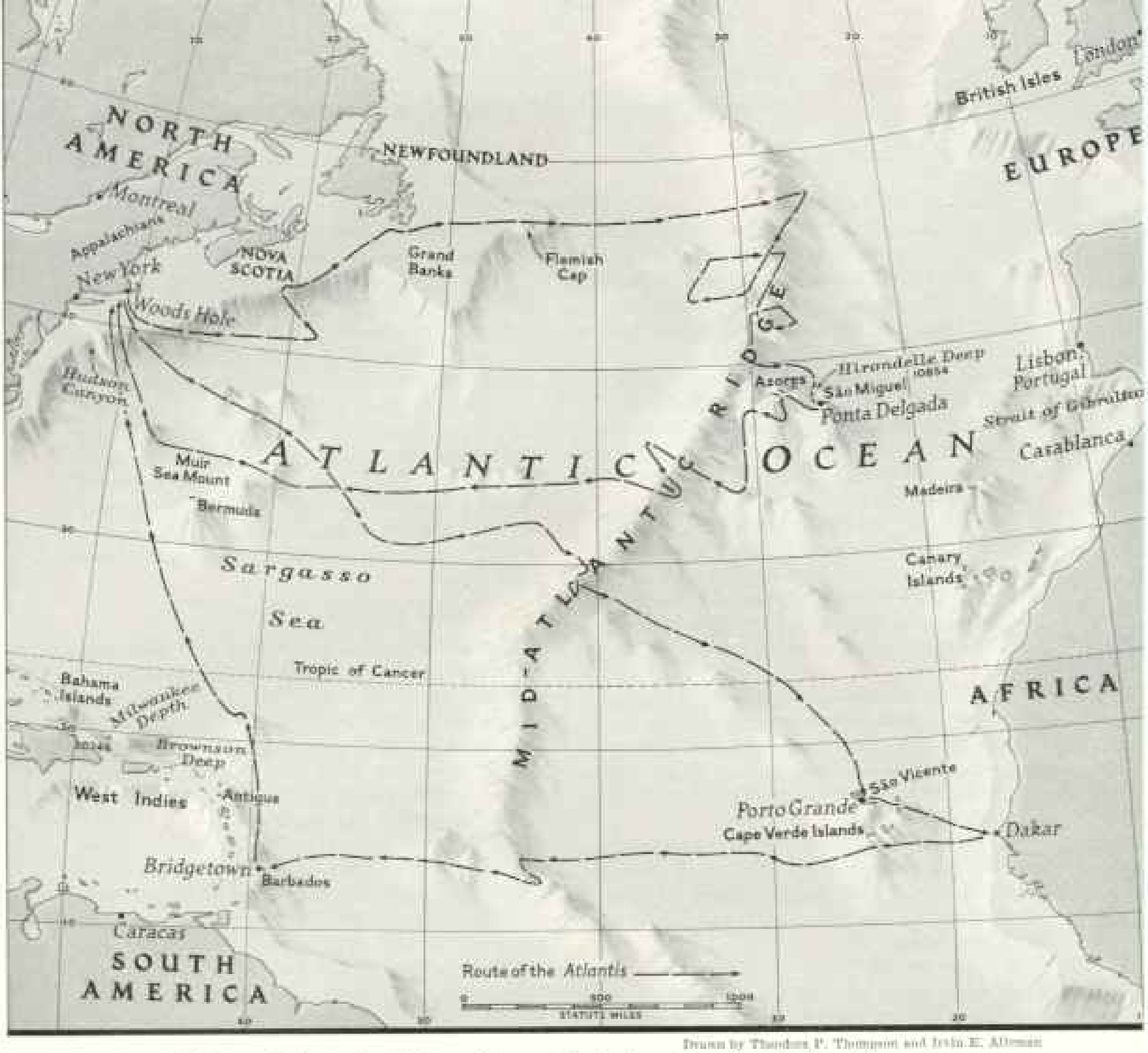
Another mystery of the sea, as yet unsolved, showed up again on our fathometer, as it had the year before. This is a strange echo that in the daytime is reflected from about 300 fathoms (some 1,800 feet) down and is entirely separate from the echo sent back from the ocean bottom. At night this unusual echo comes from near the surface.

Everywhere in the sea we found this echo. It may come from the plankton, vast hordes of small sea creatures which move up near the surface at night and sink during daylight. It has been suggested, however, that the echo might come from great schools of fish far out in the open sea where no one has thought they existed.

Should this be true, the sea may contain greater resources of food than anyone has suspected. We again gave the data we gathered on the echo to Dr. H. B. Moore, who is studying the subject at Woods Hole.

We dredged up rocks of igneous, or "fire-made," type from the sides and tops of peaks on the Mid-Atlantic Ridge, which indicated that submarine volcanoes and lava flows have been active there. Probably the whole Ridge is highly volcanic, with perhaps thousands

* See "The Mighty Hudson," by Albert W. Atwood, National Geographic Magazine, July, 1948.



Drawn by Theodore F. Thompson and Irvin E. Altemus

Atlantis Followed a Zigzag Course Exploring Ocean's Hidden Mysteries

Scientists from Woods Hole, Massachusetts, made two trips spanning 18,300 miles during the second Mid-Atlantic Ridge Expedition. The first trip included the Azores and Bermuda Rise; the second the Sargasso Sea and the waters around Cape Verde Islands. *Atlantis* probed hollows and mountains ranging from a four-mile deep off Antigua to the Azores, where peaks of the Ridge emerge from the Atlantic Ocean.

of lava outpourings and active and extinct cones scattered along its entire length.

With the Blake trawl, a long conical net with a yawning mouth, we hauled up specimens of deepsea life, among them a vicious-looking fish whose lower jaw slid in and out instead of opening in the usual way (pages 624, 625, and 639).

Once we were surprised to find pieces of lettuce in the trawl, until we realized the mess boy had dumped some table refuse over the side just before the trawl was hauled to the surface!

Behind the ship we towed what we called "the fish," a magnetometer that recorded changes in the magnetism of the rocks on the bottom far below, the first time this had been done in the ocean basins. Rocks of igneous origin are strongly magnetic. When the magnetometer record showed an increase or distortion in magnetism, it was a strong indication that we were passing over old lava beds or volcanic areas on the sea floor.

At such times our fathometer often would show a mountain or small rise on the bottom at the same point, confirming that there are many peaks of volcanic origin scattered over the Atlantic Basin.

Ridge's Peaks Rise to Form Islands

Its peaks and ranges, as rugged and precipitous as any mountain range known on land, rise about 10,000 feet above the level plains on either side. These plains average about three miles below the surface. Only a few of the Ridge's highest peaks emerge above the water surface to form the islands of the Azores, St. Paul Rocks (Rochedos São Paulo),

Ascension, Tristan da Cunha, Gough, and Bouvet.*

There is no reason to believe that this mighty underwater mass of mountains is connected in any way with the legendary lost Atlantis which Plato described as having sunk beneath the waves.

Our ship, the *Atlantis*, research vessel of the Woods Hole Oceanographic Institution, is a 146-foot steel-hulled ketch, specially designed for oceanographic work. She travels primarily under sail, giving her a cruising range out of all proportion to her size, and an auxiliary Diesel engine provides motive power when winds fail.

As on the previous cruise, we carried a crew of 18, commanded by Captain Lane, formerly of the U. S. Coast Guard, and a scientific staff of ten. Robert F. Sisson, National Geographic staff photographer, made the cruise to obtain a pictorial record of our work.

Weighing anchor at Woods Hole, we soon were under full sail eastward.

One of our new and welcome pieces of housekeeping equipment was a deep freeze, which insured plentiful supplies of fresh meat and vegetables.

Stowed in the hold, on deck, and anywhere else we could find space were rock dredges, coring tubes, trawl frames, cases of bottles for preserving biological specimens, boxes for rock specimens, etc.

Wound on the three winches were more than four miles of half-inch steel-wire rope for lowering our coring tubes and dredges, five miles of 5/32-inch wire for the deepsea camera and the bottles for collecting water samples from the depths, and 2,000 feet of 3/32-inch wire for sending down our temperature and pressure-measuring instruments (page 640).

Toy Balloons and TNT

An important, if bizarre, item was 2,000 brightly colored toy balloons to be used as floats for the TNT charges we exploded for measuring the depth of bottom sediment. We carried 4,500 pounds of TNT, stowed on deck where it could be quickly thrown overboard in case of fire (page 620).

Schools of porpoises frequently turned up to escort the ship, diving under the bows and playing about. A few cases of seasickness soon cleared up, and all hands began getting settled in the cramped quarters and learning to stand watches on some of the scientific projects that went on day and night.

Once every hour, around the clock, we set off a "reflection shot" to measure the depth of sediment on the ocean bottom. A small charge of TNT was attached to a couple of toy balloons for floats and flung over the side with the fuse ignited (page 622).

When the charge exploded, the sound waves traveled down through the water to the bottom. Some were reflected back to the surface from the mud on the sea floor, but others went down through the mud and were reflected back from the solid bedrock below. The difference in the time it took for the two signals to be picked up by our hydrophone established the depth of the sediment.

Often sea gulls and petrels were attracted by the bright colors of the balloon floats, only to fly off with loud squawks of injured dignity when the underwater explosion showered them with water.

Shark Gets Dose of Castor Oil

Sharks were more troublesome kibitzers. Suddenly the hydrophone would fail to work, and we would find the tips of sharks' teeth imbedded in the towing cable (page 612). One shark bit off some celluloid tubing, rubber sheathing, and a good dose of castor oil used in the sound pickup apparatus. We felt the castor oil served him right!

These ocean-bottom sediments we measured are formed from the shells and skeletons of countless small sea creatures that die and sink year after year; from volcanic dust and wind-blown soil drifting out over the sea; and from the ashes of burned-out meteorites and cosmic dust from outer space sifting constantly down upon the earth.

Near the coast, where much material from land is carried out into the water, one or two feet of sediment may be deposited on the ocean floor in 1,000 years, but farther out near midocean only half an inch may be laid down in the same length of time. This is known from the age of fossils found in the mud and the amount of radium in various layers, which is also a measure of age.

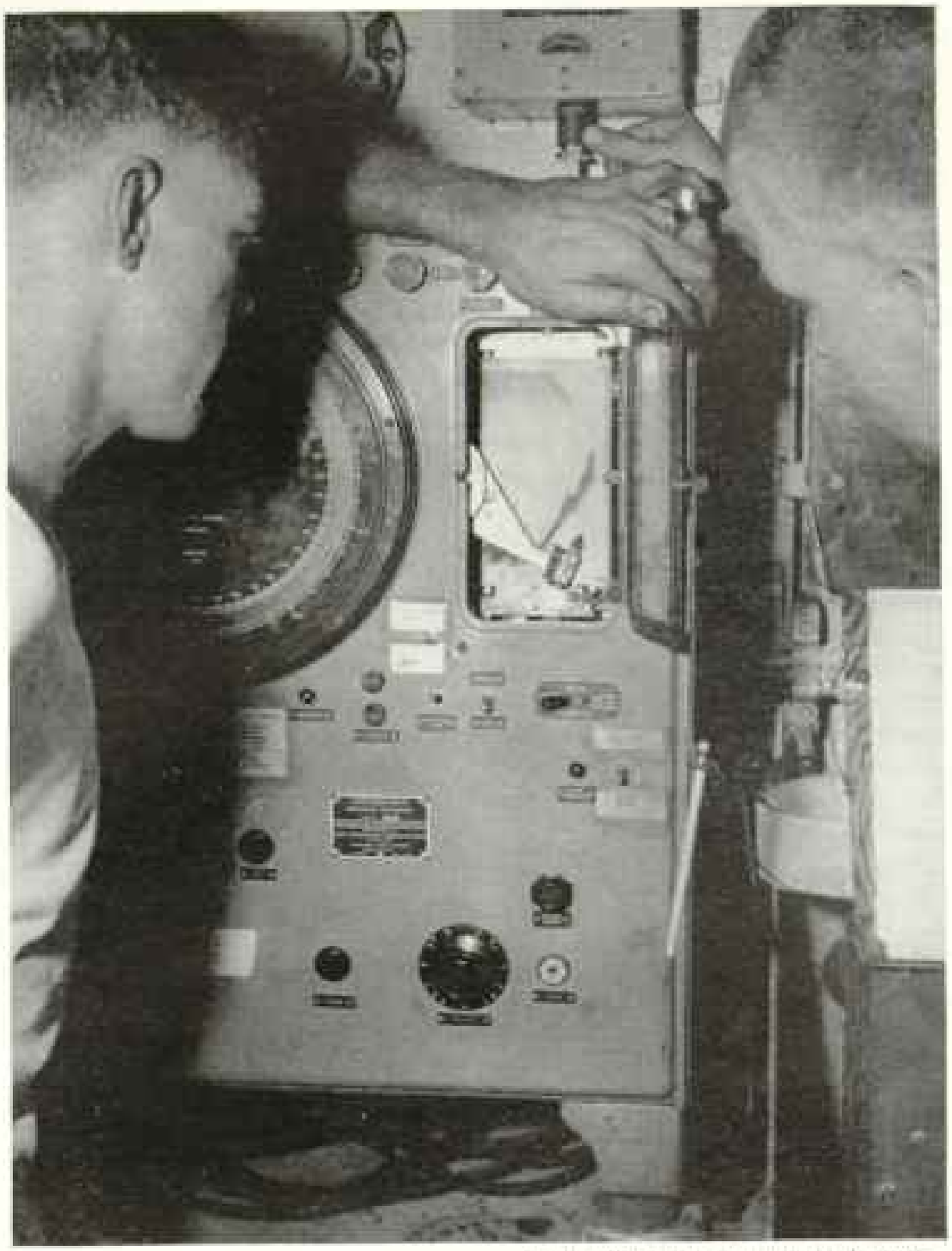
Always it had been thought the sediment must be extremely thick, since it had been accumulating for countless ages, like snow in Arctic areas. But on the level basins that flank the Mid-Atlantic Ridge our signals reflected from the bottom mud and from bedrock came back too close together to measure the time between them. These echoes are complicated, but we think we are reading them correctly and that they show the sediment in the basins is less than 100 feet thick!

* See "Our Global Ocean—Last and Vast Frontier," by F. Barrows Colton, National Geographic Magazine, January, 1945.

Sediments seem to be thin, too, on the upper highlands of the Mid-Atlantic Ridge. But on the flanks of the Ridge, its terraces and foothills, are layers of sediment in some places thousands of feet thick, as was expected. Perhaps submarine currents have swept it off the highlands down upon the lower areas, but this would not explain the absence of thick sediment on the level plains. Here is another of the many scientific riddles our expedition propounded.

Heading east we hove to occasionally to make flashlight photographs of the ocean bottom. At first they were only in black and white, since we wished to perfect our technique before trying undersea color photography.

Camera and flashlight are attached to a pole and lowered on a wire. When the pole hits bottom, a trigger opens the shutter and sets off the flash. At the same time a small coring tube on the end of the pole scoops up a sample of the bottom that has been photographed.



Don Fay, Woods Hole Oceanographic Institution

Mile-deep Mountain Reveals Itself on the Fathometer

On a moving strip of paper under the man's hand, the stylus traces the steep profile of a submarine peak over which the ship was sailing when the picture was taken. The fathometer measures depth by the time it takes for a high-pitched sound to echo back from the ocean bottom. As each echo returns it causes the moving stylus to pass a spark through the paper at a point corresponding to the distance the echo has traveled upward. Such profiles of the Atlantic's floor now cover 60,000 miles (page 614).

We also dragged the bottom with the Blake trawl, bringing up a brilliant red starfish of a new species, many sponges, two dozen fiddler crabs in their shells, and small rocks (page 623). The rocks were coated with bryozoans, tiny tuftlike "sea mats" or "moss animals" with minute tentacles for gathering food, and serpulas, or worms that build little tubelike houses out of calcium that they extract from the water.

East of the Grand Banks we explored Flemish Cap, a mountain that rises to within only 500 feet of the ocean surface. We dragged our rock dredge up its eastern slope, but caught only a few small baseball-size rocks and sponges.

Submerged Peak of the Appalachians?

Our tests with sound waves sent through the bedrock showed that it is very near the surface on the Cap, indicating that this is not just a hill of sediment but a real mountain of rock, and suggesting that the Appalachian Mountain system may extend at least this far out under the North Atlantic, perhaps even all the way across.

Life on *Atlantis* by now had settled into the normal routine of long hours of work and too little sleep (page 625). As Bob Sisson said, "The only way we knew it was Sunday was that the cook served turkey for dinner!"

What little sleep we did get was broken by the hourly explosions of the bottom-sediment measurements and the roar of the big winch lowering or raising a coring tube or dredge. Below decks the winch sounded like a whole squadron of B-29's passing low overhead!

Beards sprouted, and a stream of salt water from a hose on deck provided the only chance for baths. One strict rule was that shirts must be worn at table. Though we had to eat in shifts, meals were regular and ample. There were always cheese, sausage, bread, and coffee ready in the galley for the men on night watches.

Now and then a gang off watch would gather below to sing old chanteys to the accompaniment of Captain Lane's accordion.

We washed our own clothes with strictly rationed fresh water, and almost always the rigging was decorated with odds and ends of underwear, T-shirts, and towels hung up to dry.

Ship Stopped to Bake Bread

Sometimes we had to heave to to let the cook bake bread. When the ship was under way in heavy weather, her steady pounding against the waves would prevent his bread from rising, but not his temper!

Crossing the Ridge, we drew a detailed profile of its peaks with our fathometer. Flanking the central highlands we found deep trenches separating the main Ridge from the lower terraces on either side. These trenches drop down to depths of more than two miles, while the central peaks of the main Ridge are approximately one mile under water.

We found similar trenches when we again crossed the Ridge farther south, but do not yet know whether they run its entire length.

These trenches may mark the locations of the great faults that undoubtedly extend somewhere through or near the Mid-Atlantic Ridge and which are the sources of many submarine earthquakes that center there.

In these ditches and in other deep places we lowered thermometers to get the temperature of the water far down in them, a clue to whether they are canyons or enclosed basins. If basins, the water would be comparatively warm, because the cold water of the ocean bottom could not flow into a basin entirely surrounded by walls.

Turning south, we cruised along the eastern flank of the Ridge, with our fathometer drawing a picture of terraces between two and three miles deep under our keel.

Farther along, in a depth of 3,600 feet (600 fathoms), we found rocks that tell an interesting story about the past history of the Atlantic Ocean. We photographed some on the bottom that were over a foot in diameter, and those we brought up in the dredge proved to be granite and sedimentary rocks of types which originally must have been part of a continent.

Most of the rocks that we dredged up here were rounded and marked with deep scratches, or striations. This was a good indication that they had been brought out here by ice, for it showed that they had been dragged over other rocks while in the grip of the glaciers on land. But we also found some loosely consolidated mud stones, so soft and weak they would not have held together in the iron grasp of a glacier. How they got out here is another riddle to be solved by further research.

Crossing the Ridge again to the westward, we stopped to make one of our frequent measurements of the speed of sound through the basement rock beneath the sea bottom, to see if it was basalt or granite.

In these tests the *Atlantis* served as a listening post for explosions set off from the whaleboat, which sailed off about 12 miles. A beam from the ship's radar, reflected off a target in the boat, gave an accurate measure of the distance. When the boat's crew set off TNT charges in the water, the sound traveled down through the bottom sediment, horizontally through the bedrock, and up through the sediment again to the ship's hydrophone.

Uncharted "Sea Mount" Found

As we sailed toward the Azores, our fathometer revealed an uncharted "sea mount" on the bottom, about half a mile below the surface. Near by we lowered our coring tube again in a depth of 8,000 feet on the Ridge itself and brought up a core 28 feet long. It contained many layers of volcanic ash, probably from eruptions in the near-by Azores.

Running south parallel to the Ridge, we crossed the Hirondelle Deep on the Azores platform, the base of the islands, where our fathometer showed a great hole dropping down to 1,809 fathoms, as if a volcano had caved in there at some time in the past.

As we neared Ponta Delgada on the island of São Miguel, the ridges and valleys 100 to 300 fathoms beneath us seemed almost to duplicate the terrain above water on the island ahead (page 628). Going ashore we stood dryshod on one of the few points where

Kodachrome by Robert F. Sisson

From Two Miles Deep a "Corer" Brings Up Mud Telling of the Sea's Ancient Past

Expedition members swing aboard a 40-foot coring tube containing a cross section of age-old Atlantic bottom sediments. Weight on the end drives tube into the ocean bed. This one was bent by striking a hard layer.

Kodachrome by Robert F. Sisson

Swords into Plowshares: Surplus Navy TNT Is Loaded on *Atlantis* at Woods Hole for Exploring the Sea Floor with Sound Waves

When small blasts were set off in the water, echoes indicated the bottom sediments varied from 100 to thousands of feet thick. Larger 55-pound charges were exploded some 20 miles from the ship in refraction experiments. The sound went down to the bedrock, traveled horizontally through it, and finally came up to the hydrophone. From studies made of measurements of the sound speed through the basement rock, geologists infer that this part of the Atlantic Basin may never have been a continent.

◂ Has the Camera Hit Bottom? Slack in Wire Will Tell

Dr. Maurice Ewing, expedition leader, holds a piece of pipe against the taut cable on which the underwater camera is being lowered to the ocean bed. When it touches, he will feel a release of tension.

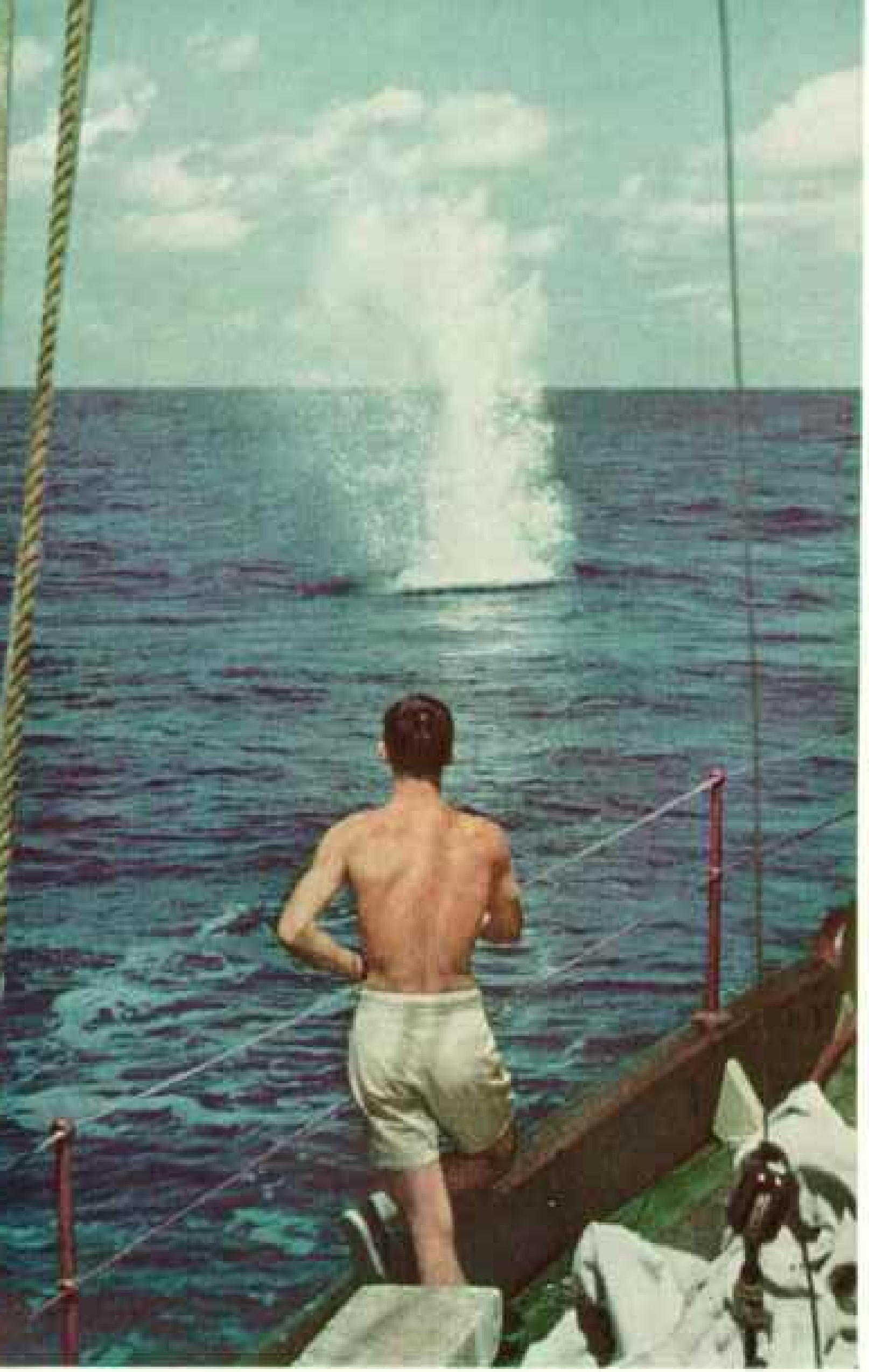
To take successful photographs of fish on the vast reaches of the ocean's bottom is as difficult as going into a large field blindfolded and trying to snap pictures of birds in flight. Nevertheless, the sea floor is so completely unknown that every photograph taken to date has given information of considerable scientific interest.

Sea's Transparency Is ▸ Measured with Colored Disks

Depth at which a Secchi disk remains visible is an indication of minute plant and animal life living in the ocean. When tiny marine organisms, called plankton, are numerous, water is less transparent.

In general, water rich in plankton looks green, while a scarcity causes it to appear blue. The Sargasso Sea has less plankton than any other region of the North Atlantic. It was here that maximum water transparency of 217 feet was recorded.

Reduction by Robert P. Bloom



Explosions of TNT Probe Deep Below Old Ocean's Bed

Behind the ship (left) a half-pound charge sends up a geyser of water. Some of the sound waves from it echo back off the bottom, while others penetrate to bedrock before returning. Difference in arrival time of the two echoes shows the thickness of the bottom sediment.

Paul Camp (upper right) holds the electrical leads on a delayed-action release of the time bomb used to measure the speed of sound to the bedrock under the sea. An inexpensive pocket watch activates the release. The whole mechanism is floated by the toy balloons.

A cigarette lights the fuse of a TNT charge (lower right). When it is thrown into the water, the whistle is blown to warn the seismologist to start his recording device.

Kodachromes by Robert F. Sisson

Davy Jones's Locker Yields Some Secrets: Bottom Mud Dug Out with a Coring Tube, and Creatures from the Depths

Like toothpaste, a core of sediment is pushed from the tube that bored it out of the sea floor and placed in a protective plastic wrapping. Mud seen here is soft, but most of the core stays hard as it emerges. Biologist Hutchins (right) sorts a deep-sea trawl catch of starfish, sponges, and mollusks.

Kodachromes by Robert F. Sisson

Kodachrome by Robert F. Bloom

What Queer Fish Has the Trawl Caught Now? Scientists Watch the Net Break Surface

A 30-foot mesh bag, its mouth held open by a metal frame, the Blake trawl was dragged along the sea bottom to catch creatures living at depths of two to three miles. It sometimes also brought up rocks.

▲ **Storm and Dark Don't Dampen Curiosity About Secrets of the Sea**

Wearing oilskins in a night rain, Dr. John Lucke and Dr. Ewing hold a bathythermograph which they will lower on the small winch at right to measure temperature and pressure in the upper 300 feet of the ocean. Routine work went on around the clock.

▼ **Tensely They Watch for Wire to Slacken, Showing Trawl Is on Bottom**

Dr. Ewing and Dr. Louis Hutchins, right, scrutinize the arrow on the gauge indicating strain on the cable that lowers the Blake trawl. When the strain eases, it shows the trawl is on the sea floor ready for towing. Cable passes over the wheel at left.

Kodachrome by Robert F. Sisson

White Houses of Ribeira Grande, Azores, Stretch Back from the Sea to Checkerboard Fields Climbing the Hilltops

Dunes separate the town from the smooth, curving beach. It is the largest settlement on the north coast of São Miguel Island, where the expedition touched. The Azores, of volcanic origin, are one of the few places where the mountains of the Mid-Atlantic Ridge rise above the surface of the sea.

Spray and Big Seas Tempt "Shutterbug" John Lucke Despite Rolling Decks

From a secure perch in the whaleboat, one of the expedition's amateur cameramen tries for photographs of *Atlantis's* bow bucking into big rollers. Here she is running under shortened sail in heavy weather, with her jib and mainsail furled (just visible at the upper right). Her "jumbo," or staysail, and mizzen are set.

Bad storms sometimes forced the ship to heave to until the wind abated. Sails were blown out by squalls and had to be repaired at sea.

Atlantis, research vessel of the Woods Hole Oceanographic Institution, is a 146-foot steel-hulled ketch. She travels primarily under sail, giving her a wide cruising range.

Kodachrome by Robert F. Sisson

Pastel-hued Ponta Delgada, Set Between Green Hills and Blue Sea, Is a Lovely Backdrop for *Atlantis's* Flag

At this leading city of the Azores, on the island of São Miguel, the expedition paused for fuel and supplies. Breakwater at the left forms a quiet, safe harbor where an Allied naval base was established in World War II. Cultivated fields march high up on the steep mountain slopes behind the city.

Where Lava Once Seethed Now Nestles the Town of Furnas in This Extinct Crater on São Miguel Island

Kodachrome by Robert F. Sisson

Twin Lakes of Hourglass Shape Fill an Azores Volcanic Crater Where Legend Says Seven Cities Once Stood

"Who's Your Dentist?" One Might Ask

Healthy teeth reinforce the friendly grin of this São Miguel workman. He wears an island-made straw hat with characteristic chin cord.

