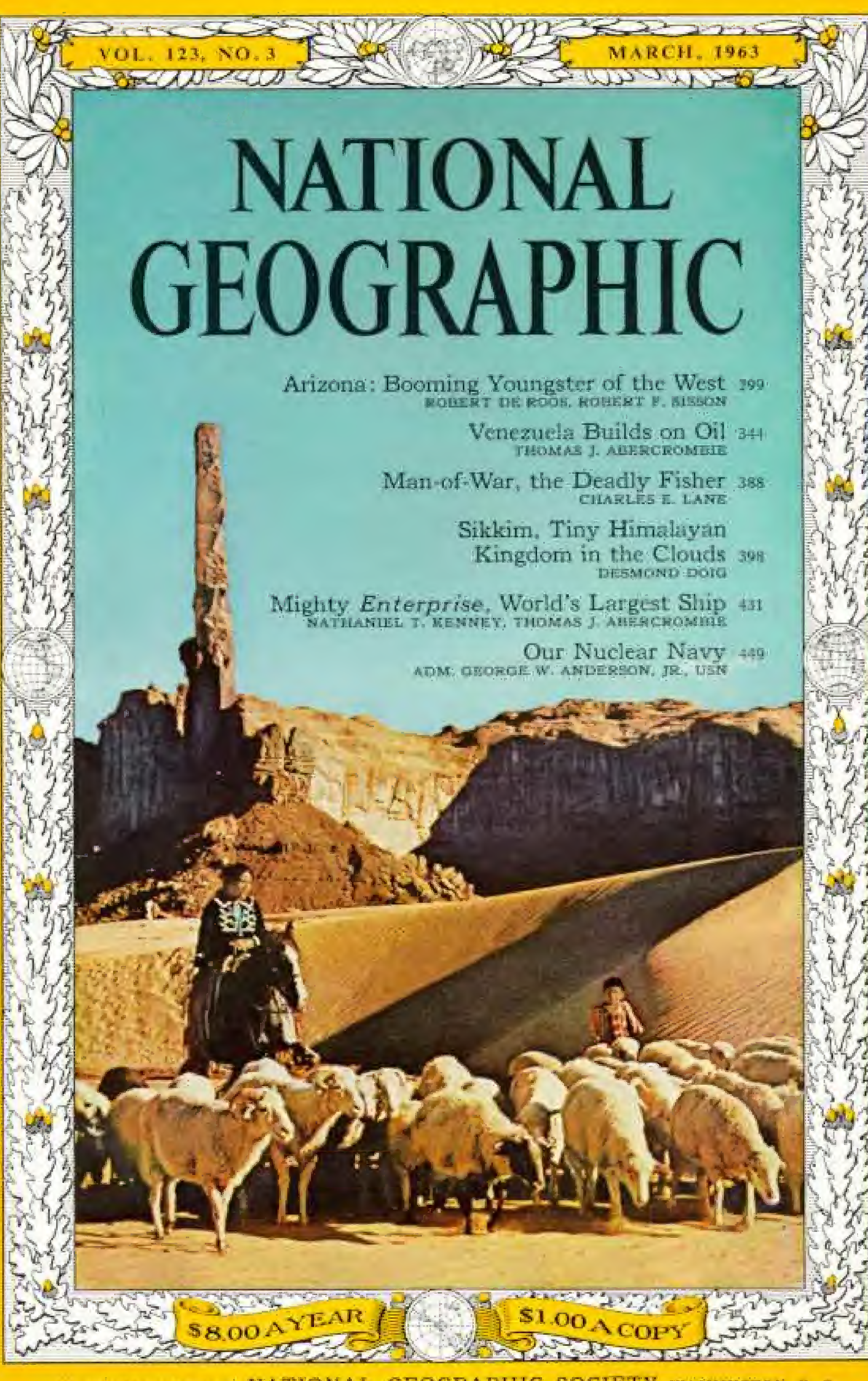
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COVER: Monument Valley's Totem Pole, a 457-foot obelisk, soars above Navajo herdsmen in Arizona.

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Modelmaker James B. Macbeth glues a nylon bristle in place (upper). He sealed the tiny crab six times larger than life-size and fashioned it from polyester resin and Plexiglas. It occupies a case in the Smithsonian's Hall of Life in the Sea (lower).

Authentic color rendering of sea dwellers is often a problem for modelmakers. Many creatures, like the boxer, fade when removed from water. So Mr. Macbeth turned to a photograph of the crab by Dr. Paul A. Zahl in the October, 1959, GEOGRAPHIC; in oil paint he matched markings revealed by the camera.

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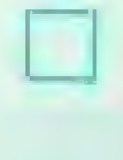

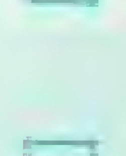

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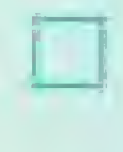

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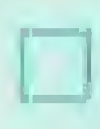

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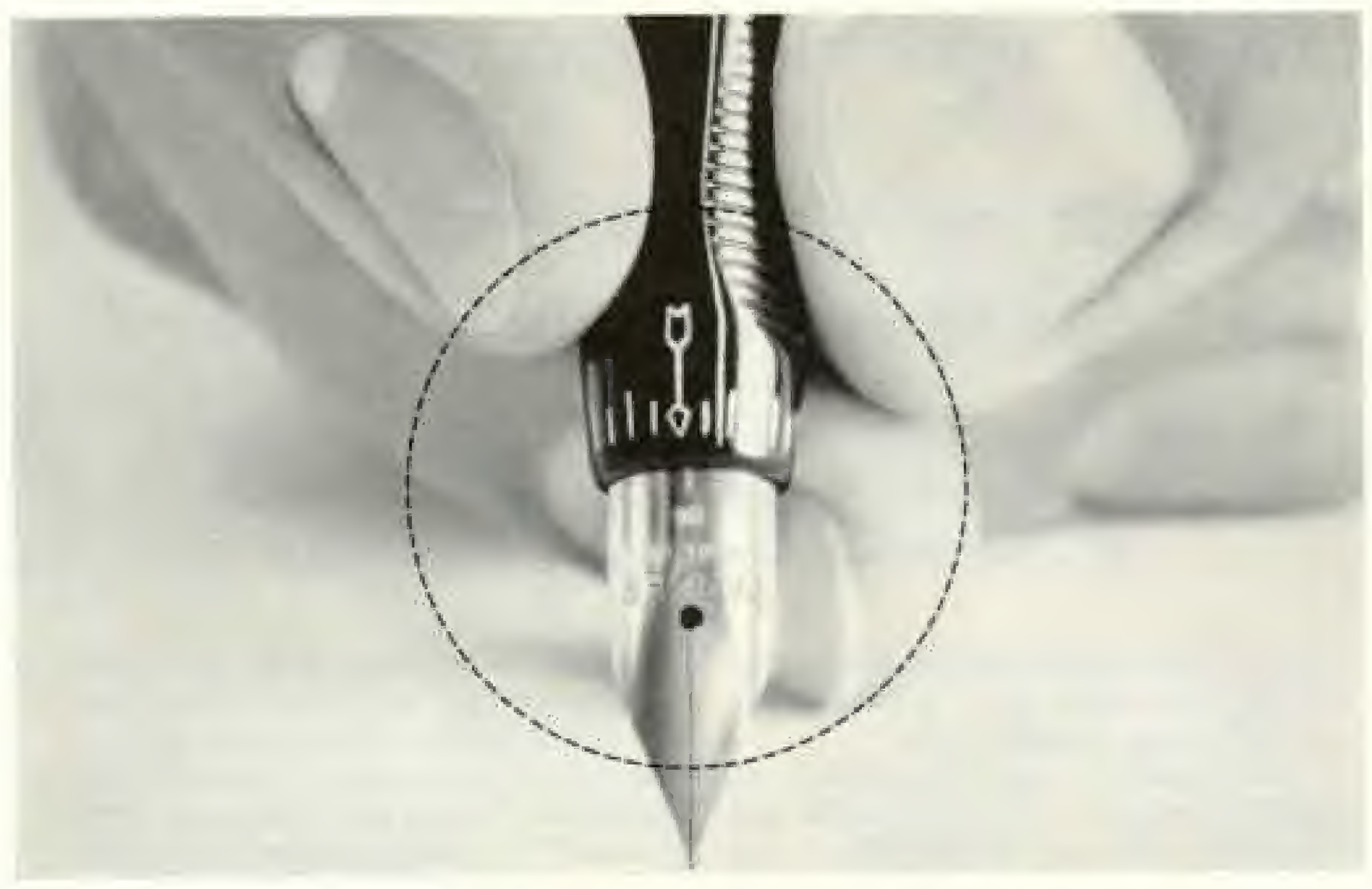