Shyness Yields to a Tasty Sandwich

Dark eyes dance as this little Azorian Portuguese girl trades a bashful smile in return for some of the photographer's lunch.

Kodachromes by Robert F. Sisson

Kodachromes by Robert F. Sisson

A Wheeled Pole Makes Carrying Papa's Lunch Easier . . . Fields Take Every Usable Inch Even on Steep Slopes

Azorian ingenuity developed this unique method of helping transport a basket too heavy for one boy. Checkerboard pattern on the hill is created by neat rows of tea plants. Tea is one of the leading exports of the Azores, and pineapples are widely grown in hothouses.

"All Together Lads, and Up She Comes!" Portuguese Fishermen Drag a Boat from the Water After a Day's Work at Sea

Small craft like these at Rabo de Peixe row offshore from the Azores to fish with nets and hooks. Long oars are stacked at the left.

Past Banks of Hydrangeas, Mule Carts Haul Produce on an Azores Coastal Road

Hedges of the massive blooms line the roads with a pastel of colors in summer on São Miguel Island. Hydrangeas, the floral wonder of the Azores, are at their best from July to September on nearly all the islands, growing to a height of 10 to 20 feet. Roses, camellias, lilies, and begonias also bloom abundantly.

the Mid-Atlantic Ridge actually reaches above the level of the sea.*

After weeks with almost no word from home, all hands avidly devoured the big stack of mail courteously brought to us at the dock by U. S. Consul Clifton R. Wharton.

Also on hand to greet us was José, the local barber, who had done a land-office business when we touched here the year before. But this time everyone had fresh haircuts given on board the *Atlantis* by seaman Otto Salberg; and poor José got not a single customer.

While the ship took on fuel oil, water, and other stores, some of us tried the Portuguese version of a banana split at an "American" soda fountain, while others satisfied their craving for fresh fruit by consuming Azorian apples, pineapples, grapes, and bananas.

Shore Interlude Enjoyed

A few of the crowd moved into the local hotel to enjoy hot baths and a brief respite from the crowded, noisy sleeping accommodations on the *Atlantis*. Most of us toured the island to enjoy its rugged mountain scenery and get acquainted with the hospitable, friendly people who made us welcome everywhere (pages 631, 632, and 633).

Volcanic eruptions built the Azores above the sea (page 629), just as similar eruptions have undoubtedly created many of the underwater peaks of the Mid-Atlantic Ridge that we had charted.

One volcano at Furnas, on the eastern end of São Miguel, is still active enough to produce numerous hot springs in its crater, the site of a health resort where people come to drink and bathe in the sulphurous waters. In the crater of another volcano are two lovely lakes, one green, the other blue, though they are separated by only a few yards of land (page 630).

While we were at Ponta Delgada, one of the Western Union's transatlantic telegraph cables broke just off the Azores. Later the company inquired whether we were operating in the vicinity at the time, suspecting perhaps that one of our coring or dredging operations might have caused the break. But since *Atlantis* was tied up at the dock when the break occurred, we were able to plead not guilty.

As we sailed on westward from the Azores, the probing finger of our fathometer found two more new sea mounts rising from a depth of about a mile and a half to within 1,200 and 3,600 feet below the surface; then we passed over a gently sloping area of the bottom about 1,800 fathoms deep, interrupted by low mountains.

Next day we zigzagged back over the Azores platform, a submarine elevation a mile and a half deep on which the islands stand. This platform is covered with thick sediment, the first place we had found where there was such a thick layer on the highlands of the Ridge, where usually the sediment is thin.

Passing off the platform and out over the deeper basin, which plunges down to 1,800 fathoms again, we made a photograph of the ocean bed. It shows mud penetrated with small holes, queer little trails apparently left by something moving along the bottom, and mounds two or three inches wide. What made them is a mystery.

We took our first deepsea color photographs on top of a sea mount discovered the year before and on its flanks in 900 to 2,400 feet of water. One showed ripples in the bottom sand which must have been made by underwater currents, though no one had believed that currents reach to depths as great as this.

Other photographs showed many of the mysterious objects known as "sea biscuits," round pieces of rock several inches in diameter, one-half to one inch thick, and concave like a saucer on one side. Later our dredge brought up two large hauls of sea biscuits for further study.

None of our pictures happened to catch starfish, clams, and other forms of life usually found at this depth, but we hope another time to send down bait or light lures with the camera to attract sea creatures into range. We proved at least that color photography in the deep sea is possible, and in the future will be a valuable tool for exploring the ocean depths.†

Small Rock a Valuable Find

Lowering our dredge, we tried to drag it up the steep side wall of the mountain to scoop up rocks. It stuck fast, but after much maneuvering, somewhat like playing a fish on the end of a mile-long line, it came loose, bringing up only a single three-inch rock freshly broken off the cliff.

This small rock proved a valuable find. Its structure indicated that this sea mount is an ancient volcano that once may have stood above the sea, since its original peak has been

* See, in the National Geographic Magazine: "New Map of the Atlantic Ocean," by Leo A. Borah and Wellman Chamberlin, September, 1941; "European Outpost: The Azores," by Harriet Chalmers Adams, January, 1935; and "American Airmen in the Azores," 10 ills. in color, February, 1946.

† See, in the National Geographic Magazine, by William Beebe: "Half Mile Down," December, 1934; "Wonderer Under Sea," December, 1932; and "Depths of the Sea," January, 1932.

eroded down to the flat top it has today. The rock contains many fossils which may enable us to determine the geologic period during which the peak was eroded.

But now bad luck overtook us. Hoping to scrape up more rocks from the mountainside, we lowered the dredge once more. Again it stuck fast, and this time all the captain's efforts to dislodge it failed. There was nothing to do but break loose by main strength.

All hands were ordered off the decks and below, for if the wire should break near its upper end its terrific backlash could easily kill or badly maim anyone it struck. Then the brakes on the winch drum were set tight, and the order was given for full speed ahead. Since the wire parted far down near its lower end, there was no backlash, but we lost a dredge and a specimen of submarine rock that we wanted badly.

More bad luck dogged our course. We wanted to sail farther to the southwest to explore again another section of the Ridge that we studied in detail the previous year, but adverse winds kept us from it.

For three days we crossed and recrossed the Ridge, tracing its profile with our fathometer, gathering samples of the bottom, and stopping now and then to take underwater photographs. Some of the pictures showed what looked like "burrows" and "anthills" in the bottom mud, so far unexplained.

For 12 days then we sailed westward, across the terraces on the west side of the Ridge and out over the vast flat plain that extends three miles deep and 300 miles wide all the way to the Bermuda Rise.

All along this route we probed into the bottom with our coring tube, to learn more of the ancient history of this great basin.

Bottom Sampling Tricky Business

Pushing a 40-foot tube down into the mud three miles below you, without being able to see what you are doing, is a tricky business. Though it is lowered on the end of a steel wire, the tube must fall freely just before touching bottom, to insure that the weights on the upper end push it well down into the mud.

To accomplish this, a trigger hangs several feet below the end of the tube. When it touches bottom, it releases a clamp holding the coring tube to the wire and permits it to fall freely.

On our previous voyage, friction on the inside of the coring tubes sometimes prevented sediment from being pushed all the way up inside. This time we rigged a piston which was pulled up within as the tube penetrated the mud, creating a suction that helped overcome friction.

On the Bermuda Rise, the great undersea platform on which the islands stand, we found sediments up to 7,000 feet thick, in contrast with the thin layers on the bottom of the deep basins on either side of it. This sediment extends southwest to the Bahamas. Why this part of the Atlantic's bed is covered with such thick sediment is a geological riddle.

Hurricane Threatens Off Bermuda

This same day the radio brought us news of a hurricane off Bermuda that might catch us before we could get home. But we risked stopping once more to take a core sample on the edge of the lower continental shelf almost opposite the point where we later charted the underwater continuation of the Hudson Valley (page 614).

Deep down in this core was a four-foot section of layers of mud and clay of sharply contrasting colors—red, green, cream, and black. Probably some ancient submarine landslide mixed up the strata to form this variegated color pattern. We wondered if it could have had any connection with the Hudson's underwater canyon.

The hurricane veered out to sea and crossed our track just a day behind us as we sailed into Woods Hole to unload our specimens, recondition equipment, and restock the ship.

Four weeks later *Atlantis* was again at sea, heading this time for a new hunting ground farther south on the Ridge. As I was unable to make this second cruise, Mr. Bruce Heezen, one of my graduate student assistants at Columbia, a veteran of our two previous voyages, headed the scientific staff this time.

For a solid week *Atlantis* sailed southeastward across the great plain on the sea floor, almost unbelievably flat and level at a depth that seldom varied much from 2,600 fathoms (almost three miles), and sloping down to a maximum depth of 2,900 fathoms.

Much floating vegetation was sighted, for the ship was now passing through the famous Sargasso Sea, named for the sargassum, or gulfweed, which is assumed to be torn loose from the bottom in coastal areas of the Atlantic and drifts to this part of the ocean (page 621). Here it multiplies, and is found in an area of about two million square miles. Tiny air bladders keep the weed afloat. I have never seen it forming continuous masses which could in any way impede the progress of a ship.*

But this good luck did not last. As one of

* See "Sindbads of Science," by George Finlay Simmons, NATIONAL GEOGRAPHIC MAGAZINE, July, 1927.

the mates expressed it, "Oh, the miseries of the sea!" First, a resistor on the big winch burned out. This meant that every time the coring tube was lowered it might not be possible to haul it back on board. Heezen radioed for another to be forwarded by air to the Cape Verde Islands, *Atlantis's* next port of call.

Another day the mainsail was badly torn by the wind so that it could not be used, putting a severe crimp in the vessel's motive power.

Then a valuable undersea camera was lost because the winch operator did not hear the lookout sing out "Hold it!" when the camera broke the surface after being hauled up at high speed from 2,250 fathoms. With the winch still running fast, the camera rig was pulled up hard against the pulley before anyone could stop it, the wire broke, and the camera plunged back into the sea. The backlash of the broken wire cut a deep gash in the winch operator's shoulder.

"Peek-a-boo" Bonnet Is Like Old-fashioned Coal Hod

Now seen only occasionally in the Azores is the long, dark *capote e capello*, which shrouds women from head to ankles. Young moderns scorn it, but a few older women still wear it to Mass. The costume is a relic of the Middle Ages. In Portugal, the Azores' mother country, it has disappeared.

Ship Crosses Another "Plain"

Sailing on toward the Cape Verdes on the eastern side of the Ridge, *Atlantis* crossed again for many days over another plain. It was as flat and level as the one on the western side and at almost exactly the same depth, though more hills and small ridges were scattered over it.

The bottom rose to 1,800 fathoms as *Atlantis* came over the Cape Verdes platform and headed into Porto Grande, on São Vicente Island. This was once an important coaling station, but it has fallen into decay since ships began burning oil. The city lies in the former crater of an ancient volcano that once blew its top off. Like the Azores, the Cape Verdes are volcanic islands, but they are 1,200 miles east of the Mid-Atlantic Ridge and have no connection with it.

In contrast to the rich green of the Azores, the arid Cape Verdes are brown and bare. As the ship stood in toward the harbor, it was easy to see where the streams run down the barren mountainsides by the ribbons of green that outlined their courses. Small patches of land are irrigated from wells worked by windmills, and some land is watered by rain from the cloud cap that almost continuously shrouds the top of Monte Verde.

It was a surprise to find anchored in the harbor the historic old schooner *Effie M. Morrissey*, which carried the late Capt. Robert A. Bartlett on his many adventurous voyages to the Arctic.*

* For articles by Captain Bartlett, see the NATIONAL GEOGRAPHIC MAGAZINE for July, 1929; July, 1940; May, 1946.

Today the *Morrissey* is that modern rarity, a sailing packet, a passenger vessel operating under sail only, with her engines removed. She plies back and forth across the Atlantic carrying Portuguese-Americans at low fares to revisit their homeland. Some of our people visited aboard and found the sturdy old vessel as spotless and shipshape as ever she was when "Cap'n Bob" sailed her into the northern ice packs.

Delay dogged the expedition here. There was no pump to transfer fuel oil, and each drum had to be hoisted aboard and emptied by hand into the *Atlantis's* tanks.

Meanwhile, the badly needed resistor for the winch had been flown as far as Dakar. But no plane was available to bring it to the Cape Verdes, so there was no choice but to go and get it. Eastbound, the fathometer showed that the 40-fathom platform on which São Vicente stands drops off suddenly to a steep slope down to 1,400 fathoms, and then to a 2,000-fathom dish-shaped basin between the Cape Verdes and the gentle rise in the bottom that marks the continental shelf of Africa.

In the very bottom of this basin the fathometer traced two strange trenches about two miles wide but only 360 feet deep. The party found them again farther south as the ship passed over the basin going west and wondered if they could be submerged river valleys like the Hudson trench.

South of the Cape Verdes, after leaving Dakar, the fathometer traced another new sea mount, a volcanic peak that rises a mile high above the bottom around it, which is 12,000 feet deep. From there the bottom sloped gradually down to 18,000 feet (three and one-half miles), before climbing again toward the Ridge.

On the Home Stretch

Sailing west toward the Ridge again, on the home stretch in fine weather, the ship's company had no inkling of what fate had in store for them. South of the Cape Verdes the *Atlantis* was hove to and the coring tube lowered in 2,900 fathoms.

Without warning, when the tube was almost on the bottom, the wire broke only a few feet from where the men were watching it pay out over the ship's side. They had a narrow escape from serious injury, as the broken end whipped back wickedly. Down to Davy Jones's locker went two and a half miles of irreplaceable wire! That was the end of probing the bottom with the 40-foot corer.

As the ship passed into the foothills on the eastern slope of the Ridge, the mainsail, weakened after being torn on the eastward trip, tore away again on the lower side. The captain decided not to try to repair it, though circumstances soon were to force the crew to fix it after all.

A new kind of underwater contour showed up on the fathometer here as *Atlantis* crossed the Ridge 1,000 miles farther south than we had explored it before. On the east side the terraces typical of the northern part of the Ridge were missing, and the Ridge itself was narrower and stood lower, well over a mile below the surface. On the west side the usual terraces were found, but with sharper rises and depressions than farther north.

All again seemed well as *Atlantis* sailed on over the great plain of the Atlantic's western basin, when seaman Fred Kent suddenly became ill with pain in his abdomen so severe that he could not eat or sleep. The ship carried no doctor, and with the engine at full speed a course was set for Barbados, three days away, the nearest point where the sick man could get medical attention.

More Trouble!

Still more trouble was on the way. Early next evening, without warning, a loud thud sounded throughout the ship, followed by the noise of the engine racing. The propeller had come loose from the shaft and was useless just at the time it was needed most!

There was no choice except to make the best speed possible under sail; but the mainsail was still unrepaired, and with only mizzen and headsails available *Atlantis* could only limp along at about four knots.

Kent became delirious, and the captain had to keep dosing him with morphine to relieve his pain. Early next morning the propeller fell off and sank. The U. S. Public Health Service radioed that arrangements were being made for a doctor to meet the ship in Bridgetown, Barbados.

All day two of our veteran seamen worked feverishly to repair the mainsail. Then that night the mizzen sail ripped! With only the headsails remaining, the ship made but two or three knots most of the time. At last the repairs on the mainsail were finished, it was set, and *Atlantis* picked up speed.

Routine scientific work went on, but of course no stops could be made to use the camera or dredge. A British tanker out of Bridgetown radioed an offer to take Kent into Barbados, but by the time she came into sight the sea was too rough for a safe transfer.

At last the ship reached Barbados, and the sick man was taken to the Bridgetown hospital where he stayed until he was able to fly home.

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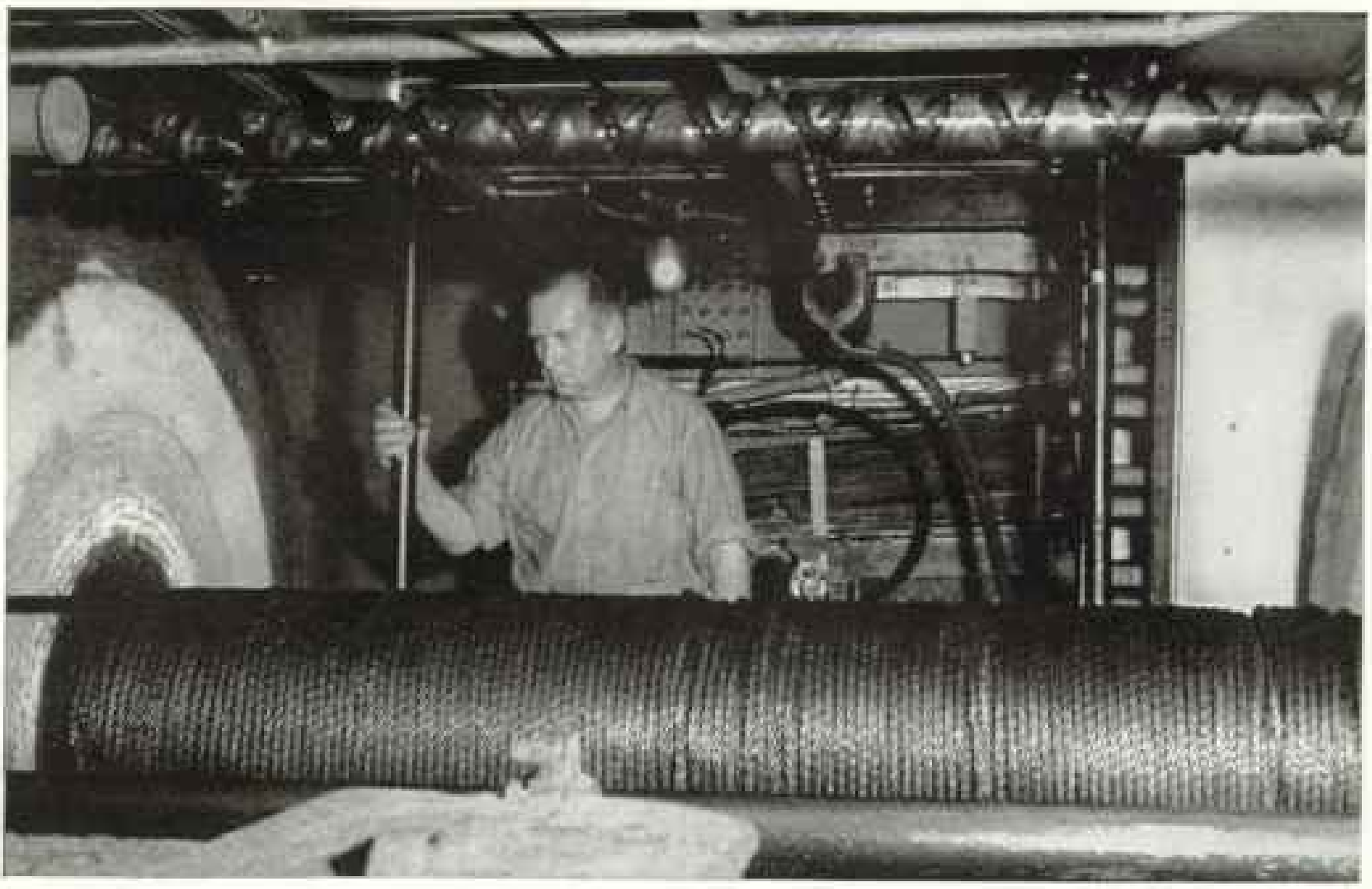
"Dat Ole Davil, Sea!" In a Rising Storm the Trawl Net Comes Up Fouled and Empty

Crewmen lean over *Atlantis*'s rail to untangle the 30-foot mesh bag from the metal framework that forms its mouth. The Blake trawl was dragged along the bottom to capture deep-sea creatures (page 615). On being lowered, it fouled because it was not towed fast enough to keep the bag streaming out behind.



Four Miles of Cable Wound on This Drum Lowered Corers and Dredges to Sea Floor

Assistant engineer Hans Cook has paid out 20,000 feet of the half-inch steel wire, leaving only 2,000 still on the winch in *Atlantis's* hold. Keeping the wire taut prevents its kinking. Two and a half miles of wire were lost when it broke at a point probably weakened by rust (page 638). No spare was carried because of the high cost. When the winch was running, electrical resistors in the control mechanism heated the room as high as 140° F.

Approaching Barbados, the fathometer showed that the bottom 100 miles east of the island climbs very suddenly and sharply from the three-mile level plain, as abruptly as the Rocky Mountains rise out of the Great Plains of our Middle West.

Off under full sail, on the homeward tack at last, *Atlantis* traveled for a while over the Barbados Island platform, about 1,500 feet deep; then as she passed off the edge the bottom dropped very suddenly again to nearly two miles, and more gradually to three.

East of the island of Antigua the bottom sank down to form a narrow trench 3,050 fathoms (three and a half miles) deep. Next day it dropped to 3,500 fathoms (four miles), in a very broad trench, the greatest depth found on this cruise, probably an extension of the Brownson Deep, which begins at Milwaukee Depth, greatest depth in the Atlantic Ocean. Then it rose again sharply to a level plain about three miles deep.

One day a squall suddenly caught the ship with all sail set. First Mate Arvid Karlson expertly threw the helm hard over just in time to "spill wind" out of the sails and relieve the strain on the much-mended mainsail. It held for the moment, but next day another blow ripped it beyond hope of repair.

Christmas was now only a week away, but *Atlantis*, crippled without her mainsail and propeller, made exasperatingly slow progress toward home. Some of the boys, fearing she might not get there in time, built up a little holiday spirit by decorating the laboratory with spare toy balloons, tin cans, old photographic flashlight bulbs, and other colorful odds and ends.

But "dat ole davil, sea" was not going to let them off without one more lick. Two days out from home the worst storm of the entire cruise hit the ship. A hatch cover was blown off, all sail was furled, and the *Atlantis* was hove to to ride out the blow. The barometer jumped up and down so fast that it seemed as if someone were trying to pump all the air out of the ship.

Then, to top it off, when the storm passed they found themselves becalmed with no wind at all!

But finally the sea showed mercy. A new strong breeze sprang up, and *Atlantis* sailed into port at last, just three days before Christmas.

The Pink Birds of Texas

By Paul A. Zahl

With Illustrations from Photographs by the Author

AT THE DROP of the smallest hat, almost every Texan will sing loud and long praises of his State's cattle, its rice and cotton, its oil and industry, its orchards, skies, coasts, and lands.

There is, however, one natural treasure possessed by Texas, almost alone among the States, about which few of its proud citizens have any knowledge—the roseate spoonbill. This avian treasure lies in the virtual shadow of oil derricks, within sight of tank barges and steamers. It is one that exists in the common domain of the Nation's natural wonders.

To comprehend this spectacular coup of Nature, one must distill the pink from a Texas sunrise and pour the essence over a mass of soft feathers. The feathers must be delicately molded into the shape of a bird about the height of a wild turkey, but more slender.

Before releasing the creation to travel through air and sky like a patch of flame, one should add a droll head from which extends a grotesque spoon-shaped beak (page 643). These components blended, there emerges the roseate spoonbill (*Ajaia ajaja*), found today in secret abundance along the Gulf littoral of Texas, and in more scattered rarity in Louisiana and Florida.

Lost in Quest of the Roseate Spoonbill

It was in quest of this incredible bird that John H. Baker, president of the National Audubon Society, two of its staff, George Burrows and Nick Schexnayder, and the writer found themselves on the evening of June 8, 1948, squirming on the horns of a real Texas dilemma.

We had set out from Houston early that morning, and by nightfall were west of Galveston. In the prescribed channel there was ample depth to accommodate the 20-inch draft of our Chris-Craft cruiser; but on either side were dangerous shoals and uncertain shallows. Dusk had fallen and was rapidly being replaced by darkness.

We were desperately seeking a chart-designated tributary channel which would lead us into deep and sheltered waters where we could safely anchor for the night. But we were unable to find the channel markers indicated on the chart. We dared not cast anchor in the main channel for fear of barge traffic, and we dared not venture out on either side for fear of shoals.

To make matters worse, the bulb in our overhead searchlight suddenly burned out.

Finally a small schooner came within call. We hailed it. With native skipper and family aboard, this outfit should certainly know these waters.

"Where's the channel into the harbor?" we called, to be answered immediately by a confident "Follow us."

Gratefully we fell behind, and in the now-sullen darkness inched along, careful to follow every turn of the schooner. Still no harbor. At last the skipper of the schooner announced, "I'm lost."

At this embarrassing moment the lights of a shrimper hove into view, coming from the opposite direction. The schooner was soon hailing it, and we could hear voices raised in the darkness. Shortly the schooner—and we in turn—were following the shrimper; but before long the leader of this nighttime parade came to a halt.

"We're lost, too," the shrimper captain shouted to his followers.

Said the skipper of the schooner, "We're anchoring here till morning."

With similarly abrupt and impatient finality, Schexnayder, our pilot, made for the nearest buoy and anchored alongside. Bars to the left of us, shoals to the right! Invoking heaven for salvation from barges, we turned uneasily into our bunks.

Good Luck Follows Bad

Such was the beginning of our spoonbill adventure, but with the episode of our first night out we had apparently used up our full quota of bad luck. Beginning next morning, and in succeeding days, the expedition moved with the smoothness of a Hollywood script.

My compulsion on this trip was to see the fabulous spoonbill in its natural habitat. The Audubon people were out to survey the efficacy of their sanctuary system for water birds of the Gulf coast. As of 1948, how were the birds withstanding the oil operations, the canal dredgings, the fishing for too much by too many? Was the maintenance of guardian wardens at island hide-outs during the breeding and hatching season paying conservation dividends?

Earlier that first day we had drawn up a quarter of a mile off Vingtune Islands, which, quiet and low, lie in the tawny waters of his-

toric Galveston Bay, less than 40 miles from Houston's towering skyscrapers and metropolitan bustle.

We were peering through our binoculars when the vegetation suddenly burst into pink flame as a mass of spoonbills left their foliage-hidden nests and erupted into the sky.

The initial burst of spoonbills was quickly diluted by the joining-in of vast numbers of other bird species which were circling the shoal. Heightening the contrast of the spoonbills' roseate color were multitudes of snow-white egrets, black-and-white ibis, skimmers, and several species of slate-hued herons.

Perhaps sensing that we had come as friends rather than foes, most of the birds soon settled and disappeared into the shrubbery. Others not so trusting glided down on distant but still visible shallows, where, alert and anxious, they watched and waited. Folding its wings in landing, each spoonbill seemed to draw a candle snuffer over itself and dim its brilliant flame.

With skilled speed the Audubon observers studied every move through their glasses, counting and recording the number of adults and the number of immatures. From such figures would result fairly accurate estimates of the avian population, the probable number of nests, and the season's rate of reproduction.

Species Coming Back from Near Extinction

Here on this island, not far off the shores of Galveston Bay, we had seen evidence of the miraculous rehabilitation from virtual extinction of one of America's most glamorous birds.

This fact was made more dramatic by other sights down the bay. Dozens of oil rigs dotted the distant horizon, and several derricks stood there geared for active drilling. Gas vents from some of the wells burned with a color only weakly competitive with that of the spoonbills. Both avian and oil activities seemed to proceed with mutual unconcern.

As long as the drillers do not pollute the bay with oil and salt waste, as long as their personnel does not trespass on or too near the bird islands, as long as there is no shooting—the spoonbills pay little attention to man's reaching below the surface of the water for black treasure.

But let any of these conditions be violated, and the spoonbills will quickly abandon nests, eggs, and young. All they demand is privacy for their connubial activities.

An effective truce between man and bird did not always exist. There is evidence that before 1850 the whole coastal area from the Rio Grande to Florida was alive with untold thousands of flocking spoonbills.

The great encounter developed as American civilization commenced its southwestward march. It is perhaps understandable why, with their own physical survival at stake, the pioneer and early settler shot for needed food any bird that came within gunsight.

Later, even though the need for such food had long since vanished, slaughter of birds increased, stimulated mainly by demand for plumage. By 1900 the spoonbill had become an American rarity. There were no known breeding colonies in Texas in 1919, virtually none in Florida. However, in the remote lagoons of Mexico and Cuba the spoonbill clung to life. Occasionally a few members of the declining species would venture back to the islands of the Gulf coast and attempt nesting, but with little success.