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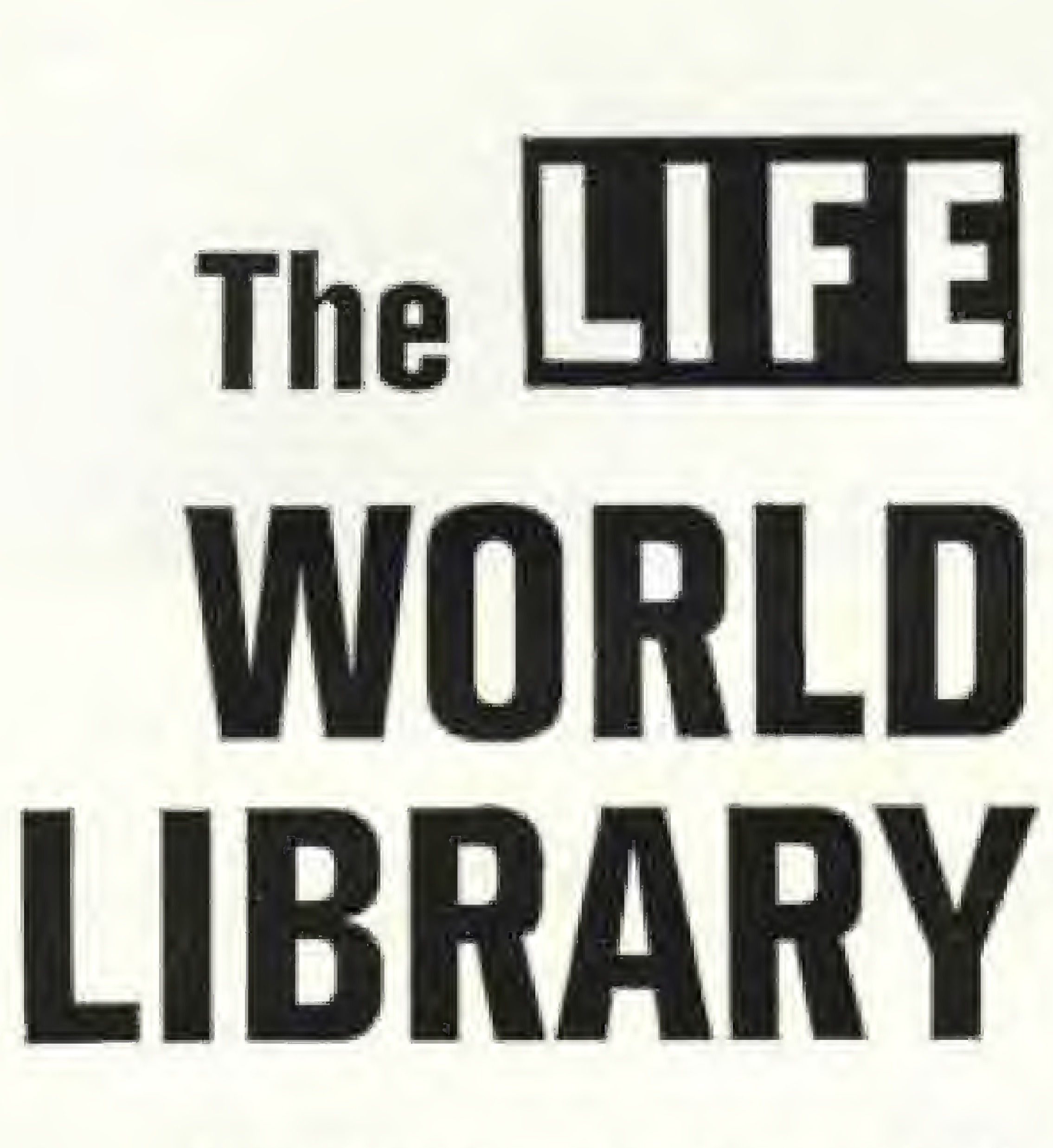