Audubon Society Sanctuaries Successful

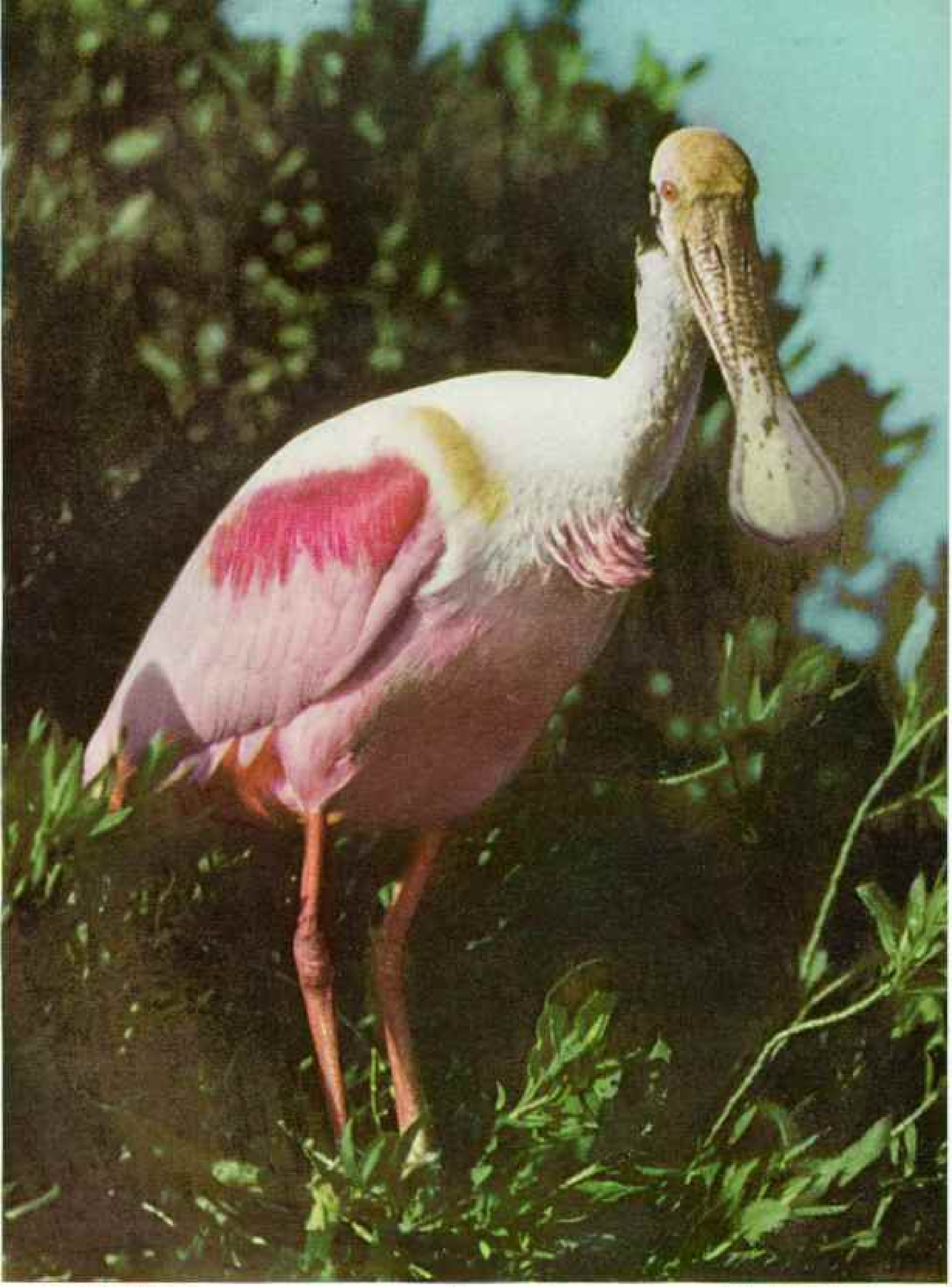
Beginning in 1931, and extensively since 1936, several island groups along the Texas coast known to harbor spoonbills were set aside by the National Audubon Society as sanctuaries and thoroughly patrolled during the nesting months of March through August. By 1941 the spoonbill population of the Texas littoral had miraculously jumped to thousands.

As a result of direct educational efforts, people living in the neighborhood of the important islands developed local pride in "their" birds. Oil companies became increasingly aware of the good-will value of wildlife conservation in their drilling areas. Local nature groups became active in promoting bird protection for both economic and esthetic reasons.

The principle of truce was practicable; and the roseate spoonbill was saved to adorn Texas skies, saved to help maintain the biological balance between air and water fauna.

Our cruiser lay only a few hours off the Vingtune Islands in Galveston Bay. We did not go ashore, for nothing can be more disastrous than the blistering heat of noonday which beats down on eggs and young when parent birds are frightened from their nests and into flight.

Swinging the bow of our boat southward, we proceeded down the bay, past Texas City, through Galveston Harbor. It was west of Galveston that our charts had proved unavailing and we had spent the night humbly anchored by a buoy. But next morning bright and early we were off again, speeding southwestward on the Intracoastal Waterway. Our intention was to visit, or at least to reconnoiter, every principal bird island along the coast from Galveston to Laguna Madre, south of Corpus Christi, an area teeming with all manner of water birds.



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Roseate Spoonbills Are Back with Gorgeous Plumage and Faces Only a Spoonbill Could Love

After virtually disappearing for nearly 50 years, these rare birds have returned to the Gulf coast. Hundreds of them now congregate each spring and summer in colorful nesting colonies on oyster-shell islands off the Texas shore.

Kodachrome by Paul A. Zahl

Baby Spoonbill Literally Jumps Down Its Parent's Throat To Get Its Breakfast

Concealed in a blind about 7 a. m., the author caught this week-old nestling taking a meal of predigested and regurgitated food. The adults' diet consists of top minnows, aquatic insects, and shrimp and other crustaceans.

Kodachromes by Paul A. Zahl

From Splotched Egg and Awkward Nestling the Spoonbill Grows Up To Be a Beau Brummell

The eggs, slightly smaller than those of a chicken, hatch in about three weeks. Until ready to fly, the young are dependent on father and mother, much alike in looks, who take turns at nest building, brooding, and feeding.

Atop Island Trees above Their Brooding Mates, Two Spoonbills Keep Lookout, Ready To Take a Turn on the Nest or Go in Search of Food

Spread Pinions Reveal the Rich Color of Spoonbill Under Feathers

At the right, this bird had just landed on the branch, where she flapped and fluttered before attaining balance. Reacting to a gust of wind (left), she readjusted her position, using a wing as balancer much as a tightrope walker uses his pole.

When she flies, she stretches her neck out to its full length and extends her long legs behind. She ascends occasionally to great heights and circles in somewhat the manner of hawks.

As for vocal ability, the spoonbill's only accomplishment on breeding grounds is a low, grunting croak, virtually inaudible except at close range.

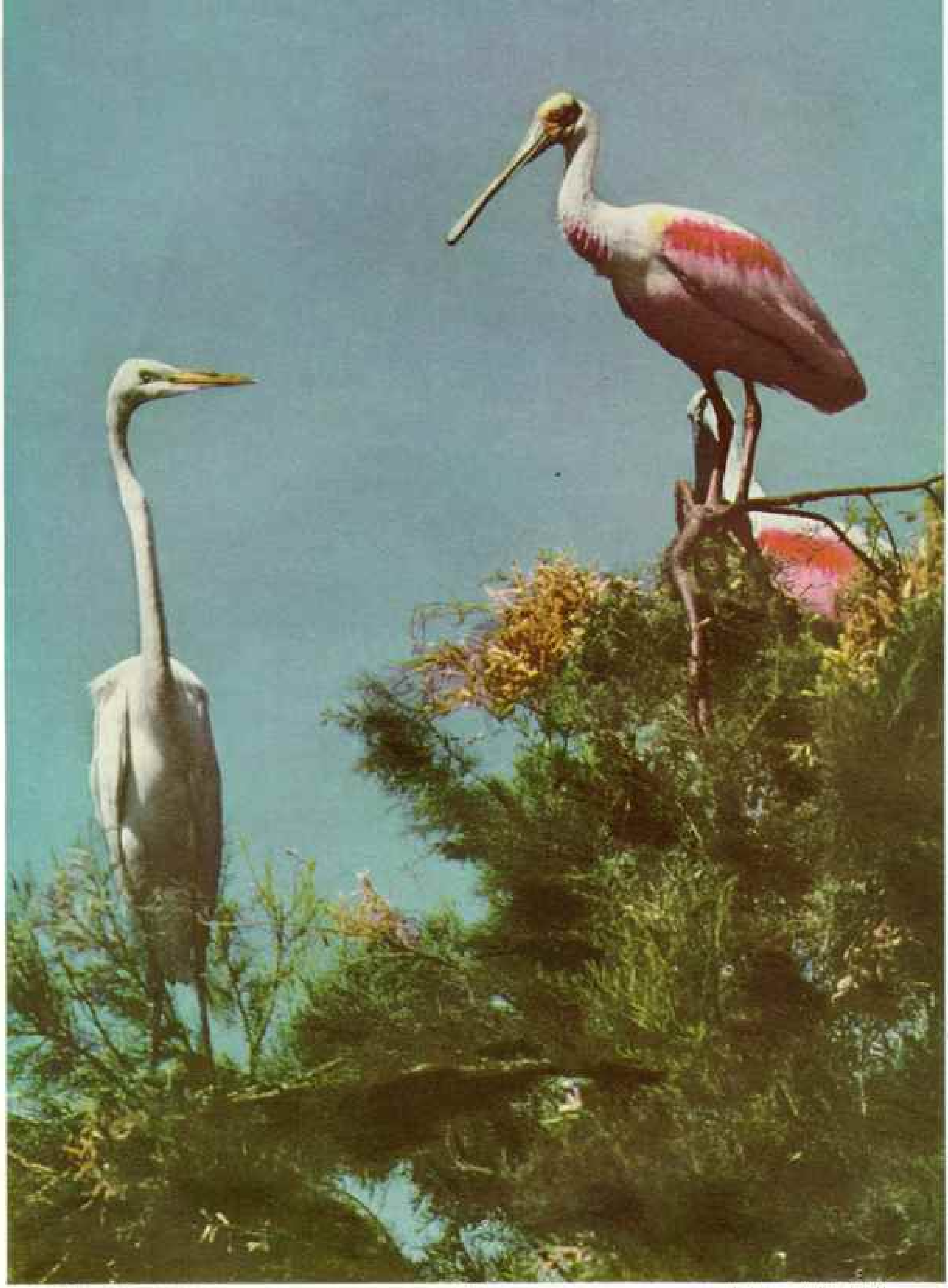
Roseate spoonbills range from the Gulf coast of the United States to Argentina and Chile. Once abundant in southern Florida, their numbers have been much depleted and the birds today are extremely rare.

Kodachromes by Paul A. Zahl

Kodachromes by Paul A. Zahl

Only During Breeding Season Do Spoonbills Associate in Large Groups

The top photograph shows adult birds wading in food-rich shallows somewhere in Galveston Bay. They accomplish their feeding by swinging their spoon-shaped bills from side to side, the while drawing in small fish and other water fauna. The two lower pictures show landing and take-off sequences.



Kodachrome by Paul A. Zahl

Nesting Side by Side with the Spoonbills Are Egrets (Left), Ibises, and Other Water Birds

Although a territorial possessiveness frequently asserts itself in squawkings and peckings, these dissimilar species apparently like one another's company. The two shown are not eyeing each other as the position of their heads seems to suggest, but rather the blind in which the author was concealed.

↑ Spoonbills Leap Down Hurriedly upon Their Foliage-covered Nests

To leave eggs exposed, especially in midday heat, can spell disaster. Lest he frighten the birds off their nests when the sun was on them, the author took his pictures in the morning or late afternoon.

↑ A White Ibis Contemplates a Handsome Neighbor Brooding a Family

For hours the spoonbill parent, either mother or father, will crouch over the nest as the bird at the left is doing, its hovering wings acting as a sunshade for the newly hatched young.

In the days that followed we found islands white with egrets, others covered with lumbering brown pelicans, some alive with skimmers, gulls, and terns. But the islands to stir one's avian dreams we found in what is known as the Second Chain, separating Mesquite and San Antonio Bays. It was on this Second Chain of Islands that some years earlier Robert Porter Allen had made many of his now-classic observations on the biology of the spoonbill.

It was over these islands, relatively remote from human visitation, that James J. Carroll, late of Houston, willed that his ashes be dropped from a plane. Carroll was among the first Texans to realize the danger of the spoonbill's extinction and the importance of its protection. His interest in conservation led to the naming and establishment of Carroll Island as one of Texas's great bird sanctuaries. The island, happily isolated, and alive with a fantasy of breeding birds, is today a dynamic monument to a distinguished conservationist.

Breeding Place of the White Pelican

Again we did not tarry long. There were many more islands to visit, long distances to travel. In succeeding days we went as far south as South Bird Island in Laguna Madre, the only breeding locale of the stately white pelican in the southern United States. We did not stop even there for more than half a day before turning northward again.

It was in the midst of wild Buccaneer Days celebrations that we docked at Corpus Christi. After many days of sloshing about in marshes or plodding on barren wastes, a reassociation with urban life and the experience of a fresh-water shower were welcome indeed.

Here, too, the formal aspects of the expedition were scheduled to conclude. My Audubon companions were due at their Kerrville, Texas, nature camp. But for me the expedition was just beginning. My plans called for a revisit to both the Vingtune and Second Chain of Islands, and, with the able assistance of Andrew Nowak, a more careful and intimate study of the spoonbills there.

After one refreshing day at Corpus Christi, we proceeded north by car as far as Tivoli, then to Hopper's Landing where rendezvous was made with the late P. O. Davenport, Audubon warden. Aboard the Audubon Society's converted shrimper, the *Pelican* (page 654), and in company with Mr. and Mrs. Davenport and their son, we were soon chugging out into the bay, heading again for the Second Chain of Islands.

We passed the night hauled up alongside a mud bank just east of the great Aransas National Wildlife Refuge of the Federal Government. Here 47,261 acres administered by the Fish and Wildlife Service of the U. S. Department of the Interior serve as a haven for wintering ducks and geese, for the few surviving whooping cranes, one of the rarest of North American birds, and for resident deer and turkeys.

From aboard our boat that evening, lying somewhere between the Aransas marshes on the mainland and the islands out in the bay, we watched an almost continuous stream of spoonbills, egrets, cormorants, ibis, etc., swiftly and quietly making their way from the feeding ponds of the refuge back to their island homes.

Next day we proceeded to Carroll Island. As we waded ashore from where the skiff was grounded, I was momentarily less aware of the clouds of birds flying overhead than of the words of mainland natives who had warned me to be wary of rattlesnakes. There was the caution that rattlesnakes, during a good blow, are washed in large numbers off more barren cays and onto the foliaged bird islands.

It was explained, to add to my comfort, that rattlesnakes, after being so dislodged, swim majestically forward, head above the surface like a periscope, looking for the nearest shore onto which to slither. But despite such unpleasant recollections, I quickly concluded that snakes wouldn't have a chance on any island occupied by aggressive and sharp-beaked herons and egrets!

Birds Little Frightened by Visitors

Many of the spoonbills left their nests as we splashed ashore and, like those of the Vingtune Islands, settled in adjacent shallows. Slowly we walked around the periphery of the shoal, which was about 200 yards long and 50 across, tapering sharply at one end.

At maximum altitude the island was not more than four or five feet above water level. The egrets, being less timorous than the spoonbills, had not risen in flight; instead, their long serpentine necks stood erect and snowy all over the island, like pickets of a white fence (page 649).

Along the shore, hard by the water's edge, great numbers of young white ibis watched in frozen attention. From a distance it was not easy to recognize them as ibis, for in the adolescent stage this species is dusky, contrasting sharply with the white adult. These young were old enough to have left their nests and were sitting or standing on the shore, apparently feeding on whatever they

could find in the gently lapping waters.

As we approached, they eddied noisily into the air, followed instantly by such adults as were still brooding on near-by nests; soon ibisian multitudes were riotously circling above. The portion of the island occupied by the white ibis seemed to be delimited from that occupied by the spoonbills, although egrets and herons were mixed among them all.

Second only to the spoonbills, the white ibis impressed me as the most spectacular birds on the island, especially when in full flight. With long, red down-curved beaks thrust forward, the brilliant whiteness of a flying ibis is broken only by the flickering of black-feathered wing tips.

Their nests were deep in ground brush and tules, and we were scarcely aware of their tremendous number until, as we approached, they stormed up en masse like great coveys of mountain quail. Reddish egrets also joined the flying squadrons, followed almost immediately by several hundred skimmers. These last, ternlike, were nesting in a myriad of little sand depressions on an exposed shoulder of the island.

By this time we had reached the far end of the shoal. We turned and, crouching motionless half out of view, studied the activities of the spoonbills which had settled in the shallows. One by one they began to return to their respective nests.

Landing of a Spoonbill a Marvel of Grace

If the take-off of a spoonbill is an act of beauty, one is all but wordless in describing the reverse picture. With up-tipped wings revealing the intense pink of body and underwing feathers, the female catches hold of branch structures above the nest; then flaps and flutters for a time until balance is attained (page 647).

If the wind is considerable, she must constantly readjust her position, using her graceful pinions to balance, much as the tightrope walker does his pole. Finally, after looking about a bit to be sure the environment is secure, she steps and flutters down to her nest and, lowering herself upon eggs or young, disappears from view.

Courtship in this colorful species begins in early spring and is almost as exotic as the bird's appearance itself. Spoonbills returning from a winter of dispersion usually begin to congregate on specific islands in April.

During this preconnubial period one may observe some very interesting exhibitions of mass behavior. Sometimes a wading group, quite undisturbed by outside influences, will burst skyward in unison, circle for a while, and then settle again (page 648). Sometimes all the individuals of a wading group, again in seeming mechanical unison, will point their beaks skyward and gaze rigidly into space for long periods. When the hypnosis suddenly breaks, the birds lower their heads and proceed with normal feeding activities.

It is during this period of odd mass behavior that pairing occurs, accompanied by elaborate stick play between the sexes. Male and female are almost identical in external appearance; it is only by their actions that the observer may distinguish between them.

Mating Follows a Period of Coquetting

When the crucial period of her physiological development has arrived, the female finds a perch in some area of the island suitable for nest building. She establishes herself securely atop a bush in the chosen nest area. Then by vigorously shaking twigs held tightly between her mandibles she announces to interested parties that she is approaching connubial susceptibility.

An equally susceptible male responds by flying excitedly at her and trying with much wing flutter to get a foothold close to her, the while plunging his head in an odd jerking movement. If the female does not beat him away from her perch, betrothal is established.

After this episode the two birds keep constant company, and often may stand in strange quietude side by side with heads buried in back feathers. Soon nest construction begins; the male brings in twigs, and the female fabricates them into a nest whorl. If during this period an interloping male approaches the female or tries to interrupt nest-building activities, he is summarily driven off by the spouse.

As nest building nears completion, the male becomes more amorous in his behavior toward the female; but for a time yet she may resist his advances. Finally, on some instinctual impulse, she perches herself on the nest with a strong twig grasped in her mouth.

As she crouches, the male seizes the same twig from behind, and they both hold on to it. At length the twig is dropped, and the male clamps on to the narrow part of the female's beak with his mandibles. Mating then occurs, and is repeated during ensuing days.

Eggs begin to appear in the nest within a week. The male and female alternate in brooding, and after an incubation period of about 23 days the young—usually two or three to the nest—are hatched.

Naked little pink creatures at first, the

Baby Roseate Spoonbills Belie Their Name: They're White, Not Pink

The author found this trio of hot and hungry three-week-old spoonbills on one of the Second Chain of Islands, Texas. They were huddled in a nest of twigs only a foot above ground. At this age young birds develop a fluffy white coat of down which later turns pink. The elaborate plumage of adulthood is not attained until a spoonbill is three years old.

young soon develop a fluffy white coat of down, which, as they begin stilting about the nest to test their leg and wing muscles, slowly becomes faintly pink (page 645).

A little later the youngsters tumble about the bush tops with equally unfledged egrets, herons, and ibis. When the colony is disturbed and adults take flight, the young crawl deep into the brush to positions of relative safety.

During the whole nesting period the adults bring in food, mostly minnows, shrimp, prawn, insects, etc. The young help themselves by thrusting their blunt beaks into the parent's mouth for prediglested and regurgitated nourishment (page 644).

Toward the end of the summer, when the young have learned to fly and forage for themselves, the congregation begins to break up. Singly or in small groups the birds scatter over the marshlands of the Gulf coast.

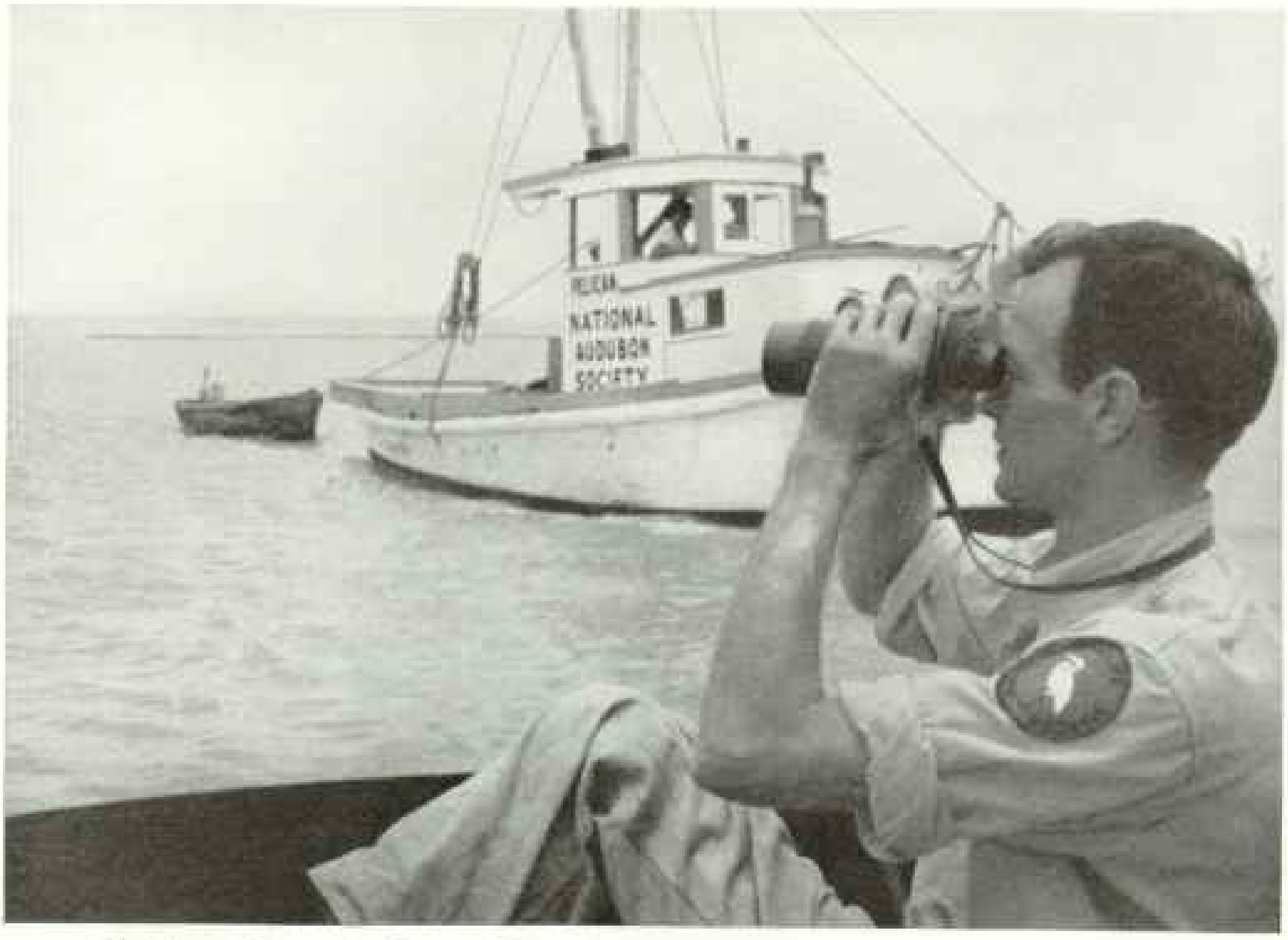
Three full molts over a period of as many years result at last in the magnificent plumage of adulthood. A dripping epaulet of crimson has developed on each shoulder; tail feathers are splashed with yellow and orange. The rest of the plumage displays more delicate hues of pink. Adults molt partially both before and after the breeding period, new feathers being always a little more brilliant than the older ones.

In this glorious dress the adults, together with the less-colorful nonbreeding adolescents, return each spring to their island homes in Galveston and San Antonio Bays.

Oil Pollution Being Reduced Rapidly

Although it may seem that in Texas the principle of maintaining guard over the spoonbill islands during the breeding season has completely justified itself, not all factors harmful to the spoonbill are under control. For example, one hears voices raised by local bird-minded Texans against oil pollution of the lagoon waters.

Passing within a few miles of the bird is-



Cruising Along the Texas Coast, He Spots Spoonbills in San Antonio Bay

Thirty years ago plume hunters had virtually wiped out these rare birds in the United States, but today, largely because of the work of conservationists, there are several thousand spoonbills in Texas alone. George Burrows, above, of the National Audubon Society, accompanied the author on his tour of bird sanctuaries during the summer nesting months.

lands is the Intracoastal Waterway, a dredged channel used mainly by oil barges which are pushed by powerful tugs from oil-field pipeline head to refinery. Ever so often oily bilge water must be pumped from the bottoms of these barges. If this is done in the open, the petroleum scum is washed ashore to blacken white beaches; some sours and in time sinks to the shallow bottom. Thus, surface, bottom, and shore organisms alike suffer, and consequently the birds that depend on these organisms for food also suffer.

In fairness to the oil interests, it must be said that most companies have seen the long-range folly of such pollution and have taken independent action to correct the situation.

Other threats to the spoonbill fall into the class of natural hazards—parasites, storms, unseasonably chilly weather, etc. But against these the spoonbill seems to have been adequately equipped by Nature. It is man-made hazards against which the spoonbill has little protection. Against these the conservationists have directed their principal energies; and with remarkable success.

That is the Texas spoonbill. The fate of the spoonbill in Florida is another story. Although many nonbreeding immature spoonbills visit Florida each spring and summer, few adult birds seem inclined to nest. The immature visitors migrate from parts unknown, probably Cuba or other Caribbean islands.

Through the years the National Audubon Society, in collaboration with the Fish and Wildlife Service, has guarded the nesting sites of the roseate spoonbill in Florida Bay. Although the number of nests has increased somewhat, the total still remains far from satisfactory.

In Texas, however, for the moment all seems to be well with the pink birds. We did not stay on the islands longer than necessary to make our observations and take photographs. We left with the hope that we could tell an adequate story of how Texas's *rara avis* had been snatched from the brink of extinction by the simple formula of seeing to it that during the breeding season the roseate spoonbill is accorded a reasonable degree of privacy.

Jungle Journey to the World's Highest Waterfall

By Ruth Robertson

With Illustrations from Photographs by the Author

SPURTING from a cliff more than half a mile high in the jungle fastnesses of eastern Venezuela is Angel Falls, world's highest waterfall, 15 times higher than Niagara Falls or, by another yardstick, more than twice the height of the Empire State Building. Its first drop is 2,648 feet; its total 3,212.

I saw it the first time from the co-pilot's seat of an old unconverted C–47 just two years ago as we flew over this weirdly beautiful high jungle between the Orinoco and Amazon Rivers.* On that flight to Auyán-tepui, so-called Devil Mountain, I shot more than a dozen Kodachromes in the dead-end Angel Falls canyon.

As we flew over the dense jungle floor of the canyon, I resolved someday to enter that canyon valley on foot to get photographs from the base of Angel Falls and to determine its exact height.

A "Lost World"

From almost impenetrable jungle rear mesas like mighty fortresses a mile to two miles high, their sides and flat tops eroded into queer shapes.

This part of Venezuela suggests the setting of Sir Arthur Conan Doyle's *Lost World*, of W. H. Hudson's *Green Mansions*, of L. R. Dennison's *Devil Mountain*, and some of those tag names still stick to the area. But Venezuelans and the pilots who fly south of the Orinoco on their jungle runs call it simply the Gran Sabana—great high jungle plains.

Auyán-tepui has been scaled from the south side by the veteran explorer and ornithologist, William H. Phelps, a Caracas businessman, and by his skilled son, Billy Phelps, Jr. Others who have reached the top were members of an expedition from the American Museum of Natural History, New York, and a few hardy individuals.

The aviator Jimmy Angel (page 657) and his wife, Marie, and Gustavo Heny crash-landed in the boulder-strewn swamp on the mesa top in 1937. None, however, reached Angel Falls from the top or through the Churún canyon almost a mile below.

Thousands of years of erosion have dug out huge crevices and fissures over the flat surface of the giant mesa of Auyán-tepui, making it impossible to travel far. These deep crevices serve as a catchall for heavy rain.

At one point this water bursts out a few feet below the canyon rim into a waterfall of such proportions that it is no wonder Jimmy Angel was astounded when he first saw the falls which now bear his name. That was in 1935.

Not until the autumn of 1948 was the problem of how to get into the canyon solved. I met Alejandro Laime, a Latvian who had been roving around the Gran Sabana for several years. He offered to act as guide to the falls.

Later a talk with bush pilot Sam Fales brought the suggestion that Laime take Indians into the jungle to the north end of the giant mountain and clear one of the little savannas near there as a suitable landing place for a small plane. In that way, we hoped, we could cut out tedious weeks of going by *curiara* (dugout) on the rapids-strewn rivers and days of hacking through jungle with machetes.

A DC-3 could take us into Uruyén at the south end of Auyán-tepui, and we could then be shuttled, one or two at a time, to the advanced airstrip. There Laime and the Indians could be waiting for us with enough curiaras to take us into the canyon and to the falls.

Laime went back into the jungle, and this spring we sent him word to get the airstrip cut. April 23, 1949, was set as the date of take-off from Caracas.

Hectic Last Days

The last few days were hectic. There were last-minute conferences with the Venezuelan Government's Minister of Communications about the radio and radioman going with us; there were purchases of cases of dehydrated foods and camping equipment. There was the assembling of waterproofing, jungle hammocks, snakebite kits, first-aid kits, compasses, machetes, rope, ammunition and guns, flashlights—a hundred other things.

* See, in the National Geographic Magazine: "Caracas, Cradle of the Liberator," by Luis Marden, April, 1940; "I Kept House in a Jungle," by Anne Rainey Langley, January, 1939; "Journey by Jungle Rivers to the Home of the Cock-of-the-Rock," November, 1933, and "In Humboldt's Wake," November, 1931, both by Ernest G. Holt; "Through Brazil to the Summit of Mount Roraima," by G. H. H. Tate, November, 1930.

Lacking a Hat, Simón Bolívar Dons a Bird's Nest

The Indians have a lively sense of humor. This old fellow made a fetching creation in imitation of the author's headgear. Among the tribespeople it is customary for any man to take the name of the person he most admires. The great Liberator of South America is honored in this case.