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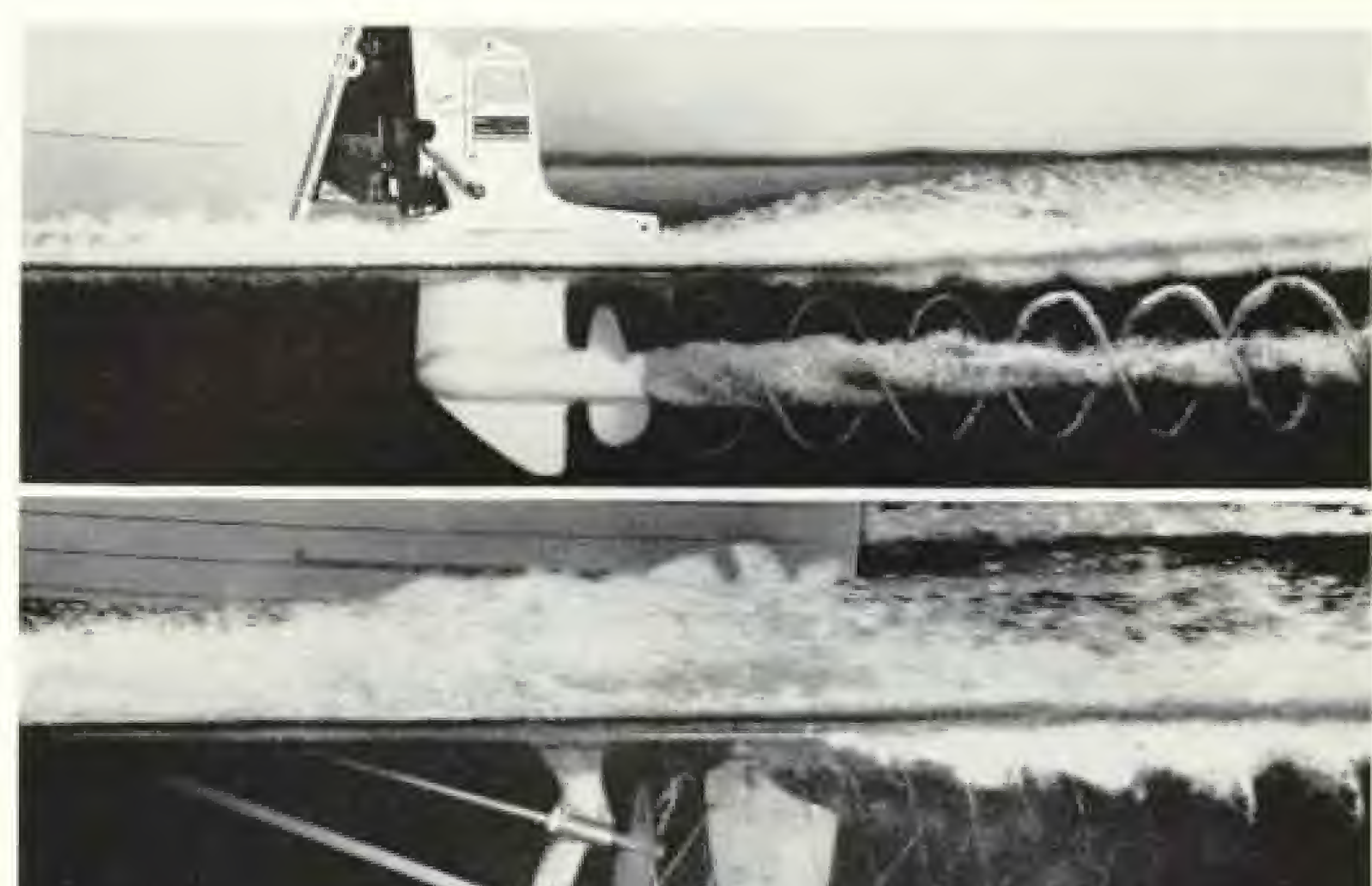

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Ordinary inboards are not on the level

MerCruiser Stern Drives push your boat more efficiently because the propeller thrust is directly parallel to the plane of motion. There is no drag from a rotating shaft, fixed strut, or rudder

The propeller shaft on an ordinary inboard is mounted at a steep angle through a hole in the bottom of the boat and wastes much of its forward thrust by pushing downward. MerCruiser Stern Drives, mounted through the transom, apply all of their power in a true plane with the direction of motion. *Ordinary* inboards, converted for test purposes to MerCruiser Stern Drives, show a 10 to 25% increase in speed with the same power plant.

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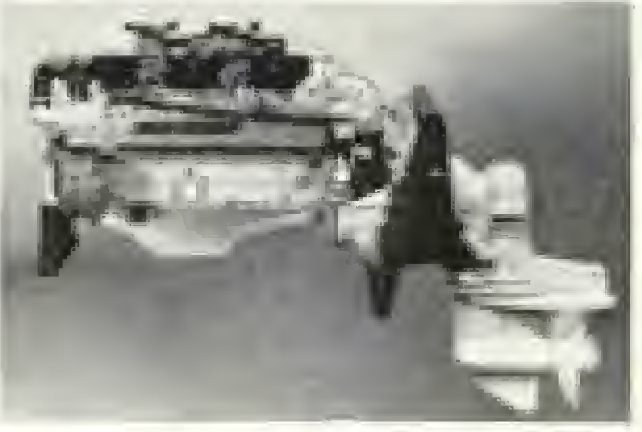
More than 110 different boat manufacturers are building boats powered by MerCruiser Stern Drive Power Packages . . . giving you a far wider boat and power choice than ordinary inboards. Ask your MerCruiser dealer to show you the boats *you* can own . . . equipped with MerCruiser Stern Drive Power.

MerCruiser 140: 140 hp. 6-cylinder, in-line engine and MerCruiser I Stern Drive. All controls and cables are inside the boat. Water-cooled gear cases. Jet-prop exhaust.



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110, 140, 190, 225, and 310 hp gasoline
39 and 100 hp diesel

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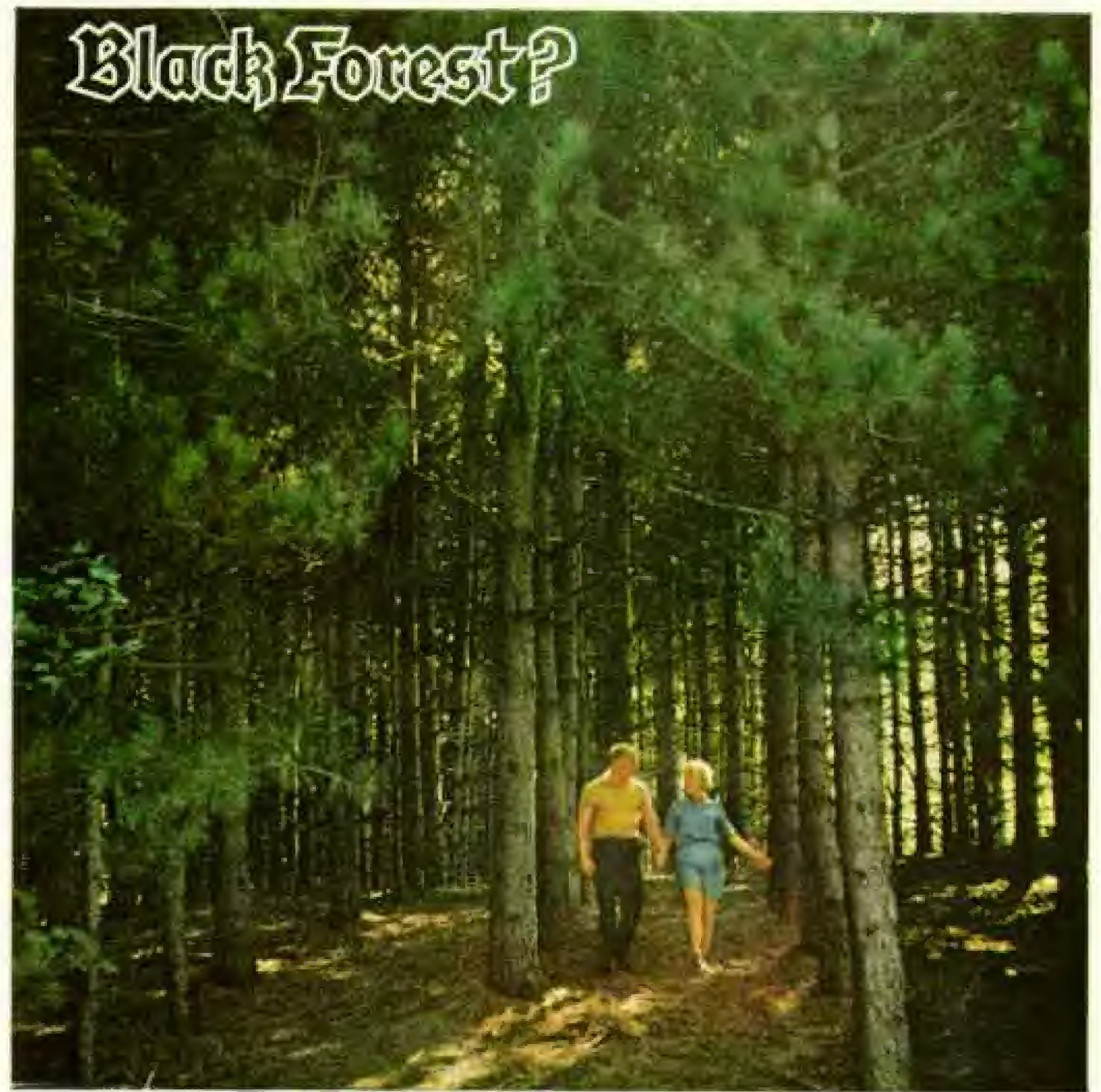