For trading purposes we bought 400 pounds of salt for the salt-hungry Indians, bolts of bright red-flowered yard goods, string sandals, combs, mirrors, fishhooks, fishing line, rice, and black beans.

The Take-off from Caracas

Lt. Col. Frank P. Bender, air attaché of the U. S. Embassy, agreed to fly us to Uruyén, take-off spot for other expeditions.

On the appointed morning I arose at 3:45, dressed quickly in slacks and flannel shirt, and carried all my camera gear downstairs to wait for the big red truck which had been packed the night before with everything except our cameras and film.

We had an hour-long ride down the mountainside over hair-breadth curves and dark, yawning abysses of the Caracas-Maiquetía road to the airport alongside the Caribbean in the half-light of daybreak.

Waiting were Ernest Knee, movie cameraman from the Princeton Film Center, and Enrique Gómez, radioman from the Venezuelan Ministry of Communications, and beside each was a huge pile of equipment. We were to catch up with our guide and engineer later (page 690).

When all our gear had been transferred to the DC-3, we took off into a sea of clouds which enveloped us until we let down at Ciudad Bolívar on the Orinoco River. We stopped there for gas and for last-minute conferences with the communications men.

There was just time to say hello to Capt. Art Jones, who had flown me to the falls two years before, and to other pilot friends whom I had met on my trips in and out of the Gran Sabana. They promised to keep a lookout for us when they flew the jungle runs. Within a few minutes we were heading south.

We flew along the Río Caroní, raggedy in its silver path across the jungle floor. Dark humps on the landscape were iron deposits, which temporarily pulled the plane's compass toward them.

Around noon we dropped down to the savanna of Uruyén in the Camarata Valley. The airstrip there is just a natural one with sticks as markers topped with rusty oilcans.

As we roared low over the airstrip to look for obstructions, the Indians all through the Camarata Valley heard the plane and came trotting toward the airstrip.

Pulled to one side was a little red and cream Cub Cruiser. Our pilot, John ("Ole") Olson, red-bearded bushman, was waiting.

After a conference Olson took off to fly from this south side of Auyán-tepui to the north side, a matter of about 55 minutes, and look for our Indians and Laime at the new airstrip. He took a load of tinned meats and food for the Indians. Laime and his party had been in the jungle since the first of April, and we knew they must be running short of food.

The rest of us sat under the wing of our plane and ate hard-boiled eggs, sandwiches, and roast venison which the colonel's wife had prepared. Then the DC-3, too, roared down the valley and disappeared around the side of Auyán-tepui, leaving us sitting on our piles of baggage in the middle of the wide, quiet valley. We made ourselves comfortable for what we supposed would be not more than an overnight camp.

From a spot in the Uruyén River above our camp we could see the origin of the Uruyén near the top of Auyán-tepui. There a large waterfall tumbled down from one plateau to another until it finally ran through a group of moriche palms and past the edge of our savanna. Below this spot the water formed a deep pool about 30 feet wide and more than 100 feet long.

It didn't take us long to see the possibilities there. I dug out a bar of Ivory soap and returned to try the pool, but retreated before an armada of *jejenes*, tiny black flies which attacked each patch of exposed skin. In a moment huge welts formed on my arms and legs.

Jimmy Angel Gave His Name to Angel Falls

Almost a legendary figure in Venezuela, he has been flying in and around Central and South America for years looking for a lost river deposit of gold nuggets which he says an old prospector once led him to on a mystery flight. He first saw the world's highest falls in 1935. In 1937 he and his red-haired wife, Marie, and Gustavo Heny landed in a small plane on the boulder-strewn mesa top. They did not, however, reach the cataract itself (page 655).

The next ten days held a series of delays, each threatening the success of the expedition. The transmitter and receiver failed. Our surveyor did not appear. Worst of all, Olson failed to find trace of the advanced airstrip. He spotted Laime and the Indians once on the river in dugouts, and dropped a note in a bamboo reed telling them to point the way to the airstrip and to return there. Laime read the note, stood up in the dugout pointing the direction, then seemingly disappeared.

Meantime, we made acquaintances among the Indians. Sabas Cardona, a young Indian who had learned Spanish from Capt. Felix

Ernest Knee

The Author's Dugout Was Small, Tippy, and Leaky, but Fast

When she ran any rapids, she had to bail constantly with a gourd dipper (page 665). She protected her cameras in the bow with large leaves and covered her film and other equipment with the waterproof top of her jungle hammock. Worst annoyances were the biting flies that raised great welts on her bare arms.

Cardona, member of an earlier expedition to Auyán-tepui, told us Laime had asked him to look after us. Sabas had gone to Caracas with the Captain and lived there several years before returning to his tribe.

One morning Sabas' wife approached with a note from him. After much deciphering, we interpreted it as an invitation to go fishing. The Indians were going to fish with *barbasco*, a plant whose juice is poisonous to fish, and Sabas thought we might enjoy taking pictures.

An Indian Fishing Picnic

Ernie and I gathered up our cameras, took salt and tinned sardines for gifts, and headed toward the Indian huts across the valley. Sabas was waiting with a bundle of barbasco.

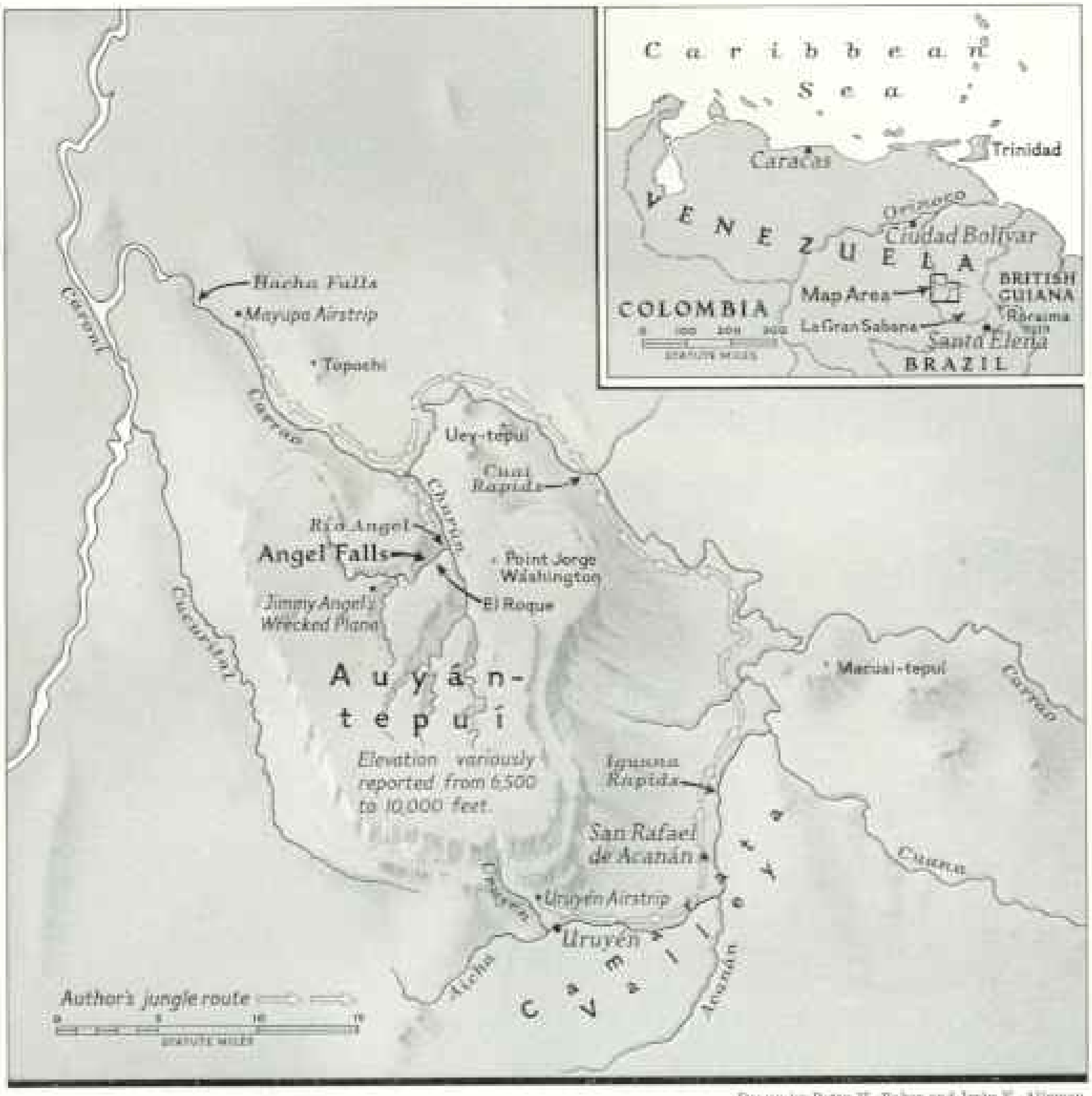
After fording several streams and crossing others on logs, we came to a backwater and joined the other Indians.

Men in red loincloths and women in red under dresses (they wear both outer and under dresses of red) stood in the water, the men with bows and arrows and the women and children with small hand nets. When Sabas passed out the barbasco, the men pounded it until a milky substance flowed through the water. Then everyone from the youngsters on up began to watch the water.

There was a yell when the first fish, minnow-size, floated to the surface. Then yelling and pointing began all around as more and more fish came up (pp. 664, 674, 675, 681).

While the fishing was in progress, an elderly woman started a fire on the bank and dropped into a clay pot of boiling water chunks of fish wrapped in banana leaves. She then dumped in a liberal quantity of hot pepper sauce. We ate the stew with relish, toning down its fieriness with bits of hard cassava bread softened in water. After we had lunched, we presented our gifts and, with Sabas leading the way, headed toward our Uruyén camp.

Sunday, May 1, we awoke with high hopes.



Drawn by Betty H. Baker and Irvin E. Alleman

Here in Jungle Fastnesses of Eastern Venezuela Roars the World's Highest Waterfall

This wild area south of the Orinoco River may be reached by plane to the natural airstrip at Uruyén, but the trip from there overland to the cataract on the north side of Auyán-tepui is a perilous scramble. The author and her party were the first explorers from outside to accomplish the feat (page 655).

The radio was repaired, Perry Lowrey, the engineer, had arrived, and the airstrip had been located by our scout plane.

Flight to the New Airstrip Abandoned

Our hopes were dashed soon after breakfast, however, when we looked toward the Indian hut and saw Alejandro Laime walking toward us! He and his Indians had paddled in during the night. Lacking any further message from us, they had taken it for granted we had turned back.

There was no advantage now in our shuttling up to the new airstrip, for the Indians would have to paddle on back. After a long powwow we decided to scrap the idea of using the advanced airstrip, and to go along with the Indians, provided Laime could induce Alejo Calcaño, their chief, to let them make another trip to the gorge.

Ernie Knee took our newcomer, the surveyor (pages 667, 684, and 690), down to our swimming hole for a dip before dinner. Gómez made contact with Ciudad Bolivar and with Santa Elena and told them we would soon be on the move (page 685).

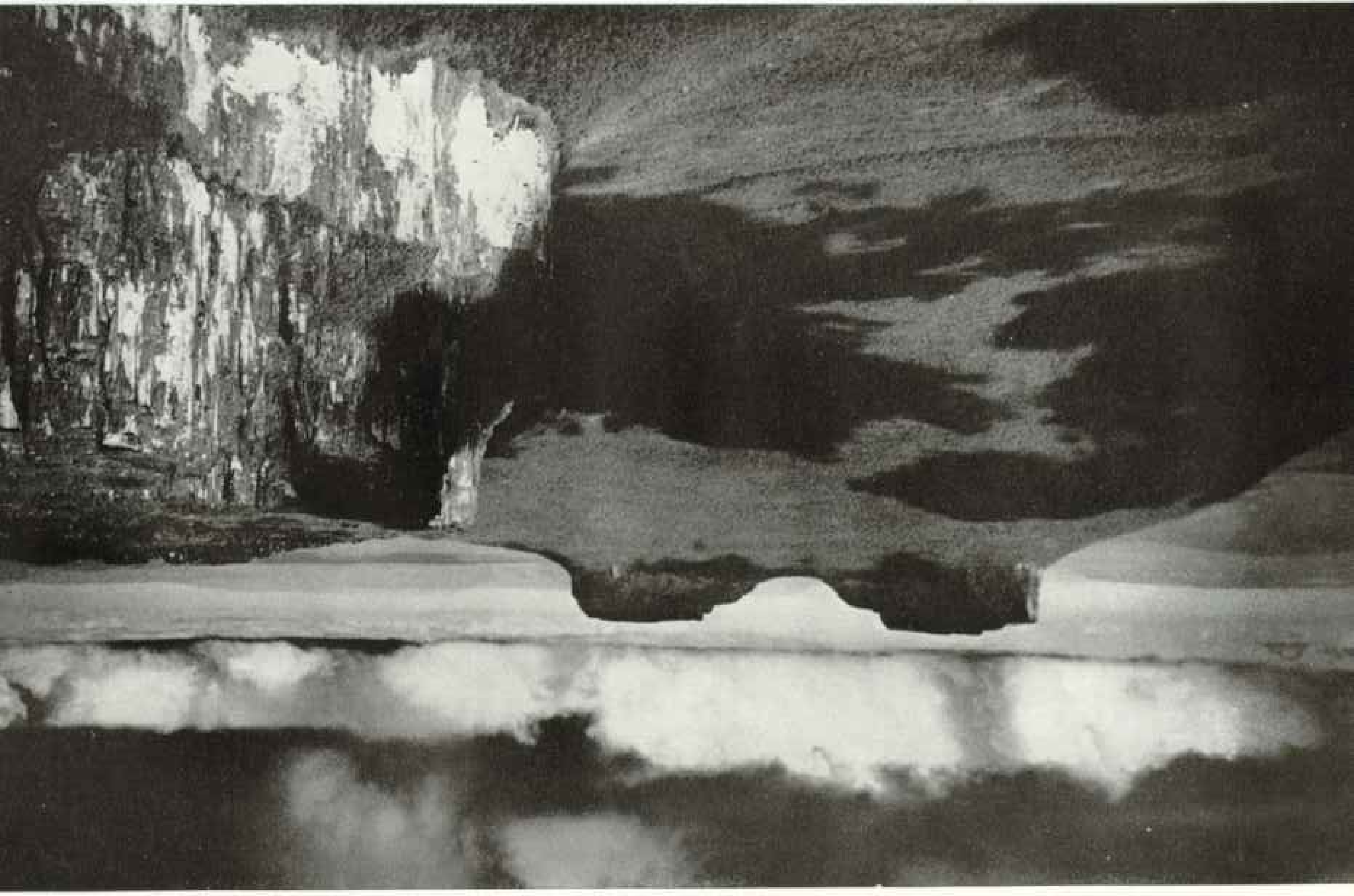
Next morning we packed early, expecting the Indians, but they didn't show up. Laime came back alone from the chief's camp later in the day and told us there was a celebration

In Unbroken White Sheet Water Tumbles More than Half a Mile from a Cleft in the Face of Auyán-tepui

In the canyon at the left of the mountain, Capt. Charlie Baughan's TACA plane, looking like a white speck, emphasizes the tremendous height of Angel Falls. The same plane and pilot searched the area in May, 1949, when the author's expedition went unreported for several days.

From the dense jungles of Venezuela's Gran Sabana region south of the Orinoco River rear mesas like mighty fortresses, a mile to perhaps two miles high, their sides and flat tops eroded into queer shapes (opposite page). This part of Venezuela suggests the setting of Sir Arthur Conan Doyle's *Lost World* and of W. H. Hudson's *Green Mansions* (page 655).

In the right foreground is part of the north end of Auyán-tepui; in the background, Uey-tepui. Around the latter winds the Río Carrao, the stream on which the expedition paddled to the gorge of Auyán-tepui and Angel Falls.



under way for the returning Indians and we would just have to wait it out. We were irked at the delay, but there was nothing we could do.

Over the evening campfire Laime told us about dangers we might encounter on our journey. He cautioned us against getting up at night without first flashing a light on the ground. In the jungle, he said, there were huge tarantulas and an occasional snake. He had seen many hills of *veinticuatros*, large ants, the sting of which causes a 24-hour fever.

On the savannas, he said, there were many tapirs, deer, and other small animals, and he had seen one jaguar. The Indians had reported finding remains of pigs another jaguar had eaten.

Digging Out Fleas

As Laime sat doubled up by our campfire, he was digging out of his feet *niguas*, small burrowing fleas, the females of which had imbedded themselves deep in calloused spots. He first took a razor blade to make an X over the spot; then, with a sharp-pointed stick, he worked around the flea and its attendant egg sack and deftly lifted them out.

Not until noon Tuesday did we get away from Uruyén and start the 10-mile hike toward San Rafael de Acanán, on the Acanán River. The Indians came early in the morning with their families, but simply sat around camp without showing any intention of moving.

Finally, around noon, they got up, packed everything in their backpacks, and started down the trail that led to the jungle. Helping me carry my cameras and equipment was a 9-year-old boy, Jacinto.

The trail led through jungle and savannas. I didn't think we could make it to the Río Acanán in one afternoon, but we finally did. The savannas had many little grass orchids of blue, purple, and pink, and everywhere were little white star grass flowers. At three of the rivers we crossed we paused for five-minute rests (page 672).

Around dusk we walked into the kitchen of the chief of the Camaracotos, Alejo Calcaño, where the fiesta for the returning Indians was still going on (page 686).

Near the river's edge was a large grass-covered square shack, open all around, and large enough to accommodate us all. It was dark by the time we reached there. Our bearers straggled in, one by one.

Since our Indians were not able to bring all our gear in one load, we had to wait at San Rafael de Acanán another day while they went back to Uruyén for the rest.

The next morning we were all up by 5. Now all our gear had to be repacked into the four dugouts on the rocks below San Rafael de Acanán. We helped carry the equipment down, for we were impatient to be on the river and on our way.

Most of the women and children of the Indians going with us had come down to see us off. They gave us pineapples and green bananas, and we gave them combs, towels, anything we could spare, in return. I was happy to see that old Reya, an Indian elder, and little Jacinto were going along with us.

Alejo Calcaño also permitted an Indian woman to go along. She was Juanita, wife of a 16-year-old Indian in our crew (page 665). Sabas told us she had had three husbands before this one.

The dugouts were filled to the brim with our equipment, cartons of food, canteens, fresh pineapples, bananas, insect repellent, cameras, bows and arrows, fishing tackle, and huge rounds of cassava bread. Besides that, the Indians brought several chunks of fried pork tied on strings and hung over the sides.

At last we stepped gingerly into what small space was left for us, and shoved off the rocks. There were shouted good-byes and hand-waving until we turned a bend in the Acanán.

We were finally on our way to Angel Falls —not the way we planned to go, but definitely headed in the right direction, and moving. There were five of us and ten of the Indians —15 in all, counting little Jacinto.

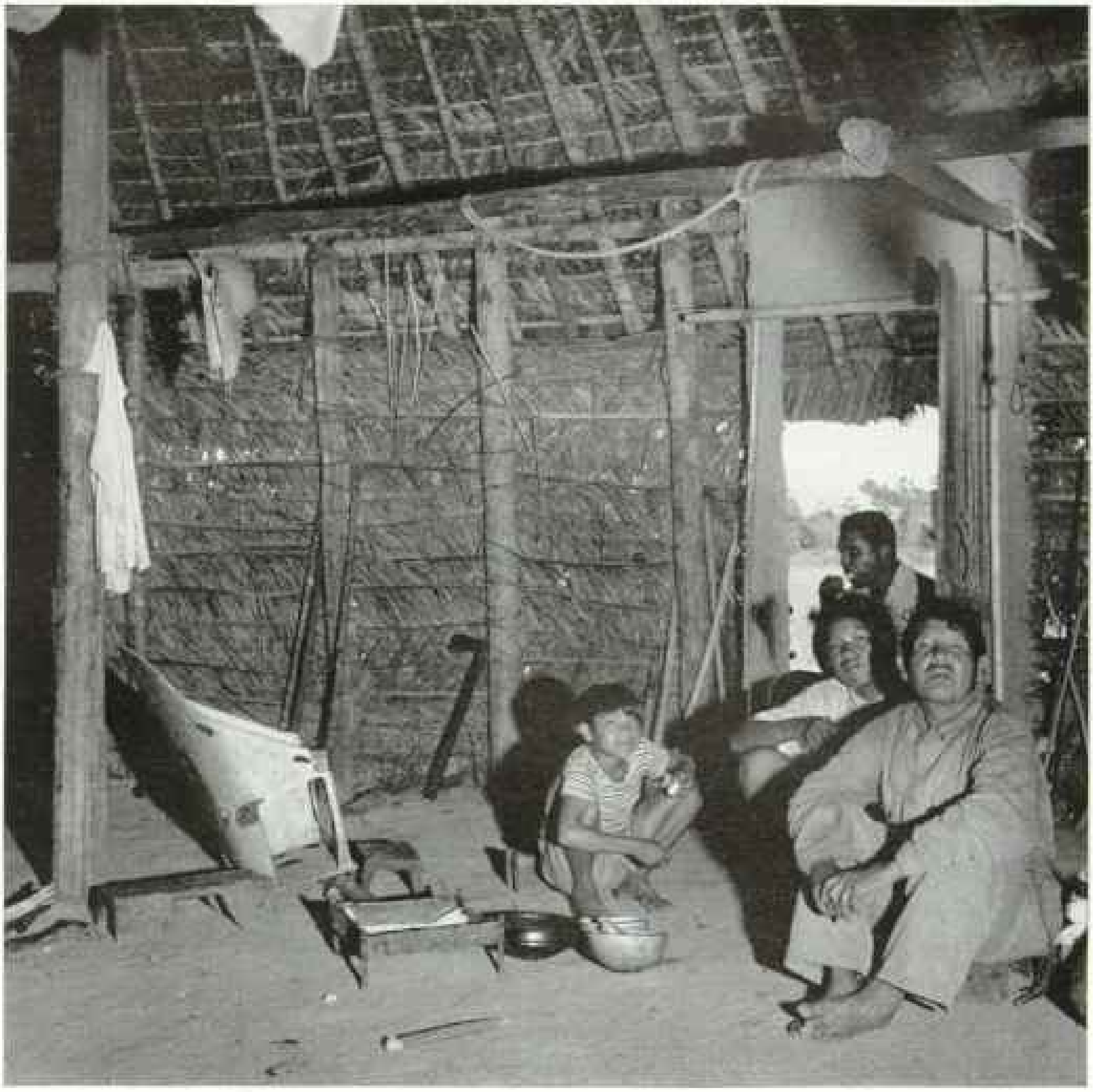
It was wonderful to be on the river. The water was cold and black-looking, and the klop-klop of the paddles as they hit the sides of the dugouts was somehow cheerful.

Late in the afternoon we were thrilled to hear a DC-3 heading down the river on the lookout for us. It was a TACA plane piloted, we knew, by either Capt. Art Jones or Capt. Charlie Baughan. The plane made several passes over us, and I stood up in the dugout with arms overhead, prize-fighter fashion, and waved we were all right.

A Wet Night in a Stifling Hut

At 5:30 that afternoon we went ashore at a spot Laime and the Indians had chosen. Up the savanna from the river were several little huts belonging to a relative of one of our Indians. The occupants were not at home, and we decided to stay there overnight.

Rain began before we had finished our evening meal, and we dashed for the huts in a downpour. Some were badly infested with fleas, but fortunately the one I was in had none. The shack was stiflingly hot, and I stood in the doorway for a long time to cool



A Pilot's Seat from a Wrecked Plane Was the Pride of the Community Grass Hut

The shiny metal had been salvaged from a Fokker which had overshot the airstrip in 1939. About 40 feet in diameter, this native home at Uruyén was clean and cool and rather dark inside, since it had no windows. Each family had a separate cooking outfit. The square woven basket on 3-inch legs holds broken pieces of cassava, the natives' main food; gourds of hot sauce made of red peppers stand beside it. Scattered about were low, carved benches about 6 inches high and a foot to 18 inches long. A platform in the center of the hut was heaped with arrows, blowguns, and assorted reeds. Outside, water jugs hung from the eaves.

off after our long run uphill in the rain.

The next morning we got under way in a soaking drizzle. After a half-hour downstream we had to stop and portage around Iguana (Lizard) Rapids.

Late in the day heavy rains set in again, and at one point, where the river makes almost a complete loop, Laime suggested we take a trail across the narrow bit of land and wait for the dugouts. It would take us 20 minutes to walk the distance, but the dugouts would need three hours to make the great circle if we all stayed in. Lightened, they could be expected to go around in much less time.

We dug out a few cans of food and crackers and started across the trail to an unoccupied hut. It was clean and spacious and had a bundle of dry wood inside. We were soon huddled around a fire, wringing out our wet socks and hanging them over the fire to dry.

While finishing our lunch, we heard a plane. The clouds hung low, and I hoped the pilot, Art or Charlie, wouldn't risk his neck looking for us in the perilous gap between Auyán-tepui on the left and Macual-tepui on the right.

Indians Make Careful Preparations Before *Barbasco* Fishing

First they dam off a stretch of backwater by piling logs and leaves between it and the main stream. They then carry out bundles of the root and pound and rub pieces of it between their hands until a milky substance is exuded into the blocked-off pool. Always they try to keep any of this poisonous fluid from seeping into the river and killing more fish than they need. They thus practice simple conservation methods. The barbasco stupefies the fish and causes them to float to the surface, where they may be scooped up in nets, or, if they are large, shot with bow and arrows (pages 658, 674, 675, and 681). A mighty yelping announced the sighting of a 25-pound whopper.

The pilot eased down slowly in circles. Finally, through a break in the clouds, he came in, perilously close to Auyán-tepuí, and flew overhead at perhaps 700 feet. Perry waved a big white towel at him, but we were not sure it was seen. The pilot doubtless was trying to locate us on the river, not on land.

We had not been able to make radio contact since leaving San Rafael de Acanán, and I was worried. I didn't want the pilots out searching for us unless it was an emergency. That night Enrique worked long into the evening until he finally made contact with Ciudad Bolívar and reported our safety.

We camped for the night beside the Acanán River at the other end of the loop, the Indians having come in too late to take off again. We need not have worried about them; they had merely stopped off to fish. Since the bottoms of the dugouts were full of fish, we didn't mind too much. Each fish had an arrow hole through the vulnerable parts, proof of the archers' skill.

Some Strange Insect Bedfellows

This campsite was full of wood ants, pests which were annoying but did not bite. They managed to get into everything, from the soup and sugar to the insides of our hammocks.

I sat up late and attempted to dry my blankets over a fire we had built under one

end of our tarpaulin shelter. By the light of the fire I caught up on my notes.

One nocturnal visitor was a beetle about an inch and a half long. Most interesting thing about him was his lighting system. He had two lights in front, much like automobile headlights, which shone ahead with a phosphorescent beam, illuminating a circle fully eight inches in diameter.

Since it was raining rather hard, I hung my hammock under the tarpaulin shelter. Ernie had his down by the river under a palm thatch. Perry, Laime, and Enrique went back to the Indians' hut on the trail.

The next morning was Saturday—two weeks since we had started out on the expedition—and we packed the dugouts in a steady rain. The Acanán was rising rapidly. Ernie had to maneuver a bit to get out of his hammock, because the river had risen several inches during the night and the shelter was inundated.

We changed into different dugouts before taking off, because both Ernie and I wanted more flexibility in our photographic work. Each of us got into one of the two smaller dugouts.

Mine was a tricky little craft. When I rested my hands on the sides, my fingertips were in the water. We were certain to ship a few gallons while shooting rapids. I kept a gourd handy, and when the water sloshed around my ankles I knew it was time to bail (page 658).

Old Reya and Manuel, a quiet, shy boy, came in my dugout and we took off to get pictures of the rest as they came around the bend (page 676).

Within a few minutes we came to the Carrao, the river which winds and turns maddeningly but eventually flows past the entrance to the canyon of Auyán-tepui.

An Indian "Rain, Rain, Go Away"

Old Reya had a habit of rain-chasing. He would nudge me, point to the rain cloud ahead, and proceed to make "ptu, ptu" sounds, tossing his head sidewise on each "ptu." That was supposed to chase away the rain spirits. Once I got the idea, I joined in, and Reya roared with laughter.

One of our Indians, a magnificent physical specimen, intrigued Ernie and me. He was Rafael, the 16-year-old who had brought his wife along. Rafael wore nothing the whole trip but a red loincloth.

Juanita, his wife, probably about 25 years old, was squatty and unbeautiful, according to our standards, but efficient and certainly an authority on each stream, rapid, and mountain. She had a name for them all.

Juanita sometimes wore her hair in two braids, sometimes combed it out to flow over her shoulders; but the whole effect, photographically, was spoiled by the shapeless dresses which the Capuchin missionaries had persuaded the women to wear.

Some earlier explorers to this country had reported these women wore nothing except the strands of beads around their necks, ankles, and wrists, and a beaded G-string. I kept a sharp lookout and discovered they still wore the bead ensemble underneath.

The flowers and flowering vines on the Rio Carrao grew more beautiful as we went along. There was one tree with waxlike blossoms that smelled like ginger lilies and perfumed the river for miles. Purple flowers hung everywhere. One vine had interesting sprays of red fronds like a rooster's tail.

Once we saw a group of "water dogs," or nutrias, cavorting in the stream ahead, unfortunately out of camera range. In the jungle we saw a long animal with bushy tail and yellowish head, probably a jaguarundi, or "otter cat."

Through jungle growth we began to see Uey-tepui, the saddlelike double-peaked mountain we must circle before again coming to Auyán-tepui (page 661). The heavy rainfall of the last few days had made waterfalls spring from every mountainside. The rapids got progressively more swift and dangerous, and we used up a lot of time in figuring how to get through them.

Nevertheless, we made excellent progress that day and successfully portaged around Cuai Rapids, a stretch of dangerous water. Even cautious Laime opined we might get to the entrance of the Río Churún the next day if we kept up our progress. Our spirits rose, for the Churún is the river which flows out of the canyon and leads to Angel Falls.

Having seen no planes that day, we concluded that the radio message of the night before had got around. We cooked a huge pot of spaghetti, dehydrated onions, garlic, and corned beef, Enrique's favorite dish, and sat around speculating on the distance yet to go. The Indians, in an adjacent hut, were really neighborly and passed us a platter of golden-fried plantains. We returned the favor by sending over a pan of spaghetti.

I turned in at 7, and for the first time took off my outer clothing. Usually it was quite cold by nightfall, so that an extra sweater, a windbreaker, and two blankets felt good over regular clothing.

This camp was not in a savanna but merely in a small clearing in the thick jungle, just

big enough for the tiny huts the Indians put up. There was no breeze in the jungle, and it was hot and sultry. The moon was half-full, and the soft light filtering down through the jungle growth was beautiful.

I was awakened in the night by a driving rain and by morning was soaking wet in my hammock. We ate quickly and got started in a light drizzle. I brushed my teeth on the way, washed my towel and socks, and stretched them on top of some broad leaves which covered my cameras as a waterproofing.

My legs and arms, even my face, were still humpy and itchy from the sessions with the Uruyén *jejenes* (page 657). They hadn't bothered us much since we took to the river and they don't bite after sundown. The men, though, had a great deal of trouble with the fleas, and every evening they searched for them and for ticks.

At 8 we began the half-mile-long rapids and shot them with a lot of excitement but no spills. The rain stopped and the sky cleared somewhat so that we could see part of Uey-tepui almost over us. We had to stop and calk my dugout, which was leaking badly.

Weird Sounds in the Land of Waterfalls

All day we heard unseen rapids and falls roaring like onrushing trains. Now and then, through the clouds and the high trees on either side, we saw waterfalls gushing down the sides of Uey-tepui.

The sun came out in the middle of the day, and old Reya was happy about the sun. He nudged me, pointed to it and then to Uey-tepui, and said: "Lo mismo." Then I understood what Uey-tepui meant—Sun Mountain.

We rounded Uey-tepui and suddenly, in the distance, was the north side of Auyán-tepui, the colorful rock and sheer cliffs so familiar to me from the air. Reya began puffing in earnest now with his rain-chasing sounds and chanting and frowning as he looked at Auyán-tepui. The Indians are superstitious about the Churún canyon we were so soon to enter, and also about Devil Mountain.

We saw a tapir in the afternoon, but it was swimming on the other side of the river. There were lots of bats, too, flying for short distances, then clinging upside down to trees hanging out over the river.

We had planned to stay overnight at a hut Laime had built when he and the Indians passed this way a month before on their trip to clear the savanna. But when we arrived at the hut, we had to leave in a hurry. The place was infested with fleas, and the boys were covered as they stepped ashore.

Downstream another half mile the Indians cut bushes and trees and made a new camp for us. They went back to stay at the old hut. I think they actually liked to get fleas in their feet. It gave them something to do at nights around the campfire!

Our camp faced the northeast corner of Auyán-tepui, looking like a mysterious dark fortress in the moonlight. Ernie and Perry went for a ride in one of the dugouts and came back with a 7-pound fish which they said they caught themselves. Pinned down, however, they admitted they had been down to the Indian camp when the men came in from fishing.

The roaring of red howler monkeys awakened me at 5:30.* If there is anything noisier than the jungle, I haven't heard about it. I had slept soundly, though, once I had given up the search for an elusive bug in my hammock.

We took off early from our camp on the Río Carrao and half an hour later entered the Churún River and the wide mouth of the gorge, which would narrow down into the canyon leading to Angel Falls. It was Monday, May 9.

While Perry was frying fish for breakfast, Enrique sent out messages that at last we were within sight of the entrance to the Churún and hoped to enter the gorge that day. After many days of rain, this morning began bright and sunny—a good omen, I thought. Our spirits, after days of enforced cheerfulness, were at high pitch, and we sang our favorite songs. The Indians seemed to enjoy hearing us sing.

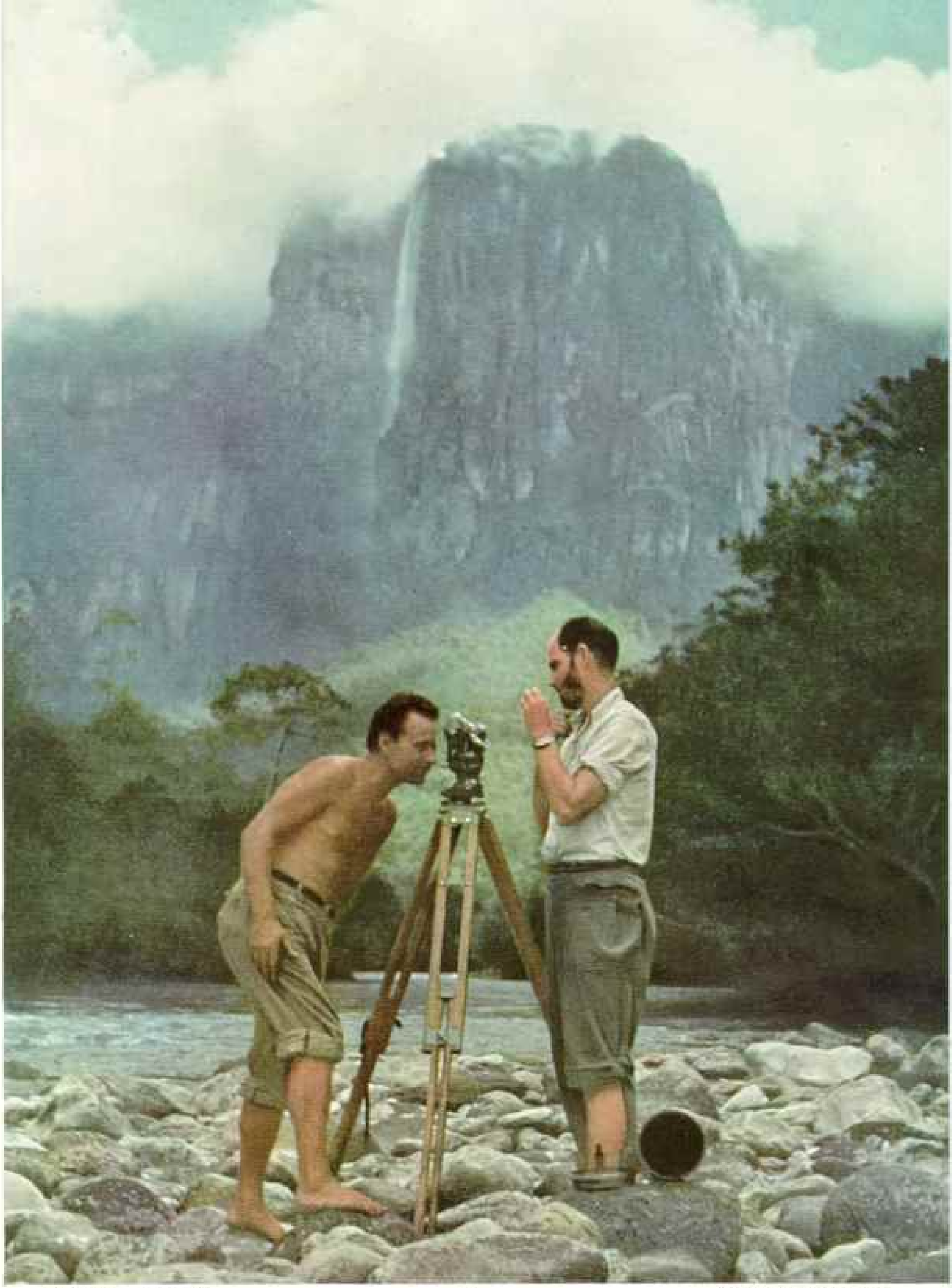
Indians Wear Red Paint To Ward Off Evil

They had come from their camp with their faces painted with a deep-red paste, which they get in the jungle. On the paddles mysterious-looking signs were painted in the same red. The Indians were quiet and solemn, and small wonder. They had never been in this canyon, and the tales we had heard about the canyon and the evil spirits inhabiting the jungles there had made good campfire tales many a night, as interpreted through Sabas. The paste was to make them invisible to the spirits.

The beauty at the mouth of the Churún is a breath-taking sight. High jagged rims of Auyán-tepui were all around us. One point we named Jorge Washington because of the definite Washingtonlike profile in the rocks along one particular rim.

I discovered this particular morning that I wasn't so immune to burrowing fleas as I had thought. I had developed itchy spots on the

* See "Monkey Folk," by William M. Mann, NATIONAL GEOGRAPHIC MAGAZINE, May, 1938.



Kodachrome by Ruth Robertson

Half Hidden in a Niche of Devil Mountain Is Angel Falls, World's Highest Waterfall

First to measure accurately the tremendous cataract, almost twice the height of Yosemite and 15 times Niagara, guide Alejandro Laime (left) and Perry Lowrey, expedition engineer, set up a transit on the rocky shore of the Churún River. Nearly two miles away water gushes from the cliff face in a single drop of more than half a mile.

Kodachrome by Ruth Robertson

Camaracoto Indians Watch the Cub Cruiser Prepare To Take Off from the Natural Airstrip in Uruyén Valley

If the expedition could have been shuttled in by plane to the advanced field prepared by the guide, they could have made the distance in 35 minutes. The journey by river took six days. Here at the south end of Auyán-tepui they made their first camp. Angel Falls is at the north end, 20 miles away as the crow flies.

Subchief Subas' Wife and Children Lead a Carefree Life

With a flower in her hair and a new print dress, the older daughter is proud of her "Sunday best." She fondly clasps her parrot playmate, prized as a pet by the Camaracoto tribe. About her ankles and just below her knees she wears the tight bead bands commonly used as ornaments. Actually, the bands cause the calf to bulge unattractively.

The mother at the right holds the younger sister, La Mona (Monkey), and on her back, supported by a head band, she carries a basket woven of grass and palm fibers. Her wrists and ankles are bound, as are those of the older child.

The husband took the name Cardona from the well-known explorer who came to the valley several years ago and with whom he went to Caracas.

Both men and women were golden-brown of skin, and their teeth white and clean. They were a happy lot and smiled or laughed constantly.

When the Indians came to camp, they eagerly looked over everything, handled each item gingerly, then carefully replaced it. The men wanted salt and sandals; the women fingered the flowered cloth of the visitors and the shiny metalware of their cooking utensils.

Kodachromes by Ruth Robertson

Kodachrome by Ruth Robertson

Only from the Air May Angel Falls, World's Highest Cataract, Be Seen in Its Entirety

The water does not flow over the edge of the cliff, but bursts out of subterranean streams some 200-300 feet below the rim in spouts perhaps a city block wide. The first straight drop is 2,648 feet, the remaining falls 564—a total of 3,212 feet. A huge pool at the bottom, darkened by spray, drains into the Churún River.

Kodachrome by Ruth Robertson

Because the Uruyén and Aicha Rivers Were Too Shallow for Boats, the Expedition Trekked from Uruyén to the Deeper Acanán

Indian bearers backpacked radio, camera, and surveying paraphernalia, as well as camping equipment and food, to the Acanán River, where the dugouts were waiting.

Under Auyán-tepuí, Hidden by Clouds, the Party Breaks Camp at the Airstrip To Begin the 10-mile Hike to San Rafael de Acanán

Alejandro Laime, far left, instructs the packers. They have been with the guide on his journey to the now-useless advance landing field near the falls (page 668). On the last night before departure, the sleeping hammocks were brought up from the forested river bank and strung on poles near the work tent.

Kodachrome by Ruth Robertson

As the Author Watches, an Indian Lad Draws a Bead on a Big Fish

Even the youngsters of the Camaracoto tribe are dead shots with bow and arrow. When *barbasco* poison is used to stupefy fish, it is confined to dammed-off shallows so that it does not contaminate the river proper.

Women Scale Without Knives a Fish Fresh from the Water

They use only their strong fingernails to clean the catch. To make a favorite dish, these Indians wrap chunks of the dry, white flesh in banana leaves and boil them with a liberal flavoring of fiery spice.

The carplike fish are stupefied with poison made from *barbasco* and then shot with arrows (page 681).

Indian Visitors Usually Stayed in Camp from Dawn Until Bedtime

At the left one is feeding a pet parrot, a rare species in the Venezuelan jungles. Subchief Salvas Cardona's wife and her children sit at right (page 669).

The Indians marveled at the expedition's portable; it was the first time most of them had ever heard music from a radio.

Face and Paddle Are Spotted Red To Ward Off Evil Spirits. Manuel Toils Down the Carrao Toward Devil Mountain

The lead boy in the author's dugout protected himself with smears and mystic symbols done with a red paste made from roots and berries.

The Largest Woodskin Canoe on the Río Carrao Carried Radioman Gómez and Little Jacinto, with Sabas and Puñatar as Paddlers

Unlike some of the *curiaras*, which are dugouts, this craft is made of bark. The Indian subchief is at the stern. Wearing the helmet is the technician from the Venezuelan Ministry of Communications. The 9-year-old lad who helped the author carry her cameras sits forward with the paddler.

Kodachrome by Ruth Robertson

Easing a Large Woodskin Through Wild Rapids Was Tricky Work

The trip on the Rio Carrao was always exciting, frequently dangerous, for the river broke into white water among huge rocks at frequent intervals. Between these difficult stretches the craft was paddled or poled.

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Kodachrome by Ruth Robertson

Often Four Indians Were Required To Hold the Canoe from Being Swept Away

All cargo, of course, had to be portaged around bad spots a dozen times each day. When not taking her turn at paddling, the author caught up on her notes, took photographs, or busied herself at repairing clothing.

Kodachrome by Ruth Robertson

Radioman Gómez Directs Indians Transporting Equipment Across the Aicha. They Forded Some Streams, Ferried Across Others

Red-painted Indians from Tots to Grandparents Take Part in the Fishing Party (Pages 674 and 675)

With hand nets woven of grasses the two little girls at the left are ready to catch small fry. Men rub the pounded *barbasco* root over the backwater. The milky juice of this plant paralyzes fish. As soon as the prey come to the surface feebly flapping, the women and children (right) bring them to the bank or boys shoot them with arrows.

Kodachrome by Ruth Robertson

Through the Venezuelan Jungle Gleams Angel Falls, Still a Six-hour Climb Away

This was the first glimpse the author and her party caught of the cataract. To the left they found a small rock promontory at the edge of the spray-spouting caldron. There they had a box seat for the spectacle.

bottoms of my feet, and at the first stop Manuel found a twig from the right kind of bush, sharpened it, and dug out four of the pesky things.

We had to stop every few minutes along the Churún while Laime and the Indians reconnoitered to see if we could go farther by dugout. There were many shallow rapids to pole through. In the deeper stretches we all paddled like mad against the turbulent swift currents. When Manuel poled, I rested my paddle, wrote occasional notes, took a picture or two, changed film, dried clothing, or else just rested my blistered palms. The little dugout was very tippy and had developed a bad leak back on the Carrao. I dipped continually with the gourd.

Making rather good time, we soon passed the spot where Laime had stopped when he was in a month ago. We were fortunate that the rains had set in, making the Churún run higher. It was possible to go farther by dugout than we had expected.

Old Reya kept his lips pursed making his "ptu, ptu" sounds constantly. Manuel, in front of me, was openly fearful of the river. He had a bunch of herbs which he would hold aloft toward the sun, mumbling a sort of chant. All the Indians were jittery about entering the canyon, but our group laughed and sang and yelled from dugout to dugout until the tension lessened.

By noon the Churún was running rapidly. It was all we could do to make any progress in its black, icy, foam-flecked water. Rivulets of perspiration were running down Manuel's brown back. We took off our shoes and rolled up our trousers, and when we came to shallow spots we got out and helped the dugouts through.

The banks were beginning to look mossy. There were many sand spots, and the sand was of a fine quality and rose beige in color. Leaves of the small shrubs and some of the trees had pink undersides. The trees leaning over the banks were heavily mossed. Grass grew in round, mushroom-shaped clumps, even in midstream.

Stripping Down for the Final Dash

By 2 p. m. we could go no farther up the Churún. The stream was too swift and shallow. We pitched camp on a high bank and sorted out our equipment and clothing, most of which was to be left at this camp. We would take only enough for the last dash to the falls and only what we could carry on the trail. The ten Indians would be heavily loaded, and we each planned a backpack of our own.

The radio equipment, so vital on this last unknown part of the trip, took three Indians alone, and Perry's surveying equipment, Ernie's movie cameras, and my own four cameras and boxes of film and bulbs were heavy and bulky. Besides, we had our food and camping equipment and several backpacks of cassava for the Indians.

We shook out everything that wasn't desperately needed, for we knew every ounce would count. We hoped to make the trip in to the falls and out in five or six days.

This camp, on a bend of the Churún directly north of the falls, was on an elevated spot above roaring rapids. Everything we weren't taking was placed under shelter of our little palm-covered hut.

While the Indians were building it in the afternoon the cry "Culebra!" (snake) went up. However, nothing seemed to come of it. There was a tapir near by when we first arrived at the campsite, but he disappeared down the bank.

During the camp building, little Jacinto came to me with a deep machete gash in one of his fingers. I filled the wound with sulfathiazole cream and bound it tightly.

Our campfire conversation that night consisted mostly of speculation on the length of the trip to the falls. Laime thought it would take two days to get in, depending upon ourselves and how fast we could make the trail. We all agreed we would need about two days there—Perry for his calculations on the height of the falls, Ernie to take movies, and I to shoot stills. Then two days out—a total of six days. We packed food for six days, no more. If it took longer, we planned to send Indians out for more supplies.

The Indians were fussy the next morning about the load. Everything had to be repacked until they were finally satisfied. After a heavy rain during the night, we did not look forward to the walk through the jungle. This was the unknown part.

At noon we stopped in the shelter of huge rocks in a deep ravine where ice-cold water tumbled down over deadfall and rocks with the roar of a locomotive. We were wet and weary after the morning's trek.

We had plodded hours on the trail through a drizzle, and the rains of the last few days had made swamps of savannas, quagmires of soft leaf mold. The green, mossy rocks and logs were treacherously slick.

Strong vines caught at our feet and tripped us mercilessly. Trees which we reached out to grasp to regain our balance disintegrated in our hands; they had been dead for years, but could not fall because of the jungle vines

Jungle Sleeping Hammocks Were Snug and Cozy

Tucked in for the night, surveyor Perry Lowrey is protected from the vicious little flies and the chiggerlike fleas by a fine-mesh screen with vertical and horizontal zippers. A light waterproof tarp is suspended above him by dangling vines.

and other thick growth which held them in their place.

We opened corned beef, dipped cassava bread in the stream to soften it, and spread the beef over it. Some of the men finished off with a sandwich of moistened cassava with native brown cane sugar spread on it. Laime said the Indians could go farther on cassava and sugar than anything else. Sugar for quick energy, I guess.

After the first long day on the trail I was too weary to do much after assisting in the supper setting but tie my damp hammock up under the tarpaulin and crawl into it.

Enrique had made contact with the operator at Santa Elena, our first contact in two days. We certainly were relieved. We were all well, things were going right, and we didn't want planes out looking for us, as they had done on the Río Carrao when we were unreported for two days.

It is dangerous flying in this area in good weather, and I got jittery when I heard an airplane overhead looking for us in the kind of weather we had had the last few days. These mesas are high, and the canyon is very narrow.

We heard a small plane in the clouds during the morning. It seemed to be following the Churún up the gorge, but at this point our trail took a compass heading directly away from the many curves in the Churún. Naturally the pilot didn't see us, and because of the jungle growth matted over our heads we couldn't see the plane.

Slow Progress on the Trail

The second day on the trail left me inexpressibly weary. It seemed I just couldn't lift myself and light backpack over one more log or rock. The rains stopped for a while, and the sun filtered through the jungle in little cracks here and there. The heat was oppressive. I found that oftener and oftener I had to stop for a breathing spell.

We crossed innumerable streams fed from the many waterfalls off the canyon walls. The water from these streams was icy and sweet and a little flat-tasting, but at the moment of a rest stop along the trail no nectar could have tasted better.

Our lunch stop was in a rock shelter which seemed to be some animal's also. At least it was a dry place. I wrung my socks out and hung them over a bush in one of the rare sunny spots, where they steamed but did not

As Gómez Receives a Message, Rafael Is Ready To Turn the Generator for a Reply

The Indians were eager at first to help operate the strange machine which was the expedition's only contact with Ciudad Bolívar. Later, however, they became so reluctant to do the heavy work that they had to be wheedled strongly to take hold of the crank.

dry. Laime insisted I take some sugar, and I did, hoping to derive some energy from it.

Laime was getting discouraged by our slow progress. He himself was a human dynamo. His energy never seemed to let up, and at the end of a day he was still fresh.

We knew that we were getting close to our goal, because the canyon walls on both sides were narrowing. And once, in a clearing, I could see a rounded curve ahead that I recognized from the aerial photographs I had taken of the falls.

In distance it couldn't have been very far, but by trail it was a tortuously slow process making our way over centuries of deadfall and landslides. Enrique and I exchanged private confidences that day and decided that the next time we made a trip into this canyon it would be over a concrete highway!

The World's Highest Falls Sighted

And then, just when it seemed I could not go another step, a shout went up ahead. The first view of the falls!

We had rounded the curve and there, in the distance, was our goal. There's no describing what it did to our spirits. We didn't have a front view, but rather a profile from the north-east side, and an outcropping of rock hid the lower part from view. Nevertheless, the sight was stunning.

Now we knew we could actually get there. We were all for going closer, but Laime wisely advised us to make camp and scout ahead the next day to see if there was a better place for the camp.

Little was done the rest of that afternoon. It was too wonderful to walk out on the rocks of the Churún and stand and gaze at the majestic sight, so different from the 10-second views I had had from a plane.

The Indians set to work making another hut for the night. A welcome sound, the ringing of their machetes, the pounding of poles in soft earth, and the whack-whack as they cut down palms and other big leaves for a roof. Soon we would have a fire and I could dry my clothing. I was stiff and sore from the long trek. Moreover, I was bruised and scratched, and my slacks were torn in a dozen places and filthy from scooting over rotten logs and tumbling headfirst into leaf mold.

Rafael, our Indian who wore nothing but a bright-red loincloth, came to me just after we arrived with a bad slash in the bottom of his foot. I put sulfa cream in the wound and

"The Ol' Swimmin' Hole" Attracts Naked Urchins near the Big Chief's Hut

At the home of the chief of the Camaracotos, Alejo Calcaño, the author and her four companions were royally entertained during a three-day "welcome home" festival held in honor of some of the tribe's men who had been away in the jungle with the expedition's guide (pages 659, 662). Though irked by this delay in starting toward Angel Falls, all the author could do was wait.

A pig had been killed that afternoon and cracklings were being made. The explorers sat on real chairs, the first in days, and ate hot cracklings and cassava bread dipped in water. The Indians gave them a large, luscious pineapple and offered a queer drink made from yuca and another from the juice of sugar cane. Neither suited their palates. As the drink was passed around, they sipped only a taste from the enameled cup to be polite.

These folk danced to the rhythm of a stick which the chief beat upon the ground. Men and women joined in singing a mournful little song, all the while hopping slowly from one foot to the other. Far into the night the author, sleeping in her hammock, could hear in the distance the thump-*thump*, thump-*thump* of the chief's heavy bamboo rod pounding the ground.

On taking leave, the author made arrangements with the natives to have them fry some fresh pork tenderloin and bring it to the camp beside the river.

The Indians Keep the Ground Outside Their Grass Houses Neat and Tidy

Waste is never thrown out to make a litter in the dooryards, but is carried far away for disposal. Among these people cleanliness is a fetish. Their huts, skillfully made, are designed for communal living. They sleep in hammocks hung from the inside to a strong center pole.

The women experiment with coiffures, though the favorite is a shoulder-length bob. Most of them wear bangs. An arrangement for children consists of two little braided wisps starting above the ears and passing around the head as a band (page 689).

One night when subchief Sabas and his family came to visit the expedition camp, he sat on his wife's backpack sling to keep his freshly laundered white trousers from getting soiled. The explorers opened a tin of raisins and passed them around to the Indians. Then they split up one of their Edam cheeses. The adults liked it, but the children spat it out after one bite.

After an interlude of music from the radio, old Reya, an elder among the Indians, indicated he would like to return the compliment. He played a few weirdly beautiful minor key melodies on a handmade bamboo flute.

Perry taped it tightly. The Indian woman, too, came with smaller cuts on her bare feet, and we gave her the same treatment.

For all our weariness we stayed up late that night. We took our cups of tea from the campfire and went to sit on rocks by the water. As if on cue, an orange full moon came up about 7 and turned the dark mass of the canyon wall into half-light, with the falls a shimmering silver streak down the middle.

Whatever hardships we had endured on the trip this particular moment seemed to make worth while. Perry said we were about two miles away from the falls. Enrique sent out our message that night telling those who were listening that we were in sight of our goal.

It was noon on May 12 when I finally climbed the last rock of the promontory in front of the base of Angel Falls.

For hours we had been struggling over tremendous rocks which had fallen off the top, almost a mile above us. We could hear the roar of the falls, but could see nothing because of the jungle growth.

Finally, around 11, I caught a glimpse of the top of the falls pouring off near the rim. I plunged into the dense growth again and climbed upward in that direction.

A Box Seat for Nature's Master Spectacle

The rock promontory in front of the base of the falls seemed to be made solely to observe the magnificent spectacle before us.

Plunging through jagged rocks a few feet below the canyon rim more than half a mile in the first unbroken drop roared the falls. They deafened every other sound, and whirled in spirals as the wind caught them and sent them out over the valley below. Often they swirled out to the rocks we were sitting on and drenched us (pages 660, 667, 670-671, and 682).

Behind the waterfall is a tremendous amphitheater, providing a spectacle beyond description. So far as I can learn, we were the first to see this sight from the promontory.

The rocks overlooked not only the falls but the whole valley up which we had come. We could see the deeper green winding line of the Churún and even the rocky little beach about two miles back where we had made our camp.

After one quick look Perry hurried off to begin the big job of measuring the falls. Laime disappeared to help Perry in finding spots for the base line. I sat fascinated on the rock.

Old Reya sat cross-legged near by, his impassive face bent over a reed mat he was making for me.

Before we had taken off from camp that morning, the Indians had come to me all painted with red paste. They brought a small piece of it and a mirror over to me and asked if I would also "make myself invisible to the spirits." Obligingly I had painted circles and dashes over my face.

Finally we took leave of our box seat and headed down in another direction to explore the secondary falls and the small river which joins them to the Churún.

We sent out a special message that night on the transmitter. "Saludos" to Col. Jorge Marcano, then Minister of Communications, who had been so helpful in this venture; to Col. Frank Bender, who had flown us into Uruyén at the beginning of the trip; to Captains Charlie Baughan, Art Jones, Sam Fales, and John Olson, all of whom had contributed to the success of the expedition.

"Anybody superstitious?" Perry wanted to know the next morning. It was Friday, May 13. Both Perry and Laime set off early on the surveying job with enough Indians to cut a base line for his chain tape.

Since it looked too rainy for pictures when they took off, I dawdled around camp, luxuriating in the realization that we had achieved our goal. With that achievement there had come a letdown and, after breakfast, for the first time I went back to my hammock for another couple of hours.

Friday the 13th Fairly Quiet

Friday the 13th brought only two untoward incidents. A large stinging ant climbed on one of my socks, but I got it off without getting bitten. At noon, a huge tarantula crawled to within striking distance of Enrique as he sat on the ground eating.

Laime and I saw the horrid thing at the same time as it came out of the jungle and headed rapidly toward Enrique, but Laime was quicker and yelled for Enrique to get up. Enrique literally rose from the ground in one swoop, never spilling a drop of his soup.

After Laime had killed the tarantula with a stick from the campfire, Enrique put aside his soup. He'd lost his appetite, and I didn't blame him. I made a mental note to stop wearing string sandals around the camp.

There was one more day's work for Perry, measuring angles from every conceivable spot in the canyon floor. It was ticklish business wading the swift Churún to get to the opposite side with his heavy theodolite and all the other necessary instruments.

Messages of congratulation came in on the morning broadcast time. We sent out word to have the little airplane ready at the ad-

vanced airstrip within two days. More than ever I realized how valuable to the success of the expedition was the radio equipment, which could make such arrangements from as isolated a spot as this "lost world."

On Sunday, May 15, we were up at 5 and ready for the trek out of the canyon. It was Ernie's birthday. While the Indians and Laime were breaking camp and packing everything in the backpacks, I decided on the plan I'd made the day before. I told Laime I was going on ahead alone. I explained that I was so slow on the trail that this would give me a head start.

Alone in the Jungle

I left camp blithely at 6, sure in the knowledge that the rest of the group would be along within a few minutes. The trail was not too difficult to follow, and the few times I did get lost for a moment I would simply make a small circle and find the blazed bushes.

I had not been out more than half an hour, however, when the realization of being alone in the jungle descended on me with crushing force. The light drizzle of rain and wet leaves had me soaked to the skin.

How weird the jungle seems when there is no one else around! The sudden sounds and crackles; the momentary terror at passing a lair where animals have bedded down; the unmistakable odor. I wondered if the beasts were still watching me through the underbrush. I hesitated to go forward, and I didn't want to go back to join the group that *must* be somewhere behind.