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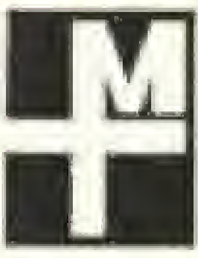

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In spring, desert poppy fields are so big and bright, you see them 10 miles away

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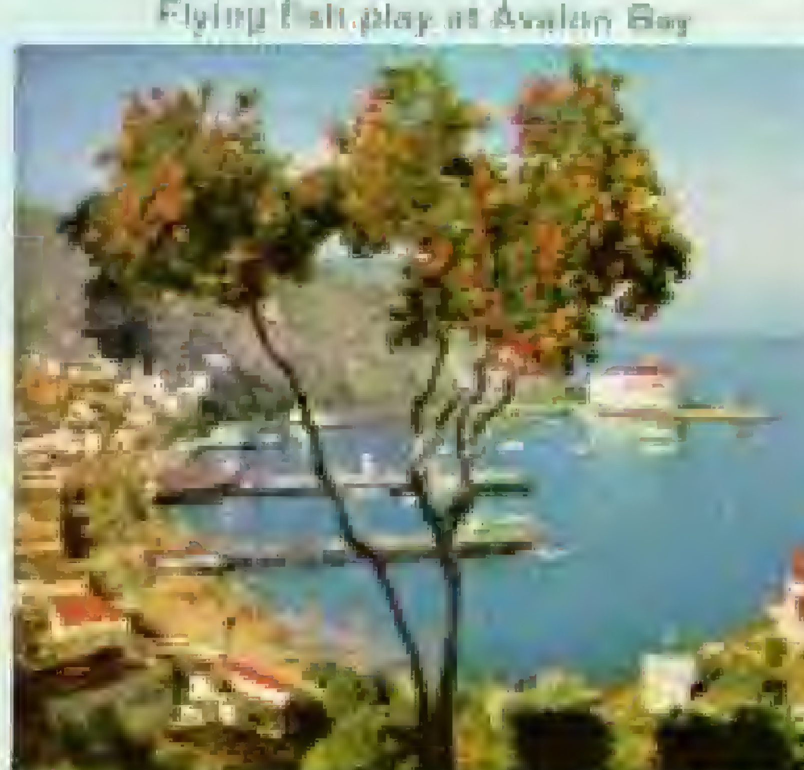

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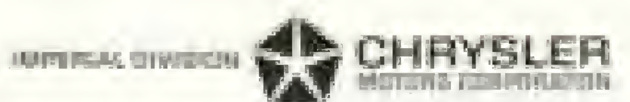