I wondered whatever in the world had possessed me to start out without a machete or a knife or *something!* Finally, reasoning overcame terror. Nothing visible moved except a bird resembling a chicken and a few lizards.

Laime and Enrique caught up with me a little after 8. We were determined to make the main camp in one day, but Laime was frankly gloomy at the prospects of my endurance on the long trip. Although impatient over the time that would be wasted, Laime agreed that we would take five minutes each hour for a rest period.

The last few hours were sheer torture for me. I kept getting slower and slower. How Enrique and Laime kept such a pace I simply couldn't see. They would patiently wait for me at the more difficult places, and often, at a riverbank, shout encouragement or point out the safest rocks or logs to pass over.

Somehow we made the main camp late in the afternoon. I have a dim memory of the last hours, the fording of the last stream, the last bog to drag my waterlogged jungle boots through, the last wet, slippery log to climb over, and, finally, voices in the distance.

Little Simona Gets Her Pigtails Braided

While all the Indians' hair was long and black, it was not coarse but soft and silky. The women and children were usually busy combing and plaiting when they visited the camp at Uruyén. Combs and pins the author gave them delighted them. Cleanly in their habits, they bathed daily in a stream near by.

Fires Were Lighted Every Night To Dry Out the Travelers' Clothing

Here Perry Lowrey, the surveyor, right, has his shoes suspended directly over the blaze. Movie cameraman Ernest Knee, radioman Enrique Gómez, of the Venezuelan Ministry of Communications, and Alejandro Laime, the guide, look on, waiting for the coffee to boil.

Camp! I dropped my pack, hunted out my damp and dingy towel, and disappeared down to the Churún to wash off the perspiration and bits of bark, moss, and earth. This time the icy water was too much. I went back to camp and hung my hammock, crawled into the damp blankets, and wrestled with the chill that had enveloped me. Later, though, a huge aluminum tin of thick steaming soup and a cup of tea worked miracles.

Getting out the rest of the way was easy. The Churún had risen very high during the last few rainy days and the dugouts rode easily. It was downstream all the way now, through the Churún in the canyon and out the Río Carrao to where the new airstrip was. The sun came out, and we gazed with awe at the many waterfalls coming off the mesas.

The Indians made a hut for us in what we knew would be our last camp on this venture. They had brought fleas over from their camp, but we endured them, knowing it would be for the last night. The wind howled and the rain blew through the shelter, and we were soaking wet before we ever went to sleep.

As soon as the red and cream plane was spotted in the air the next morning, we carried everything up to the strip. There were last-minute pictures to snap and regretful leave-takings of the loyal Indians and of our good friend, Alejandro Laime, who was going back to Uruyén with them.

There were affectionate farewells to Juanita, the Indian woman who had so competently done her work on the trip. In my pocket I had a long list of things to buy in Ciudad Bolívar for the Indians. I would send these back to them by pilot Sam Fales.

Perry, after hours of figuring angles, zenith distances, talus slopes, and what not, came up with 2,648 feet for the main drop of Angel Falls. Counting in the lower falls, the vertical drop is a total of 3,212 feet. No doubt now of its being the world's highest.

Sno-Cats Mechanize Oregon Snow Survey

By Andrew H. Brown

Illustrations by National Geographic Photographer John E. Fletcher

"WATER is wealth in the West," declared R. A. Work, supervisor of Western States snow surveys. "And from the Rockies nearly to the Pacific most of our water comes from mountain snow."

Through the open windows of Work's office in Medford, Oregon, we gazed across miles of budding pear trees to the white crest of the Cascade Range. Birds sang and spooned in the warm sun. The date was March 18.

Yet next day we'd have to choke off spring fever and turn back our mental clocks to winter. We must pull on long underwear, thick socks, and wool shirts, and set out to buck those high-country snows at the season of their greatest depth.

We were going to try to travel in over-snow vehicles the length of the Oregon Cascades—the first journey of its kind.

Lean and limber R. A. (Arch) Work would be our leader. Arch is a senior irrigation engineer of the U. S. Department of Agriculture's Soil Conservation Service. His job is snow water, from cloud to consumer.

For four years Work had been using an ingenious track-ski-and-pontoon snow sled, the Tucker Sno-Cat, for snow-measuring jaunts into the mountains (page 696). On this long trip he planned to test the feasibility of further mechanizing snow-survey work. He hoped to prove that doing the job by Sno-Cat would be speedier and less costly than by ski and snowshoe.

Snow Waters Fields, Makes Power

Arch waved toward the frosted hills. "There'd be no fruit here in Rogue River Valley without that snow," he said. "Our rich orchards are all irrigated. It's the same story in hundreds of western valleys.*

"Electricity, too," glancing at the light bulb over his desk, "would cost a lot more if snowmelt water from those peaks didn't spin turbines to give us 'juice' at fair cost."

Work explained that in eleven Mountain and Pacific States more than four-fifths of all the irrigation water flows from upland watersheds (page 706). In Utah, for instance, the 20 percent of the State's area above 7,000 feet elevation contributes from 70 to 80 percent of the total runoff. Most of the water is melted snow.

This situation makes practical accurate forecasting of stream flow based on measurements of the snow depth and water content.

In the yard outside Work's office men were piling sleeping bags, tools, and trunks of food into two orange Tucker Sno-Cats and their trailers. These were the rugged motorized sleds we counted on to haul our seven-man party the 500-plus miles from near the California border to the vicinity of the Columbia River (map, page 695).

Operation Sno-Cat Cascade was a joint project of the U. S. Soil Conservation Service and the Oregon Agricultural Experiment Station. Arch Work had invited the National Geographic Society to take part in what promised to be a spectacular journey. That's why Jack Fletcher, National Geographic photographer, and I were on hand at Medford.

"D Day" Arrives

Snow was falling as we rode to the jump-off point at Greensprings Summit. Daffodils and crocuses were blooming in valley dooryards, but up on the pass snow lay three feet deep.

Staff men of Medford's radio station, KYJC, recorded our departure. Then our two Sno-Cats chugged away up the forest path, pulling their heavy-laden trailers. Looking back, we could see cheery Hal Newhouse, the announcer, still chattering into his microphone.

Arch Work's smaller Sno-Cat led the way. With Arch rode photographer Jack Fletcher.

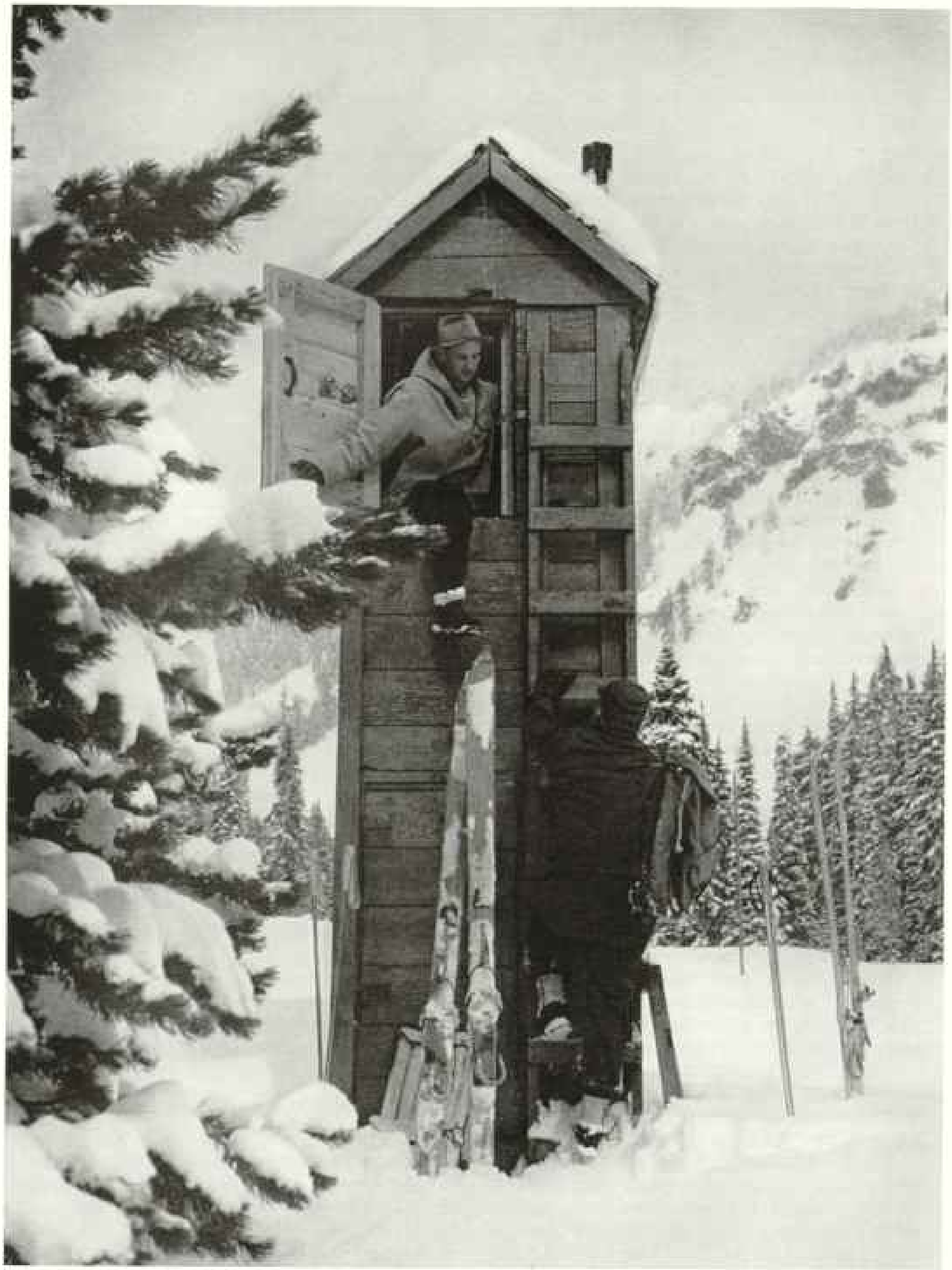
Jockey of the second Cat was Jasper Tucker, youngest son of the vehicle's inventor and builder, Emmitt Tucker. Jasper's Sno-Cat held five people comfortably. Beside Jasper sat Robert F. Branstead, visual information specialist of the Soil Conservation Service. Bob was assistant director of the expedition and its skilled cook (page 699).

First Visitors in Ten Weeks

In the second seat Dr. Harvey Woods and Gaeton Sturdevant swayed with the Cat. Dr. Woods, from Ashland, Oregon, was medic for the journey. Gaeton Sturdevant, timberman, miner, pianist, engineer, and prospector, came as snow surveyor for the Oregon Experiment Station. I stretched out in the rear seat.

Our break-in run that first day took us

*See "Native Son's Rambles in Oregon," by Amos Burg, National Geographic Magazine, February, 1934.



Soil Conservation Service

Through a "Santa Claus Chimney," Surveyors Enter a Snow-buried Field Cabin

This tower rising from the roof of a hut permits access no matter how deep the snow. Throughout the Cascades many such cabins afford shelter from storms. Each contains stove, fuel, bedding, first-aid kit, and a two-weeks' supply of food in a bear-proof concrete locker. Food cans are varnished to prevent rust.

With Charts and Graphs He Follows Snow's Course from Cloud to Consumer

Irrigation engineer W. T. Frost shows the author how snow measurements give valley farmers advance notice of summer's water supply. Next day Operation Sno-Cat Cascade set out on its three-week trip. In nightly radio talks with the party, Mr. Frost relayed instructions and received snow data.

30 miles through deep forest to Fish Lake.

We stopped overnight at George Rowden's house. Snake-hipped George guards two irrigation reservoirs and measures two snow courses. He had been "outside" once recently on skis, but Glenna Rowden and 5-year-old son Bucky were happy to greet their first visitors in 10 weeks.

Young Bucky told us of his pet deer that walked into the kitchen and begged at the bread box. Buck's father hauled the baby into Fish Lake on a toboggan when he was one month old. They kept track of the infant's weight by hanging him by his shirt from the snow-sampling scale.

Great red and Douglas firs soared 200 feet above our vehicles as we wound along the trail next morning bound for Lake of the Woods. The majesty, the utter silence and peace, of the snow-muffled wilderness impressed us deeply.

Major stretches of our whole route toward the Columbia River led through virgin woodlands, most of them in national forests.

George Bosley, Lake of the Woods resort caretaker and a part-time snow surveyor, served us sizzling-hot doughnuts fried in bear grease. He showed us the path to the other end of the lake where his only neighbors lived. The young couple, Edward and Lee Morse,

Winter's Snow Surveyors in the Cascades Plumb Next Summer's Irrigation Waters

This ski party, ramming a coring tube down to solid earth, determines the depth of the snow (lower left), weighs it (above), and expels the sample (right). One ounce of snow in the 1.485-inch tube represents an inch of water.

were "at home." Ed guards 93 summer cabins. They were creaking under the burden of 23 days' almost continuous snowfall!

Ed obligingly climbed on skis to the ridgepole of one of the half-buried cabins as Jack snapped a picture. Just then Ed's wife called that coffee was ready. Ed nonchalantly skied down the steep roof. He wanted his coffee hot.

Lesson in Snow Surveying

At the Lake of the Woods snow course Jack and I took our first lesson in snow surveying. In the following weeks we all took turns at it.

"Snow surveyors," Arch explained, "are as fussy about placing snow courses as a garden clubber planting rare bulbs. We locate 'em above the level of winter melting, naturally, and preferably in forest clearings."

A steel pole topped with a yellow sign marked each end of the course. There were eleven stations (or sampling spots) at 100-foot intervals. Sampling stations average 10 to 15 to a course.

Gaeton screwed together three hollow aluminum cylinders. When he drove the slotted tube through the snow to the ground, it showed the exact depth by inch lines on the side.

The tube picked up a core of snow. Using a small spring scale, Gaeton compared the weight of the empty cylinder and the weight of tube-plus-snow. A simple conversion gave him the exact water content of the snow at each sampling spot (opposite page).

The standard kit contains six tube sections that permit gauging snow to a depth of 15 feet. In areas of heaviest fall 20 feet of tubing often is needed!

Gaeton deftly juggled the tube in what I called the Ritual Dance of the Snow Surveyor.

"Sample number seven: Snow depth four two point zero. Core three six point zero. Full weight three three point zero." Gaeton called off the mystic numbers to recorder Bob Branstead. "Water content one two point two five inches; ground frozen."

Reports Sent by Radio

We had a nightly short-wave radio schedule with W. T. (Jack) Frost, head of Oregon snow surveys, at his office in Medford (page 693). Each day's snow measurements were reported the same evening. Integrated with many other records, these figures gave the basis for the April 1 water runoff forecast for Oregon. That's the most important forecast of the year. By April, water users have to know how much of the priceless fluid will be available during the coming summer.

Furrowing our way among ruddy-barked ponderosa pines, we reached the south entrance road to Crater Lake National Park the next afternoon.

Men waved at us from a staff car and a truck. It was a welcoming group from park headquarters.

Drawn by H. R. Eastwood and Irvin E. Alleman

Snow Surveyors Traced a 573-mile Route Along the Spine of the Oregon Cascades

To test snowmobiles for this work, Operation Sno-Cat Cascade rambled south-to-north on the first completely mechanized snow survey. Heavy spring blizzards slowed progress, later contributed to disastrous Columbia Valley floods (page 710). The party crossed Crater Lake National Park and skirted white cones of Mounts Jefferson and Hood, the latter Oregon's highest peak and heart of a popular skiing area.

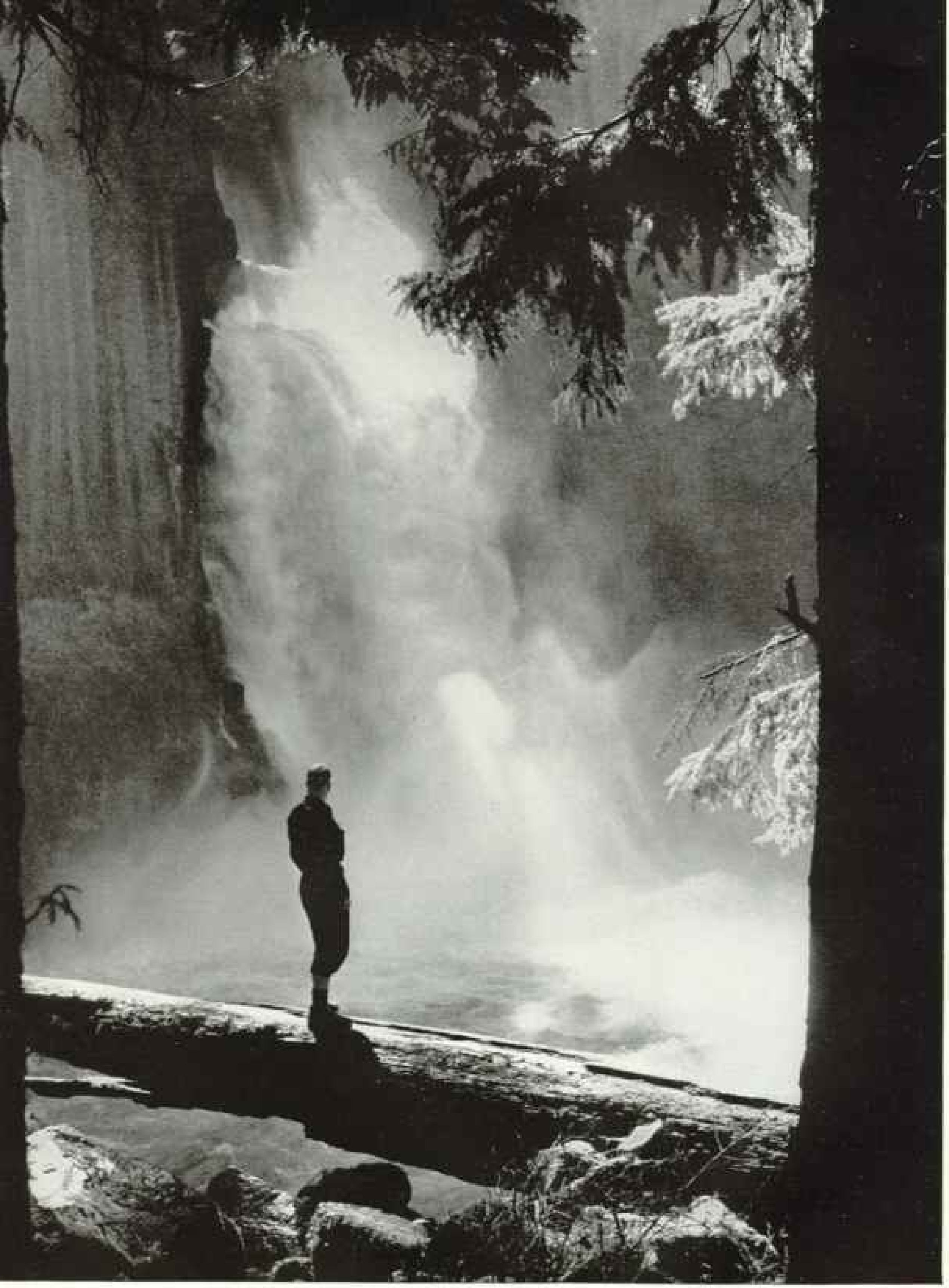
Near White-clad Mount Thielsen, Deep, Soft Snow Promises Abundant Water for Rogue River Orchards

On the road between Union Creek and Diamond Lake, the expedition halts for leg stretching and picture taking. Skis and snowshoes, used on short trips, are strapped atop the five- and two-passenger Sno-Cats. Ski-mounted trailers haul equipment and also serve as sleeping quarters.

Bell Construction Service

Unable To Find a Cabin, Surveyors Spend a Chilly Night under Canvas Stretched Between Snow Walls

Although snug huts dot the Cascades, darkness and storms often forced the party to improvise shelter. At Watchman Junction they slept in a hole 12 feet deep (page 701). Under the tarpaulin are (left to right) Arch Work, Dr. Harvey Woods, Photographer Jack Fletcher, Jasper Tucker, and the author.



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Toketee Falls, Fed By Mountain Snow, Thunders Down the Sheer Face of a Basalt Cliff

Soon to be stilled is this cataract on the North Umpqua River, northwest of Crater Lake. As part of a hydroelectric project, the river will be diverted through a tunnel from above the falls to a powerhouse downstream (page 701).

Evergreen Boughs Thrust Through the Snow Walls of Bob Branstead's "Kitchen"

In camp near Watchman Junction, the cook prepares dinner in stainless steel pots. His three-burner gasoline stove rests on logs to prevent melting the "table." This shelter, a 12-foot hole dug in the snow, also served as dining room, living room, and bedroom (page 697). Some of the party stretched out in sleeping bags on the snow; others slept in Sno-Cat trailers.

"How's Leo Borah?" assistant superintendent Tom C. Parker asked me. "I knew Borah at Bryce and Zion National Parks in southern Utah and, later, here at Crater Lake when he was writing NATIONAL GEOGRAPHIC stories on those areas." * (Parker has since retired.)

Parker and chief ranger Clyde Gilbert offered us lodgings at the park base.

"We'd rather not drive up the plowed road," Arch told Parker. "We'll climb to the rim by the Yawkey Road. With the snow this deep it'll be three or four hours before we get there."

Not three, but 33, hours later we admitted we were licked by blinding blizzard—and the Yawkey Road. In the interval, we shoveled! Snow by the ton flew off our big steel scoops as we fought to keep the Cats moving.

On steep slopes the Sno-Cats dug in until they rested on their bellies. When they bogged down this way ("She's high centered!" was our phrase for it), there was nothing to do but dig them out. Our hands grew gnarled and calloused.

When we were plumb tuckered and rested on our shovels, gasping for breath, Arch grinned and said,

"Remember, boys, we're not busting our backs just for fun! We're helping some farmer grow the right crops with the water he'll get. And the reports we send in may keep some Main Street lighted on Saturday night."

Headlights and flashlights illuminated our final struggles when we used a tow bar and lengths of cable. It was 10 o'clock at night and the storm still howled. We had to backtrack to the plowed road and rattle up to

* See, in the NATIONAL GEOGRAPHIC MAGAZINE, by Leo A. Borah: "Oregon Finds New Riches," December, 1946, and "Utah, Carved by Winds and Waters," May, 1936.

Crater Lake Snow Piles 20 Feet Deep, Bringing Joy to Skiers and Water Consumers

White blanket on ground and trees brings out the rich, dark blue of the waters surrounding Wizard Island. To reach the lake's rim, 7,000 feet above sea level, Sno-Cat surveyors battled a blizzard for 33 hours (page 699). The girls are about to run one of the ski trails on the outer slopes of the huge crater. Because of the lake's great depth—maximum, 1,996 feet—and moderate winter temperatures, ice rarely forms on it.

park headquarters on paving. Ignominious!

Our second morning at Crater Lake we found that a pack rat had been whiskering through our stuff. The rodent kleptomaniac had made off with one of Jack's felt inner soles. Sharp teeth had chewed Jasper Tucker's rawhide bootlaces into short, useless scraps.

On the Cone of an Ancient Volcano

We skirted the vast bowl of Crater Lake (above). Its matchless majesty of cliff and dark waters showed fleetingly through snow squalls.*

To dodge snowslides, we dropped down from the rim, tracing gullies that once spilled hot lava from the fiery maw of ancient Mount Mazama.

The way twisted among trees so thick we had to trim off hefty lower limbs to worm through. In summer these branches are 20 feet above ground. Floundering to the chopping spots was like wading through a bin of chicken feathers.

We had a scare. Jack Fletcher and Harvey Woods were riding the front skis of one Cat. This gave extra traction to the steering skis on steep turns. As the steel steed dove down a short pitch, Jack felt the ski he rode slide toward a tree.

He jumped just in time! When the Sno-Cat struck the tree, Harvey fell off in a drift. Men pulled him out. In the excitement no one noticed, for a moment, that Jack was missing.

As calm was restored, we heard a muffled voice: "Hey! Get me outa here!"

Arch found Jack so deep in a hole under the tree that the snow surface was four feet above his head. Jack said the Sno-Cat's left track missed his right ear by inches.

* See "Crater Lake and Yosemite Through the Ages," by Wallace W. Atwood, Jr., NATIONAL GEOGRAPHIC MAGAZINE, March, 1937.

Helped by Shovelers, a Sno-Cat Struggles up Ruddy Hill in the Teeth of a Storm

Battling over a high pass, the snowmobile threatened to slip sideways down the slope. A shovel squad, pelted by bulletlike snow, slogged ahead digging a 1,000-foot trench (page 708). The wall thrown up along the downhill side kept the Cats on course.

At midnight we were digging down through 12 feet of snow to find ground on which to build a fire. We were at a place called Watchman Junction. We had spent the evening hunting for a cabin we never found. Bone-weary, we made camp as snow still sifted down (page 697). Our fire, flaring into blessed life, threw flickering light on white-mantled pines and firs.

Stopped by the deep soft powder, we tried to locate an alternate track, a dotted line on the map. Arch and three helpers, fanning out on skis, couldn't find it.

Sunshine Cheers the Party

Our short-wave radio finally pulled us out of that jam. Arch raised his office in Medford the second afternoon. Another Sno-Cat found its way in to meet our bogged-down cavalcade. We were sprung at last from our snowy trap.

One of the only two full days of sunshine on the trip cheered us immensely on the run along the beautiful upper Rogue River.

"That rushing water's mighty pretty," Arch said, "but it's also 'liquid gold.' We recently made a dollars-and-cents estimate of the value of Rogue River water. The study showed that 2,624,000 acres of this drainage basin produced water, mostly from snow, that was worth $10,800,000 for irrigated crops, power generation, and municipal water supply."

Passing Mount Bailey's bald dome and the needle spike of Mount Thielsen (page 696), we clattered on to a cabin beyond scenic Diamond Lake.

West of this point, 20 miles down the North Umpqua River, Jack and I later visited thundering snow-fed Toketee Falls (page 698). There the California Oregon Power Company (locally "COPCO") is rushing a 40,000-kva hydroelectric installation to help meet Oregon's mounting power hunger.

John C. Boyle, vice president and general manager of the company, showed us a striking job of engineering.

Waxing Makes Sno-Cat Steering Skis Glide Smoothly over Snow and Ice

Jasper Tucker removes a Cat's hickory runner from the steering yoke (upper left). After ice is scraped off with a knife (below), the ski is coated with paraffin and tar. With a blowtorch Arch Work smooths the wax (upper right). A steel keel on the ski protects against rocks and aids steering.

Easter Sunday began with warm, bright weather that packed the trail. We sped through close-ranked pine trees up switchbacks to Windigo Pass. There we crossed into the watershed of the Deschutes River. Water diverted from that stream irrigates grain and cattle country east of the Cascades.

At Crescent Lake, we reveled in the luxury of sheets and hot baths. Next day we rambled on past Odell Lake to Davis Lake. There a black jumbled lava flow looks as if it had cooled last week instead of two thousand years ago.

The Cascade Range is largely lava-built. Forests and meadows cloak slopes and summits once seared by streams of liquid fire and pelted with ash and flying rock. "Pummy" (pumice) desert and slaglike lava flows testify to volcanic activity that once raged from California to the Canadian border.

In porous volcanic formations water does strange things. Brimful rivers shrink in a few miles to shallow trickles. Contrariwise, clear cold streams burst full-volumed from the ground in bubbling springs.

We passed Wickiup Reservoir, a man-made lake. It lost, we learned, 1,000 acre-feet of water a day through sievelike lava banks that seemed sound when the dam was built. Major leaks have since been plugged.

The night of March 29 we made early camp in a holiday mood at Browns Creek cabin, the halfway mark on our route. Bob was frying steaks when visitors appeared, rolling up to the door in an ex-Army weasel.

"Why, you ornery ole polecat, you!" Arch greeted long-time friend Bill Childreth. With him rode Bill Dean. They'd been measuring stream flow and a snow course at isolated Waldo Lake.

After supper Bill Childreth and Arch fell to yarning about shared adventures.

"Remember, Arch, that trip we were *really* tired?" Bill asked.

Arch grinned and nodded.

"Arch and I'd had a rugged day, pretty close to 25 miles on skis," Bill recalled. "We found our cabin late, grabbed a bite, and tumbled into our sleeping bags like steers felled with a club.

Robbed by Father Time

"Later I woke. It was just dim dawn, so I rolled over for a few minutes more. A while later I cracked an eye again. It seemed darker. Well, I thought, clouds must've come up. Finally we both woke. Bright morning sunshine was a-beamin' down.

"When we got to town that afternoon, we noticed a calendar in a store window. It said 'February 8.' We just looked at each other. I knew we'd measured the snow course on the 6th.

"Suddenly the truth struck us. That 'dawn' light I'd seen was sunset light! Arch and I had slept through a whole day."

Just out of Browns Creek the nut locking the left pontoon to the axle on Arch's Cat dropped off. This mishap cost us a day, the only serious mechanical delay on the trip. Arch and Jasper had to go 50 miles northeast to Bend to have the axle repaired.

Gleaming Summits Pierce the Sky

All April Fool's Day splendid scenery flowed past us in a glorious panorama. We pushed up into the heart of great mountains: the broad cone of Bachelor Butte, the steep peak of South Sister, and jumbled crags of Broken Top. Gleaming summits lifted high above tree line.

We circled Elk Lake, a perfect Christmas card scene complete with snowy pines and half-buried cabins. At Devils Pass we clawed up a steep snow gully under beetling black cliffs. Huge boulders seemed ready to plunge down on us at a touch.

At our Soda Creek camp snow was too deep to dig through. Arch laid green logs and built the fire on them. Even so, by morning the fire and hot coals had melted a round hole eight feet deep.

Log fires at our sky camps warmed us and dried our wet clothing. Bob cooked on two gasoline stoves, with a total of five burners (page 699). Wood fires also helped with melting snow. At several camps there was no open stream or pond. We had to melt snow, a slow and exasperating procedure, not only to get water for dishwashing but even to fill canteens.

It was ironical to be almost buried in frozen water—and not be able to spare enough of the precious melted liquid to brush our teeth!

Friday, April 2, we pushed dizzily up, up, and up among peaks and clouds that fought back with blinding snow and moaning winds. Ten minutes out of Soda Creek, Arch stopped his Cat on a steep side hill. Like a combat commander, he swept his arm forward over his head in a familiar gesture. It meant: "Send up one wave of shovelers!"

Late that afternoon, after measuring the Dutchman Flat snow course, we smacked into a bit of going as vicious as anything we hit.

Twisting around the base of Ball Butte, Jasper twirled the stiff steering wheel until sweat beaded his brow. We seesawed along,

"First Come, First Served" Is the Rule in Water Supply

When water is plentiful in Oregon's pear-raising Rogue River Valley, farmers may have all they need for irrigation ditches. In dry periods, those with oldest water rights get priority. Most requests are telephoned; after office hours, they are left in this doorway box. Here Bob Kent, of the Talent Irrigation District, collects orders.

staring one moment into folds in the hills and the next upward at snowy skies. I closed my eyes. We were riding a roller coaster with elliptical wheels!

I recall brushing a couple of cameras out of my eyes. On the 30-degree slope they slanted out from their hanging place on the side of the Cat.

Blizzard "Helps" To Make Camp

Our snow camp at Marker 32, below Ball Butte, was among huge old hemlocks at nearly 7,000 feet elevation. As we off-loaded the trailers, visibility was about 100 feet in thick snow driven by a half-gale.

"You'd think a battery of wind tunnels was blowing tons of white confetti at us," someone exclaimed, "if it wasn't so danged cold!"

We carefully thrust axes and shovels upright in the snow. Anything laid flat was buried in two minutes. With tarpaulins we fashioned a roof and windbreak lashed to trees and weighted with snow blocks. The windbreak kept the drifting snow from burying us, but also spoiled the draft for the fire. Acrid hemlock smoke made us weep. All evening we were running out into the storm for a breath of fresh air!

Bob shrewdly defied the elements with a sumptuous dinner of pea soup, ham steaks, corn, rice, plums, and coffee. Full of hot food, everyone was chipper again. Then it was broadcast time. That was the only night Arch had to set up the radio inside a Sno-Cat for our 7 p. m. contact with Medford.

We heard Arch's muffled voice patiently repeating the call:

"This is Sno-Cat calling K-B-E-I. Calling K-B-E-I, Medford. Come in please, K-B-E-I! Sno-Cat to K-B-E-I, K—B—E—I. Come in, Jack! Sno-Cat calling Kay-Bee-Ee-Eye."

Then—faintly, reassuring—we heard Jack Frost's voice, calm and confident. Contact!

"Hello, Sno-Cat. Here, Kitty, Kitty, Kitty! I hear you very well. Come in, Sno-Cat. Over to you!"

Frost had the gratitude of us all. He did a wonderful job helping us from home base. In effect, he was an eighth member of the party, constantly working, *in absentia*, to aid our progress.

"Let's go, you Cat skinners! Everybody

up!" Arch's cheerful call routed us out early in the morning.

A few minutes later Jasper passed by the trailer Jack and I slept in. Glancing through the open door, Jasper was alarmed to see Jack rolling and tossing on his sleeping bag.

"What's the matter, Jack? You sick? Shall I call the doc?"

Jack stopped his contortions and grinned at Jasper: "Don't worry, pal! I'm just squeezing the air out of my air mattress."

The sun ducked in and out of clouds as the Sno-Cats "laid their ears back" plunging down to Tumalo Creek through hoary hemlocks. Dark trunks, drooping branches heavy with snow, and racing patches of sunlight made a setting of Wagnerian splendor and somberness.

From the town of Sisters our Sno-Cats clattered swiftly over Santiam Pass and down to the little lumbering town of Detroit. Now we were on the west slope of the Cascades, in the gathering ground of the North Santiam and other streams that feed the Willamette River, trunk stream of one of America's richest agricultural valleys.

Turning back into the high mountains, we stopped the night of April 5 at Breitenbush Hot Springs. As we pressed on toward the end of our journey, travel grew easier. Snow was well packed and the trail smooth and easy to find.

An Expert on Water for Others, He Uses It Sparingly Himself

Bob Branstead fills a canteen from a stream near Upper Klamath Lake. The party often went without water for washing. Snow was plentiful, but melting it over a fire was usually a slow, exasperating process (page 703).

Arch Has a Narrow Squeak

Tuesday our "hard luck boys," Arch and Jack, had a close call with the lead Cat. Arch crossed a deeply buried bridge over a swift creek. Sculptured by wind, snow had built up in a slanting pile on the bridge and had corniced on the upstream edge.

Half the snow bridge collapsed just as Arch's trailer pulled off it. By a margin slim as a dime Arch and Jack were spared a dunking in a cold black stream.

Arch didn't talk much about the adventurous, hazardous side of his work. Of course danger is not the daily fare of snow surveyors. But they get backed into nasty corners now and then. Gaeton told us how Arch once almost came a cropper.

Arch climbed on skis to a high shoulder of Devils Peak at the head of the Middle Fork of the Rogue River. He jammed his ski poles into the snow, one on each side of his tracks, then went out on a snowy shelf to take motion pictures of the valley below.

When he turned back to pick up his ski

Ray Atkeson

Giant Reservoirs, Like Eastern Oregon's Owyhee, Store "Snow-melt" Water To Irrigate Once-desert Farmlands

Swift Waters of Hell Creek, Knifing Through Deep Snow, Carve Tiny Islands Like Frosted Cakes

Operation Sno-Cat Cascade halted to let members of the expedition admire this winter phenomenon near Devils Pass. Dark streaks show how snowfalls added layers to the mounds built upon sandbars. Some islands rise eight feet above the stream's surface. Sno-Cat and trailer wheels drop down for travel on open ground.

poles, one of them was gone. Where it had been was a round hole. Arch peered down this window in the snow floor—and saw Cliff Lake a thousand feet almost straight down! He swallowed hard and trod mighty gently back to solid rock.

All unsuspecting, he'd casually walked out on a thin snow cornice overhanging a sheer drop nearly as high as the Empire State Building. Later, Arch showed us a movie sequence of the forest far below taken right through the hole!

Up the icy slope of Ruddy Hill we dug a 1,000-foot ditch for the Cats, blasted the while by hard, stinging snow (page 701). We measured the Olallie Lake snow course and reached the Forest Service guard station at the north end of the lake as the storm quit. Sunset gilded the forest.

That was our last night away from civilization. We feasted on thick steaks and fed huge logs into the fireplace. After supper, lusty voices lifted in loud but tortured harmony. Some prankster stuffed shoes, chunks of wood, empty jars, and wet socks into our sleeping bags.

Sunrise came calm and clear on April 7. To the south mighty Mount Jefferson doffed a cloud cap from its 10,495-foot cone. Framed by pines, the white frozen lake, and blue sky Jefferson symbolized the beauty and splendor of this wild country.

Bob Thomlinson, special events commentator of Portland's radio station, KGW, was at the Wapinitia Highway crossing to greet us as we approached Mount Hood.

"We've been here a few minutes," he said. (We had estimated our scheduled arrival time by radio the night before.) "We knew Arch Work would make it on time."

I caught Arch covering a wry smile with his hand. By our original itinerary we were six days late already!

In the luxury of Timberline Lodge on Mount Hood we relaxed for a day. Up from Portland to visit with us came N. J. Penick, forest supervisor of the Mount Hood National Forest; L. G. Jolley, assistant supervisor; ranger J. P. Langdon; and fire guard James J. Ralph. With them was Bob Henderson, assistant to the director of the Oregon Experiment Station. Bob finished the trip with us.

Ranger Defines a Rabid Skier

Mount Hood is the West's most populous ski resort for the area exploited. The Forest Service and the Ski Patrol find lost skiers and haul casualties to the doctor.

District ranger Langdon defined a rabid skier for us: "We heard that a skier was helpless up on the peak with a leg fracture. When we got to him, we found him suffering no pain. It was his wooden leg he'd broken!"

Mr. Penick told us of the Forest Service's interest in snow surveys: "The Forest Service attitude toward the forest has changed. We used to be housekeepers of the woods, protecting the trees, regulating cutting, and supervising recreation. In a way, we couldn't see the forest for the trees.

"Now we have a new interest—a vital concern with the water crop the forest holds. We know that the money and welfare value of the snow-melt water grows year by year.

"The snow pack in the forest affects our plans for fire control. It affects stream flow and lake and reservoir levels, of crucial importance to farmers. Sport fishermen also have a stake in water stored on the peaks as snow.

"You'll find every western national forest shares our concern with the high-country snow pack."

Crag Rats Meet Sno-Cats

Friday, April 9, was our last day on the trail. An easy run led us around the east side of Mount Hood to Tilly Jane Creek. Below us lay the fruitful Hood River Valley and the Columbia River gorge.

Our sturdy, long-suffering Tucker Sno-Cats ground to a halt. On hand to greet us were members of Hood River's climbing club, the Crag Rats. Despite dire predictions, cordiality marked the encounter of Sno-Cats and Crag Rats!

We seven members of Operation Sno-Cat Cascade looked, I'm sure, as smug as fishermen with full creels. It *was* a fine feeling to be standing at our goal.

The faithful Cats had ticked off 573 speedometer miles. We had crossed the main divide of the Oregon Cascades 15 times. We had measured 13 snow courses. We were behind schedule for a reason that brought joy to water users: It had snowed on 20 of the 22 days we were on the trail!

This glee was tempered later, in May and June, when runoff from the heavy spring snows devastated parts of the Columbia Valley with record floods.

We never really "had it tough." Arch Work had planned the expedition with utmost care. We always had those essentials to the success of a hard trip—dry bedding, plentiful food, and adequate shelter.

Doc Woods saw to it that we stayed healthy. The only ailments suffered were scratched hands, sore muscles, and blisters from the spluttering tar-and-paraffin we

Jack Frost's Popsicles Make Up in Size What They Lack in Flavor

At Crater Lake National Park, these winter vacationists nibble king-size icicles hanging from a barrack's roof. The expedition spent two days here measuring snow, repairing Sno-Cats, and resting at this scenic spot high in the Cascade Range of southern Oregon.

heated to wax the Sno-Cat skis (page 702). We all owed a special debt to Bob Branstead for fueling us with wholesome food tastily prepared.

"What do you think now, Arch, about the feasibility of mechanizing snow surveys?" I put the question to Work as we downed a Gargantuan dinner in Portland that night.

"Well, Andy," came the considered answer, "I don't think there's any doubt but that motorized snow surveying is here to stay. On this trip, the way I see it, we've proved one point and disproved another.

Sno-Cats Can Streamline Surveying

"Sno-Cats, or similar vehicles, will greatly simplify and speed up trips from the valleys in to the mountain snow courses. But I don't think it'll be good sense to try to run all our Cascade courses in one continuous journey such as the one we've just finished. Too many unpredictable factors. You saw how deep, soft snow and one major mechanical breakdown knocked the props from under our schedule."

"How do you think the best use can be made of over-snow vehicles in snow surveying?" I asked.

"Here's the way to do it," Arch promptly replied. "Putting the Sno-Cat on a truck, two men drive into the mountains to the end of the plowed road. Unloading the Cat, they run in to one, two, or three near-by snow courses, measure them, and are out to the truck again that same night or next day.

"Moving along foothill roads, parallel to the mountains, they repeat the process, measuring maybe 30 snow courses in two weeks. Think of the saving in manpower and effort!"

In city duds once more, Jack and I went with Arch to Reno, Nevada, to attend the 1948 Western Snow Conference. This congress summarizes the year's snow-survey activities of all the Western States.

There we gained some grasp of the larger picture into which our Cascade journey fits as one piece in a puzzle. Viewed as a whole, it was an impressive effort.

At Reno we learned that 180 State, Federal, and private agencies cooperate in measuring the winter's snow crop on western mountains. Here was a heartening example of

mutual assistance, even cutting, sometimes, across barriers of divergent interests.

Able men from all over the West came together to pool their intimate knowledge of mountain snow. They served the various interests of the whole population of the rich but semiarid Western States.

Discussions crystallized for us the reason-for-being of snow surveys and runoff forecasts. It was as clear, if not as simple, as ABC. We learned that:

When farmers can be forewarned of drought, they plant only such crops as can be brought to maturity with reduced water supply. "Outwit the drought" has become a slogan.

They prune, thin, and cultivate their orchards so that they will produce only as much fruit as available irrigation water will bring to marketable size and condition.

They move livestock off the ranges and out of drought-stricken areas before they starve. And they develop wells, storage ponds, and other supplementary water supplies before the situation grows acute.

In years of abundant water supply, on the other hand, farmers can bank extra cash made as profit on added acreage brought under cultivation. Surplus water means "bonus" crops.

At the Reno conference we learned that the water requirement of alfalfa, grain, pasture, orchard, or other irrigated crops for a given soil type can be precisely stated. All this planning saves time, seed, labor, and money. Best of all, it largely eliminates the possibility of total crop failure.

Snow surveys are important, too, in giving advance warning to help in confining flood destruction.

A sentence like "Snowflakes sift down thick and soft to the silent forest floor," summons up a picture of quiet peace and hushed beauty.

Yet what an unruly giant may be unleashed when spring sun and rains melt drifts piled deep on mountain slopes! Rivulets gurgle under the solden snow. Great rivers roar on swirling rampage.

Snow Melt Boosts Columbia Flood

That's just what happened in the snow-burdened Columbia River Basin in the spring of 1948. Warm weather and continuous rains made raging sluiceways of every mountain valley.

The 45-day Columbia flood ran up a heavy toll: Vanport City shattered, with many drowned; a $25,807,300 loss to agriculture, in crops and cattle destroyed in the field; approximately 224,000 acres of farm and grazing land inundated; homeless estimated at 30,000; total losses in agricultural resources alone estimated at $370,307,300.

Early summer floods on many western rivers are due almost entirely to melting snows. The magnitude and time of each flood is, therefore, approximately predictable on the basis of snow surveys.

Pioneer of snow surveying in the West was Dr. J. E. Church of the University of Nevada. In 1919 Dr. Church began measuring the depth and water content of Sierra Nevada snows, whose melting affected the level of Lake Tahoe.

For a decade private companies in California, Wyoming, and Washington made scattered snow surveys. In 1924 Utah started to study the relationship between snow cover and runoff. Five years later Oregon and California were operating State surveys.

Federal Government Backs Snow Surveys

Methods and equipment, however, still were not standardized, nor was there yet free exchange of information.

At last, in 1935, Congress charged the U. S. Department of Agriculture's Division of Irrigation with the task of coordinating and extending the snow-survey program. The work was transferred to the Soil Conservation Service in 1939.

Today almost a thousand snow courses at elevations from 2,000 to 12,000 feet are measured in 12 Western States—California, Oregon, Washington, Arizona, New Mexico, Utah, Nevada, Colorado, Wyoming, South Dakota, Montana, and Idaho—and in British Columbia, Canada.

Nine hundred and forty-one snow surveyors, traveling 30,150 miles in 1948 by ski, snowshoe, or mechanized vehicle, made 40,014 individual snow measurements.

Snow-surveying and water-forecast work in the West is estimated to cost less than a cent for each acre of irrigated land. The West has 21 million irrigated acres!

This is how Arch Work summed up the new hold that snow, as stored water, has on western thinking.

"People in the West," he said, "now recognize that snow is a vital basic resource. They've come to realize it must be measured, conserved, and 'harvested' as carefully as soil, forests, food, and fuel.

"They know that water means life to the West." *

* See, in the National Geographic Magazine: "More Water for California's Great Central Valley," by Frederick Simpich, November, 1946; and "Columbia (River) Turns on the Power," by Maynard Owen Williams, June, 1941.

NATIONAL GEOGRAPHIC SOCIETY

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To carry out the purposes for which it was founded sixty-one years ago, the National Geographic Society publishes this Magazine monthly. All receipts are invested in The Magazine itself or expended directly to promote geographic knowledge.

Articles and photographs are desired. For material The Magazine uses, generous remuneration is made.

In addition to the editorial and photographic surveys constantly being made, The Society has sponsored more than 100 scientific expeditions, some of which required years of field work to achieve their objectives.

The Society's notable expeditions have pushed back the historic horizons of the southwestern United States to a period nearly eight centuries before Columbus crossed the Atlantic. By dating the ruins of the vast communal dwellings in that region, The Society's researches solved secrets that had puzzled historians for three hundred years.

In Mexico, The Society and the Smithsonian Institution, January 15, 1931, discovered the oldest work of man in the Americas for which we have a date. This slab of stone is engraved in Mayan characters with a date which means November 4, 291 B. C. (Spinden Correlation). It antedates by 200 years anything heretofore dated in America, and reveals a great center of early American culture previously unknown.

On November 11, 1935, in a flight sponsored jointly by the National Geographic Society and the U. S. Army Air Corps, the world's largest balloon, *Explorer II*, ascended to the world altitude record of 72,395 feet. Capt. Albert W. Stevens and Capt. Orvil A. Anderson took aloft in the gondola nearly a ton of scientific instruments, and obtained results of extraordinary value.

The National Geographic Society-U. S. Army Air Forces Expedition, from a camp in northern Brazil, photographed and observed the solar eclipse of 1947. This was the seventh expedition of The Society to observe a total eclipse of the sun.

The Society cooperated with Dr. William Beebe in deep-sea explorations off Bermuda, during which a world record depth of 3,028 feet was attained.

The Society granted $35,000, and in addition $75,000 was given by individual members, to the Government when the congressional appropriation for the purpose was insufficient, and the finest of the giant sequoia trees in the Giant Forest of Sequoia National Park of California were thereby saved for the American people.

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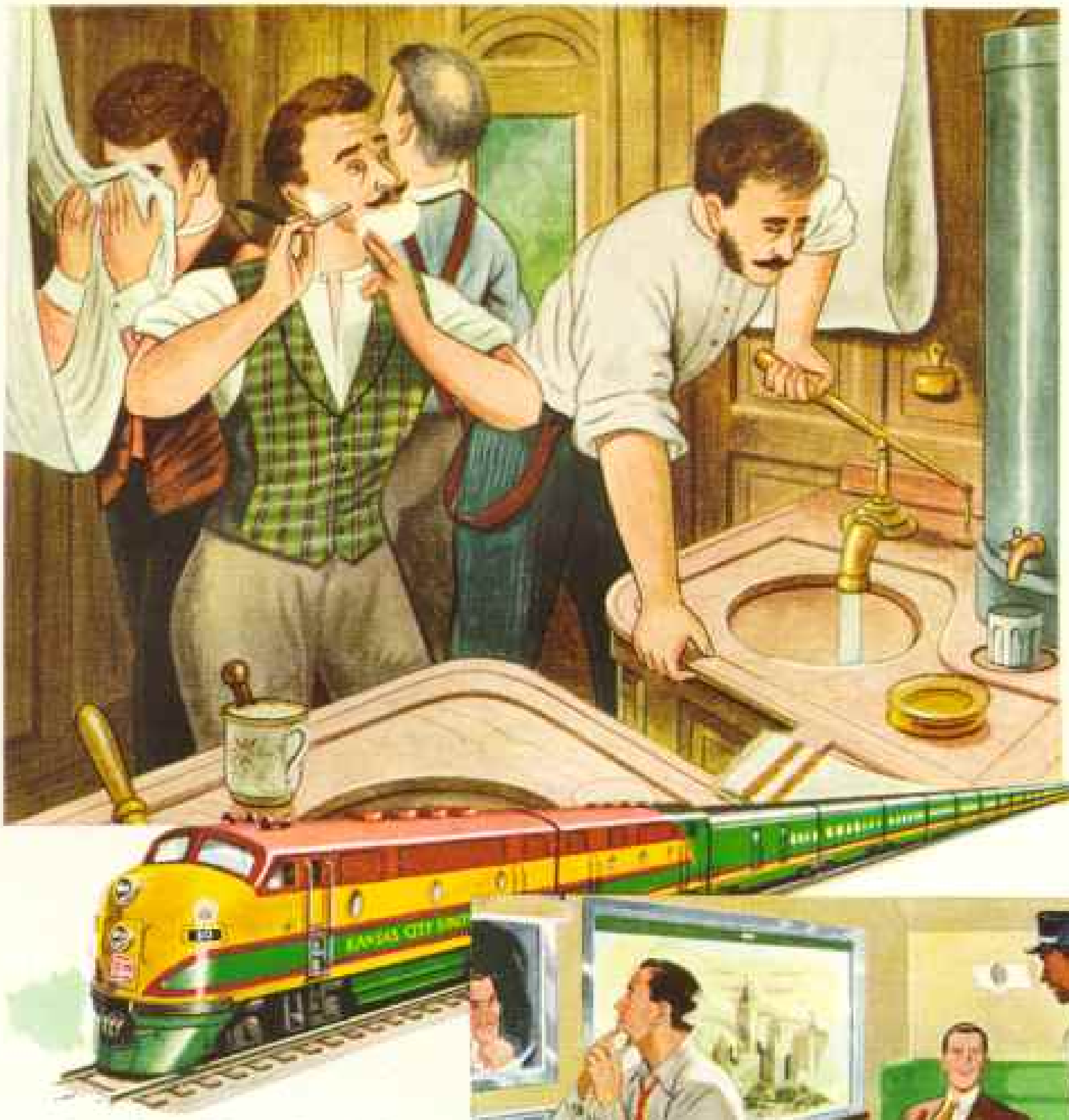

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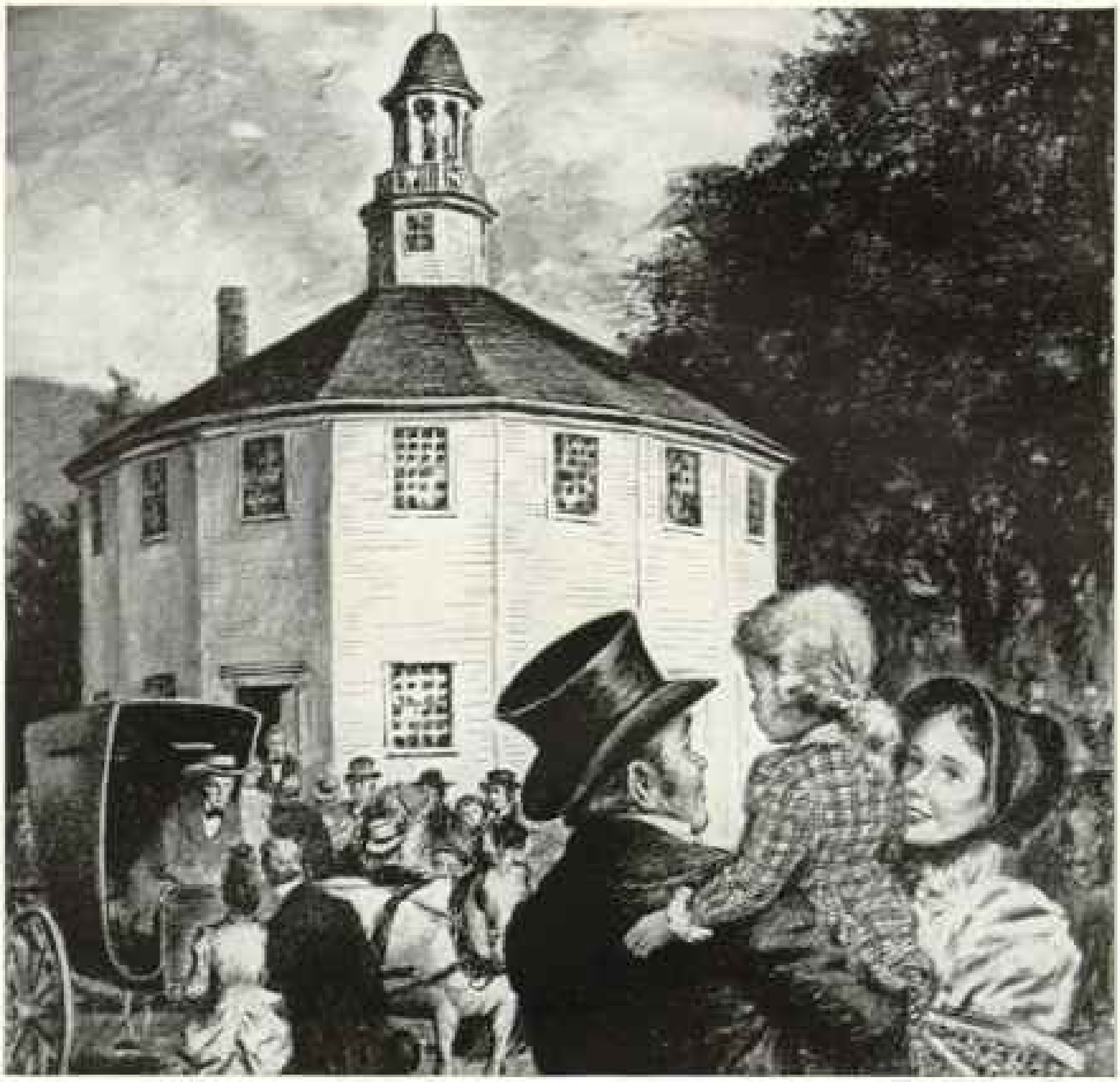

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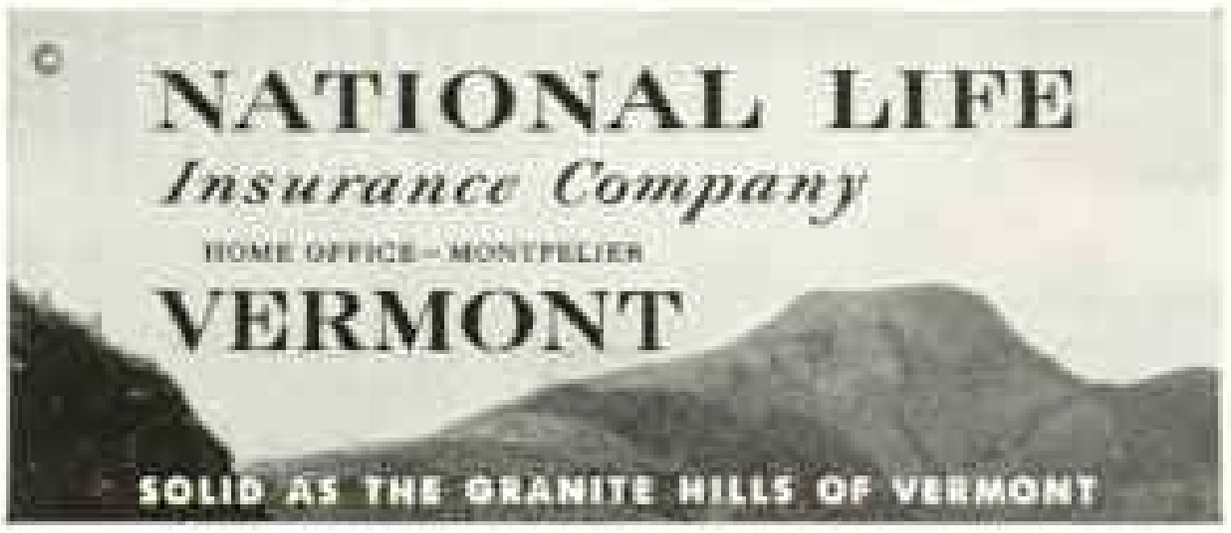

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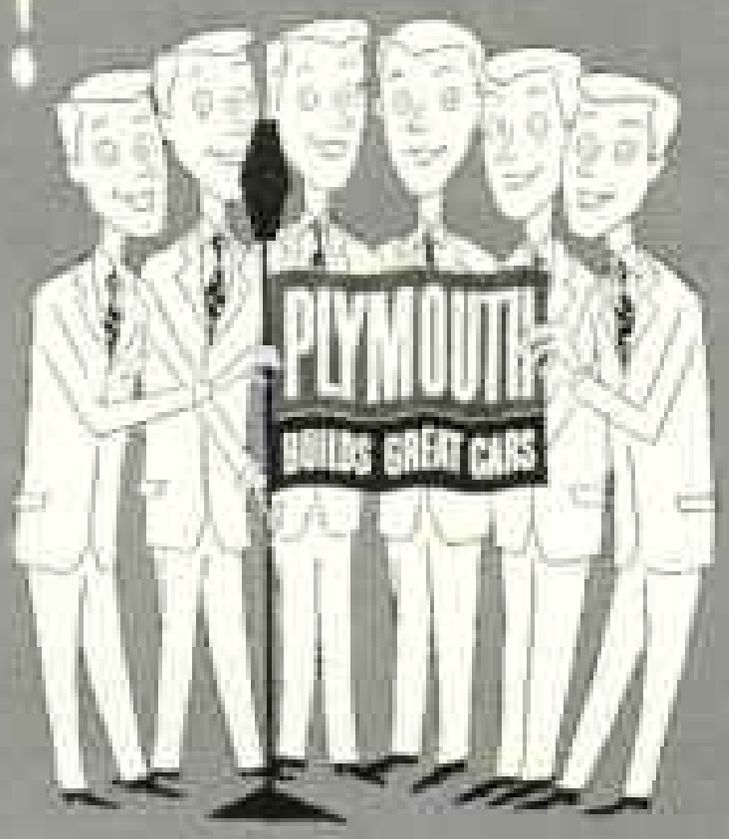