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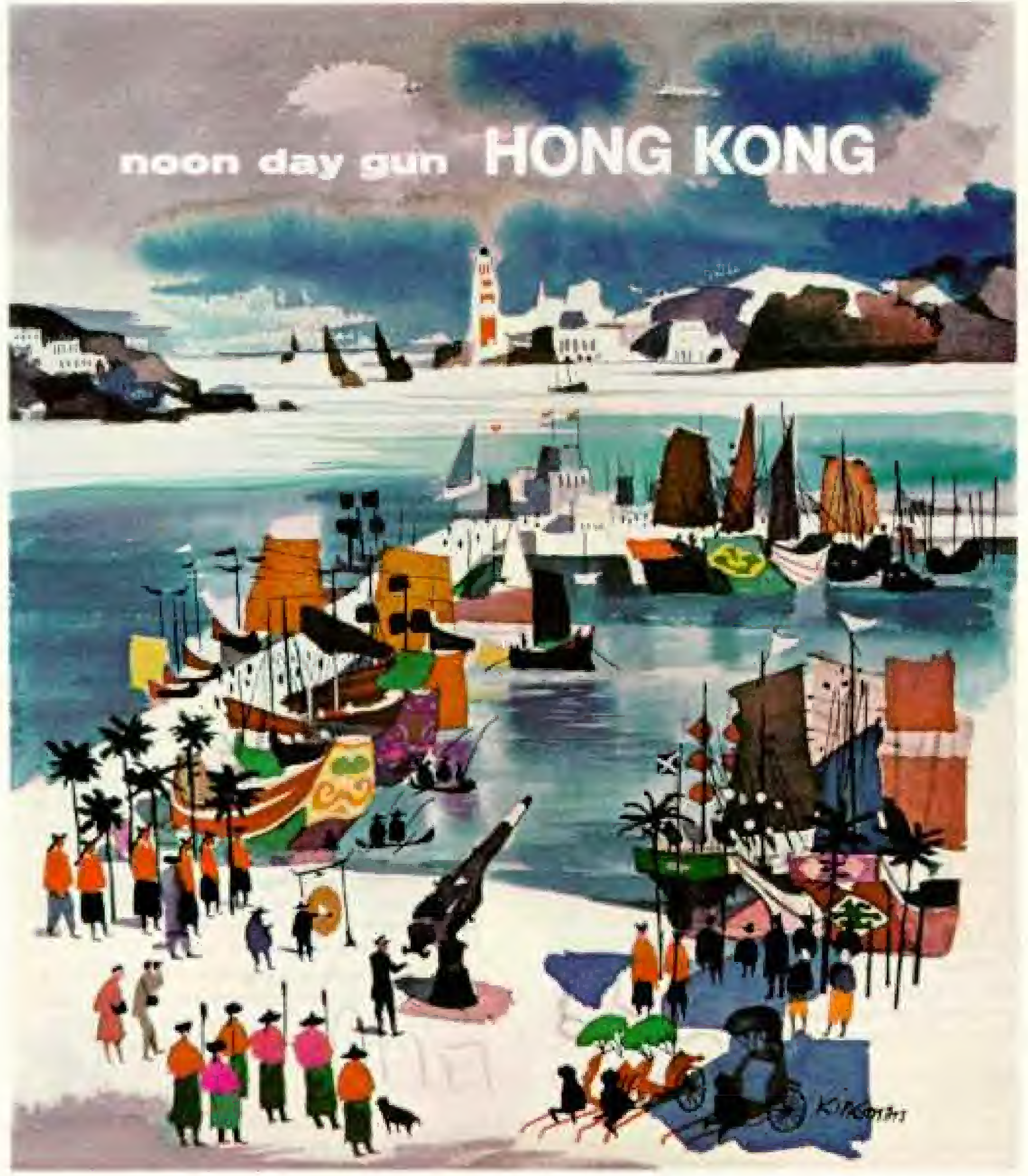

The colour of a pageant. The tradition of a British colony. The sounds of the Orient. The contrasting peoples, feelings and places. The busy harbour to the tranquillity of a view from the Peak. The ladder streets of Victoria. The open spaces of the New Territories. The tailor in Kowloon, the tourist, the rickshaw boy. All these and many more go to make up Hong Kong, the most exciting city in the Orient—gateway to the East. The Orient is Hong Kong. Come and see for yourself. Send the coupon for further information.