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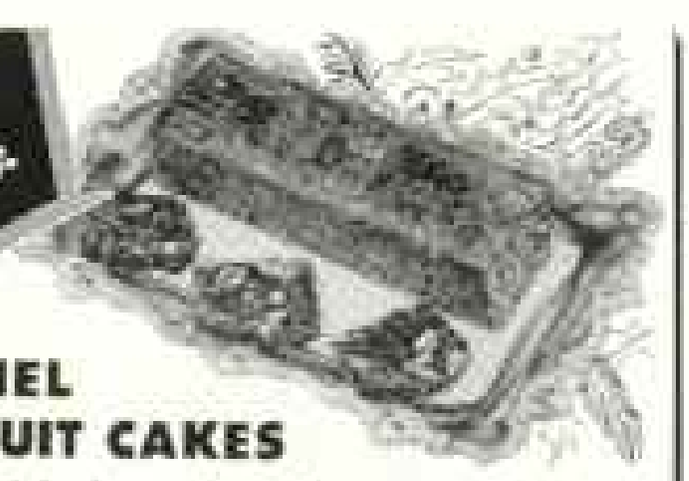

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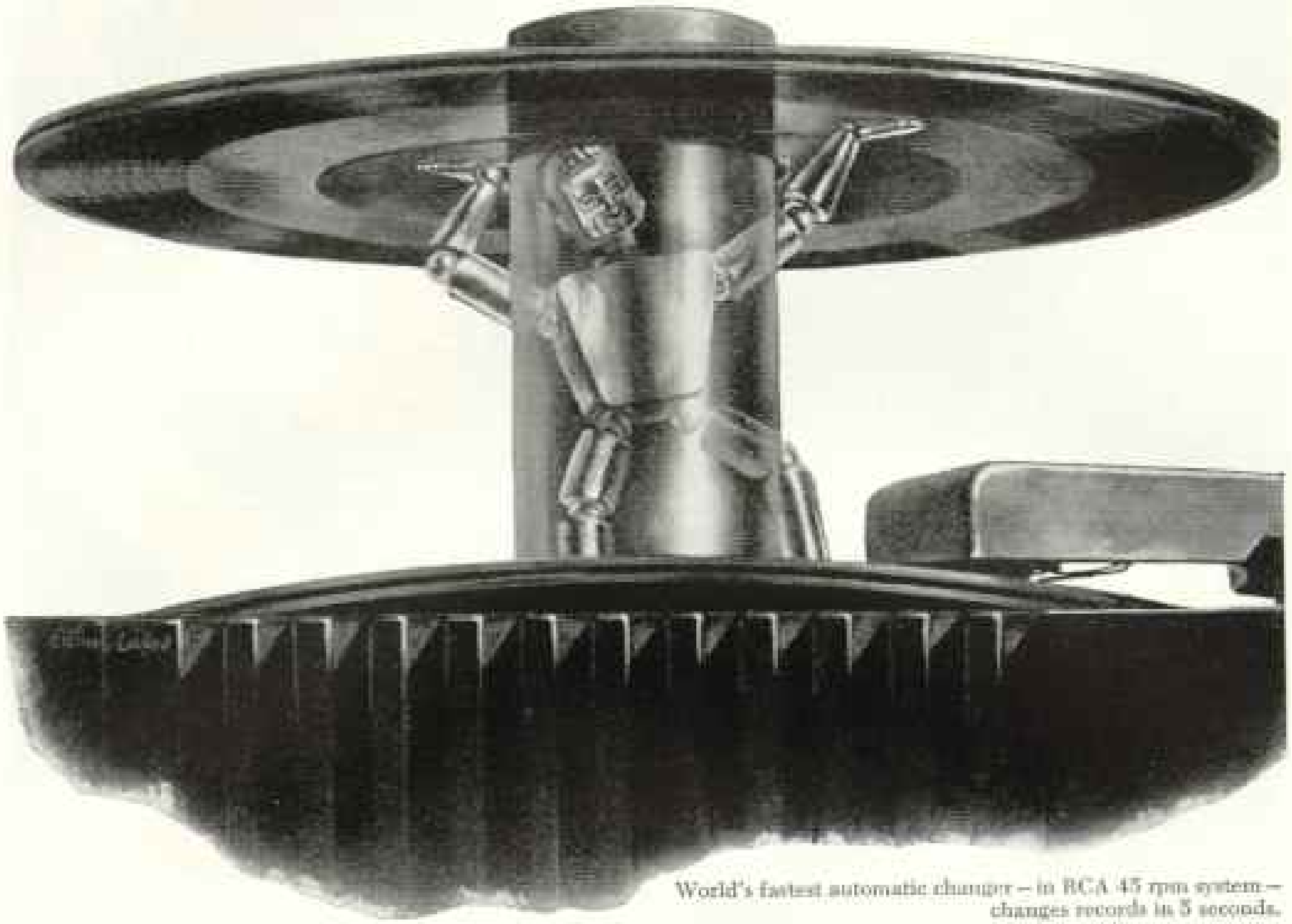

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Remarkable, too, are the new records—only 6¾ inches in diameter—yet giving as much playing time as conventional 12-inch records. Unbreakable, these compact vinyl plastic discs use only the distortion-free "quality zone" . . . for unbelievable beauty of tone.

Value of the *research* behind RCA's 45 rpm system—which was started 11 years ago at RCA Laboratories—is seen in the instant acceptance, by the public, of this better way of playing records. Music lovers may now have *both* the 45 rpm system, and the conventional "78."

* * *

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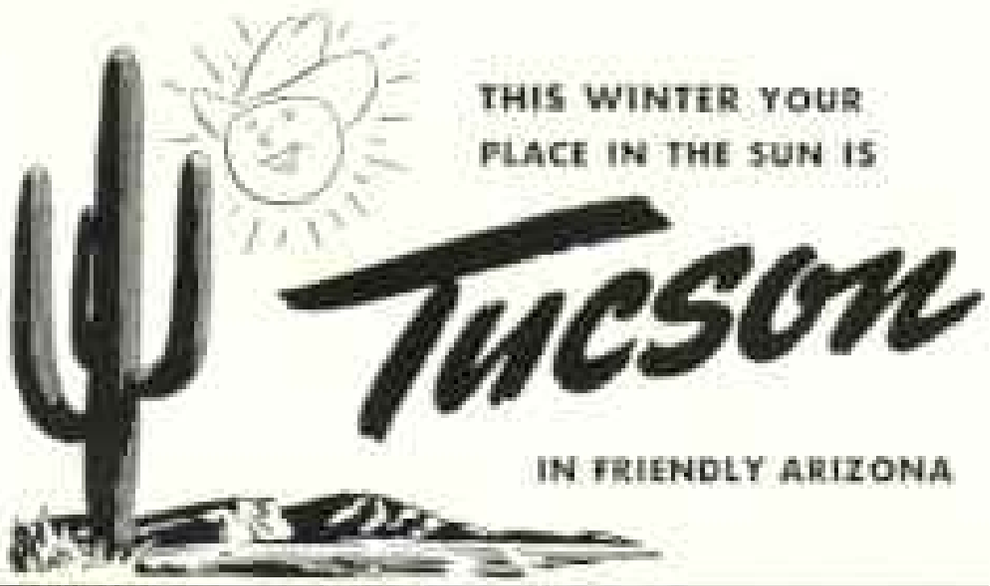

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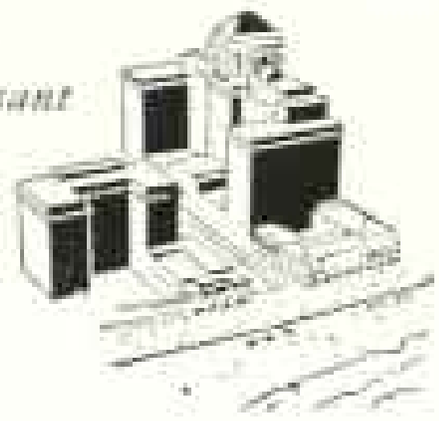

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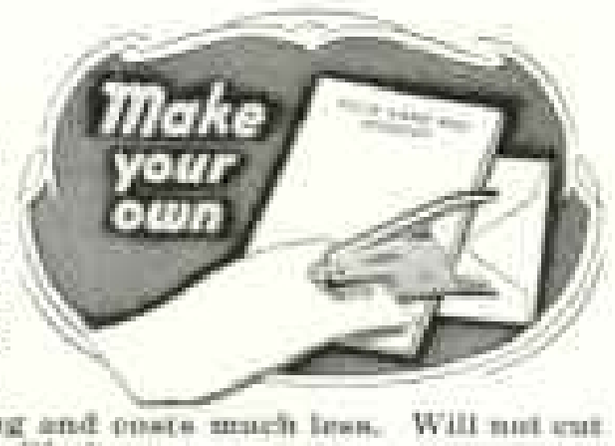

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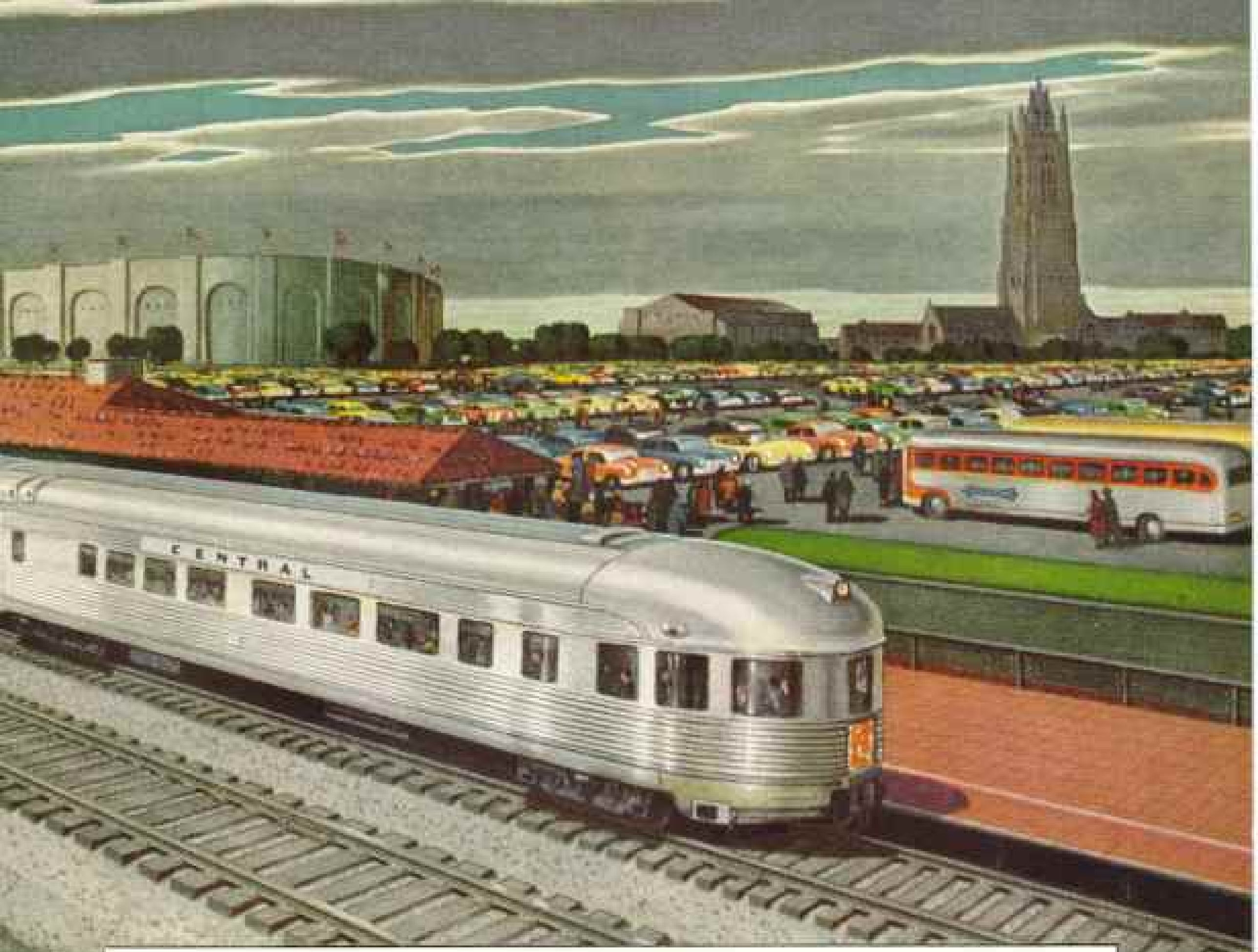

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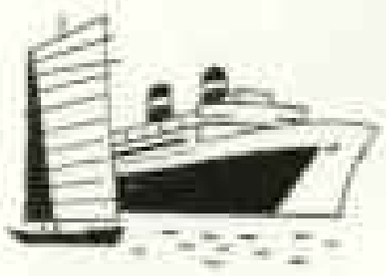

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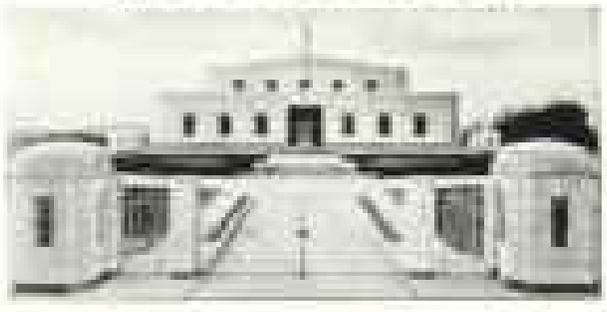

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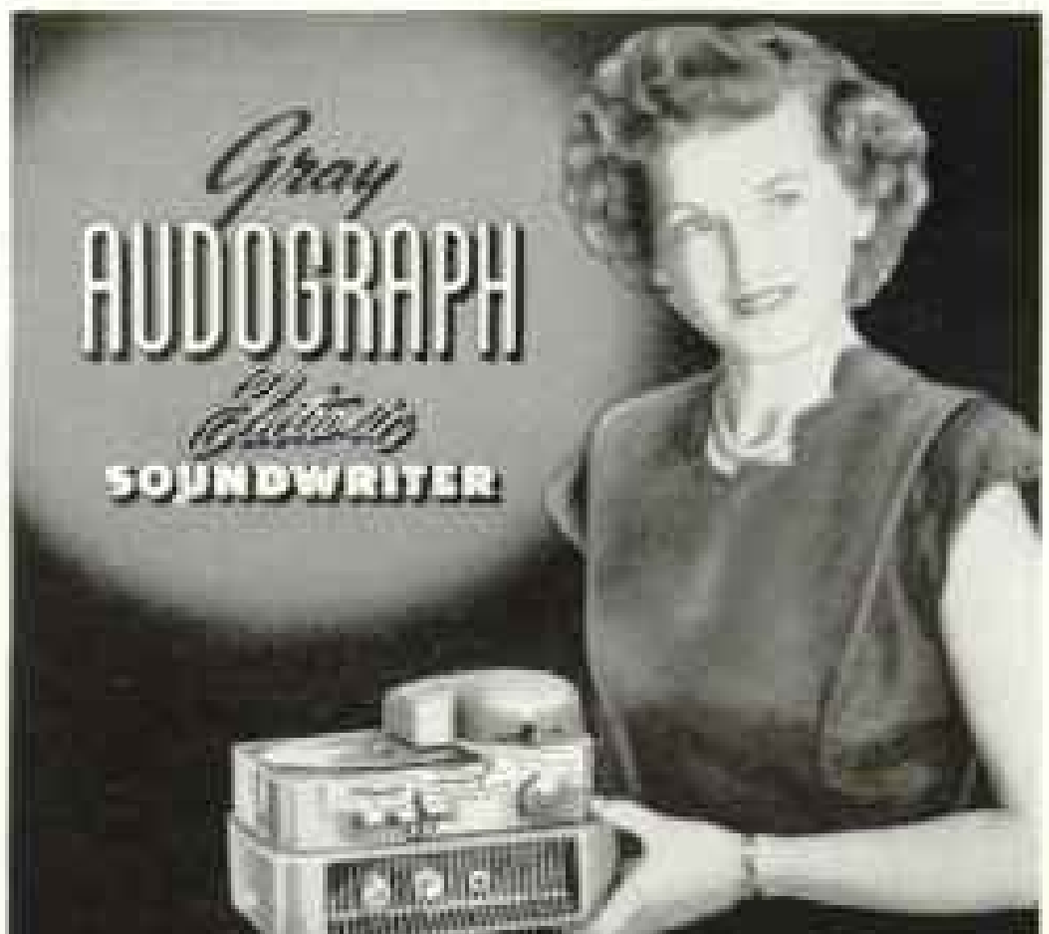

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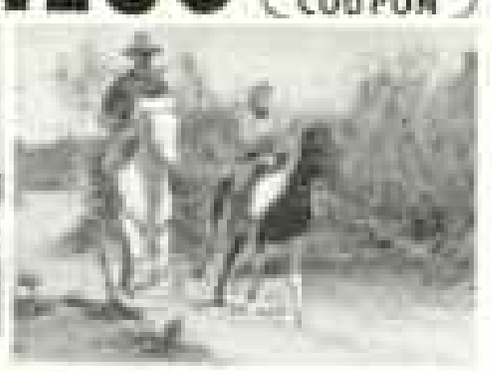

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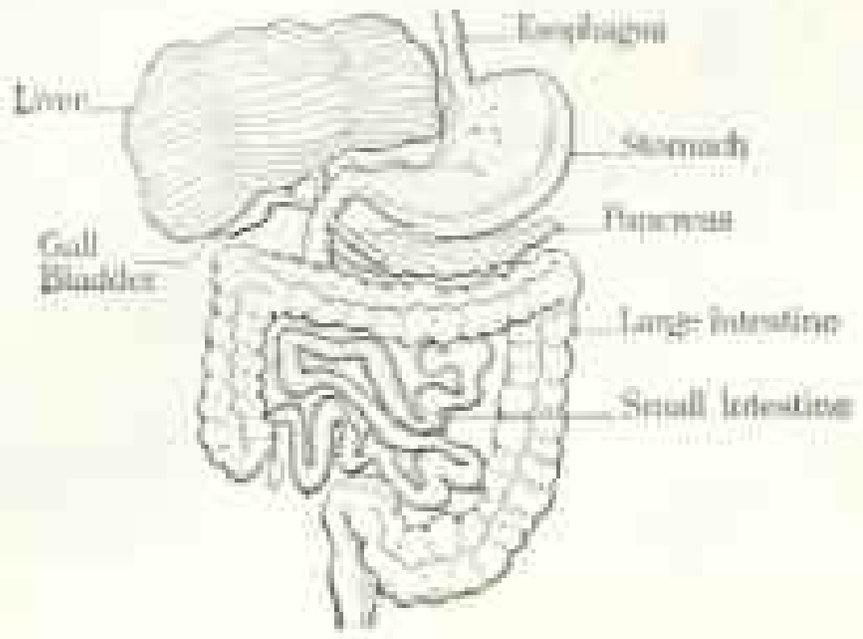

Sometimes, however, the digestive processes fail to function properly. This may be due to faulty eating habits, infections, fatigue, food allergies, emotional disturbances and other causes and may lead to minor as well as serious digestive disorders. In fact, studies show that digestive troubles are more common than any other ailments except those of the respiratory system.

1. Avoid eating when rushed or when emotionally upset.
2. Keep the teeth in good condition so that food may be chewed thoroughly.
3. Drink adequate amounts of water (six to eight glasses a day) and establish regular habits of elimination.
4. Do not eat too much or too often.
5. Cultivate an appetite for a wide variety of foods, especially those that are rich in the essential nutritional elements.
6. Avoid strenuous exercise immediately after eating.
7. Do not resort to self-treatment. If digestive complaints persist, consult the doctor.

Modern medicine has developed many instruments and tests which help the doctor to diagnose digestive disorders with great accuracy. For instance, X-rays permit the doctor to follow "test meals" throughout the digestive system and to observe the position, size, shape, and movements of the digestive tract. In addition, chemical tests and analyses give him essential information about whether the digestive organs are functioning properly.

Some digestive conditions are so trivial that they can often be corrected by surprisingly simple measures, such as eliminating trouble-making foods from the diet. Others are serious and, if allowed to progress, may affect general health, and require prolonged dietary restrictions or surgery.

So, it is always wise to seek medical advice for *persistent* digestive complaints such as pain, nausea, "indigestion," or even continued lack of appetite. The doctor, in most cases, can quickly discover the causes and suggest corrective treatment that may help to insure better digestion and better health.

His ears give Dipodomys a head start

THE LARGE KANGAROO RAT, *Dipodomys spectabilis*, lives in an underground house built for easy escape from marauders.

His dwelling is a maze of tunnels and cozy chambers. And there are many exits, any of which Dipodomys can reach in a flash—should a coyote, or other enemy, start digging for him.

Even such a silent intruder as a snake, slithering down one of his front halls, seldom catches Dipodomys unaware. For he hears two ways—through the air and through the ground.

Large resonance chambers, which take up half his skull space, allow him to detect dangerous visitors through the ground vibrations they make as well as the sounds. And he scoots the other way before he loses the head start his remarkable detection gives him.

With his supersensitive hearing and his many-doored house, Dipodomys seems well equipped by nature to duck trouble. But in dealing with misfortune, man has gone Dipodomys and nature one better. For man not only has figured ways to get out of the way of trouble. He can also provide, through insurance, for losses which his unavoidable misfortunes may entail. Think of this:

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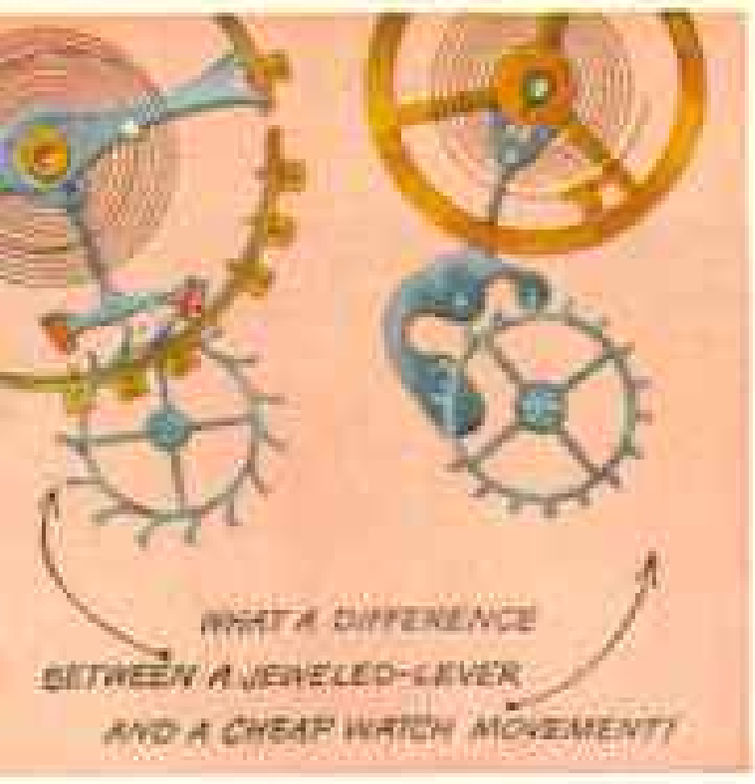

3. **Quality balance wheel** is precision-made for maximum accuracy. Cheap balance wheel is stamped out, not adjustable, apt to rust. *Don't be fooled by so-called "bargains"—you usually get what you pay for!*

4. **The jeweled-lever Swiss watch** you buy today reflects styling and craftsmanship that are a heritage of Switzerland. *A fine Swiss watch is a treasure of lasting pride for you or the fortunate one who receives it.*

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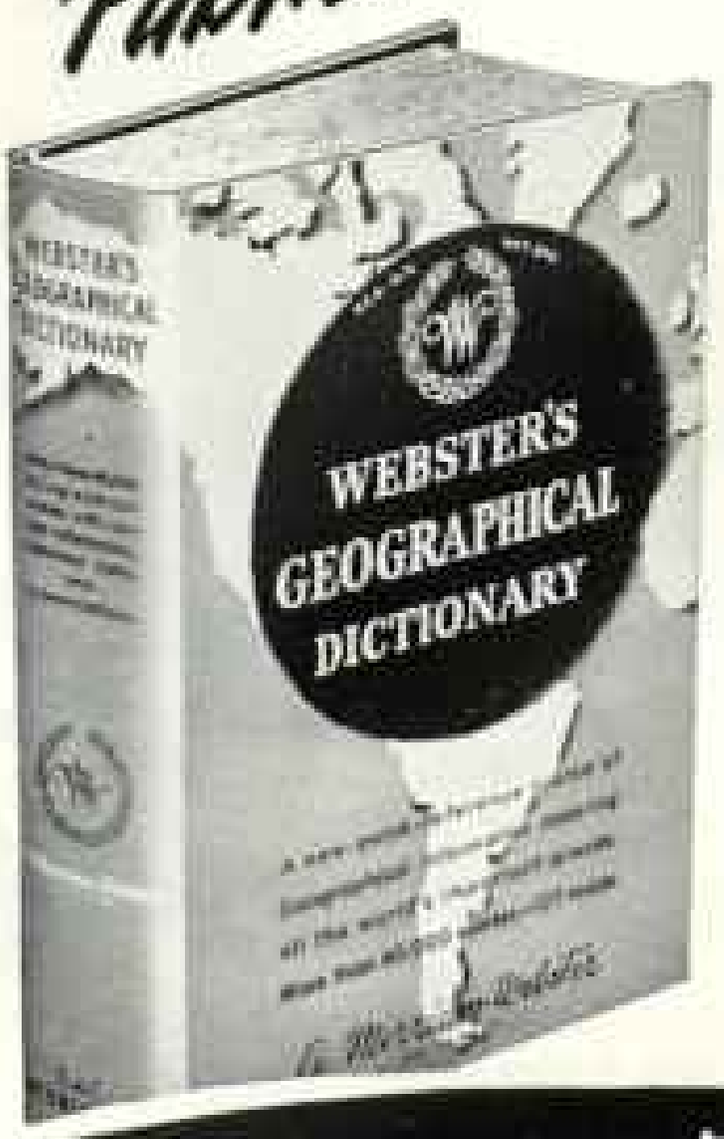

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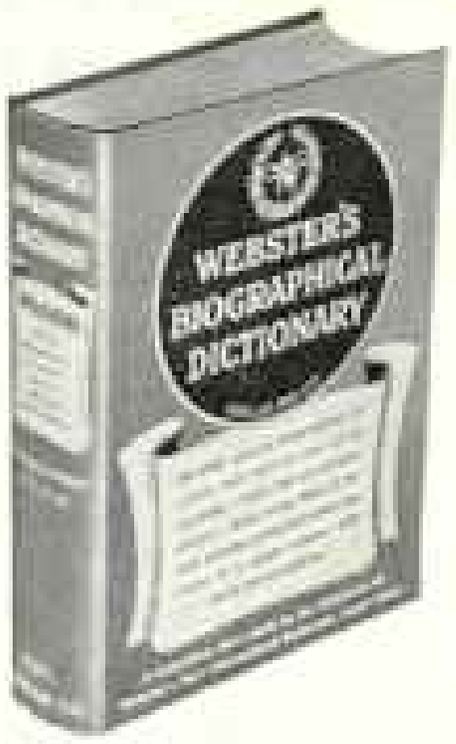

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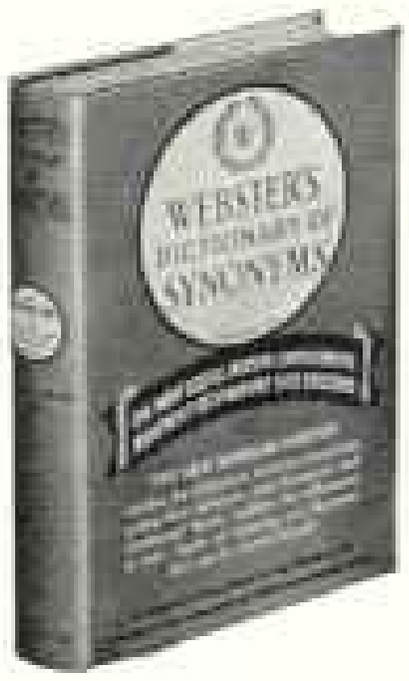

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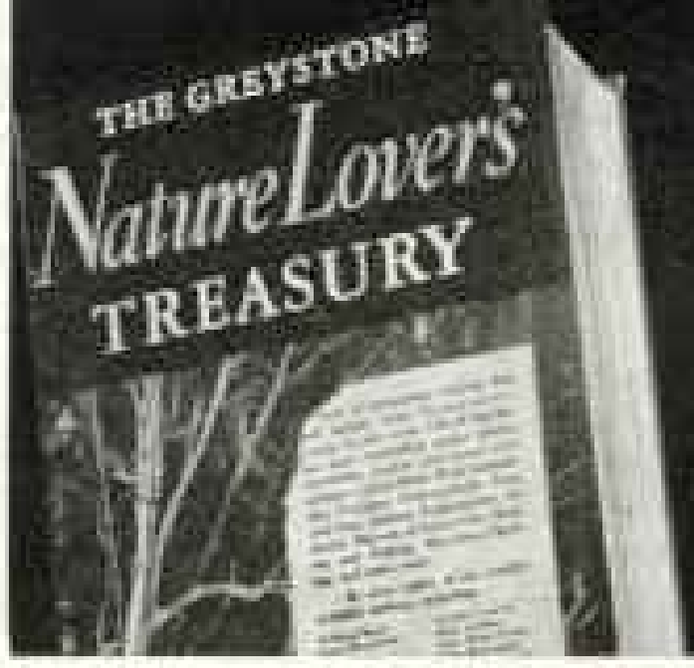

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