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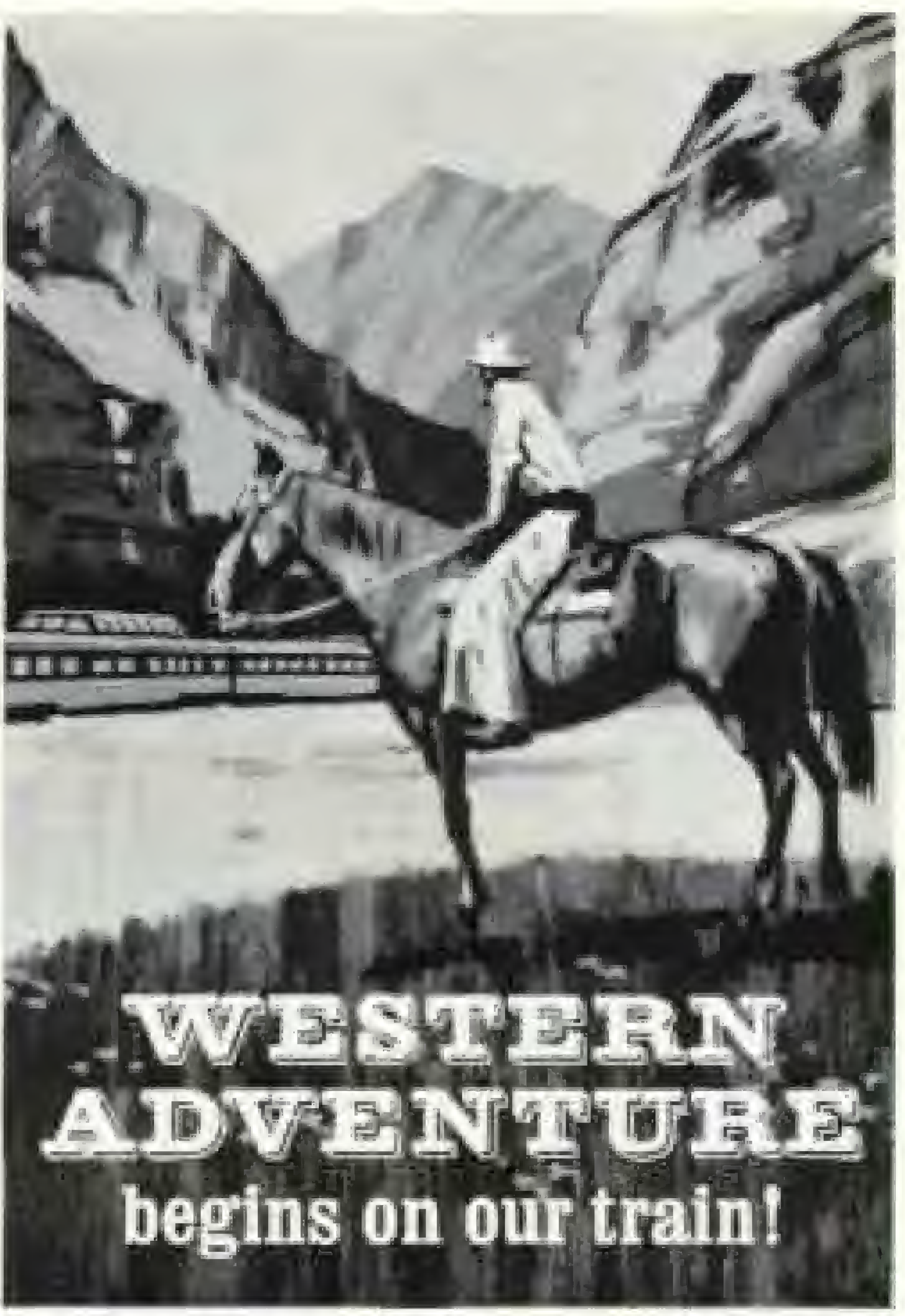

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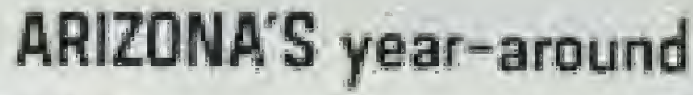

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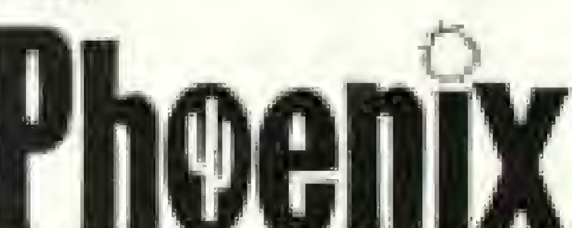

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Doing any number of things. Sightseeing in St. Catherine's Fort in the 17th century town of St. George. Cycling along the Shore Road. Swimming, waterskiing, skin-diving, sailing, fishing. Loafing on a pink sandy beach. Shopping for yourself and friends. Playing golf and tennis. When night comes, dine and dance to Calypso music or continental band.

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No other cruise experience can give you the grace and charm of the South Seas

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Matson ships are exclusively First Class. You enjoy more service, more space, more comfort. They are completely air-conditioned. All rooms have private bath. No matter which accommodation you choose, you enjoy *all* of Matson's traditionally famous service. And Matson chefs are simply marvelous.

The seas you sail are like a cushion to Matson's gyro-stabilized ships. And blue as indigo. It warms your spirit just to bask in the sun and watch the bow waves slip by, while the Trade Winds caress you.

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This is *Matson's Pacific*. No one knows it better than Matson, no one knows better how to make it unforgettable for you.

Isn't it time you took this tonic? Pick your date from the sailings listed below.

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SS Mariposa	Apr. 11*	Apr. 12*
SS Monterey	May 2*	May 3*
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SS Monterey	June 20	June 21
SS Mariposa	July 11	July 12
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Regularly every three weeks thereafter.
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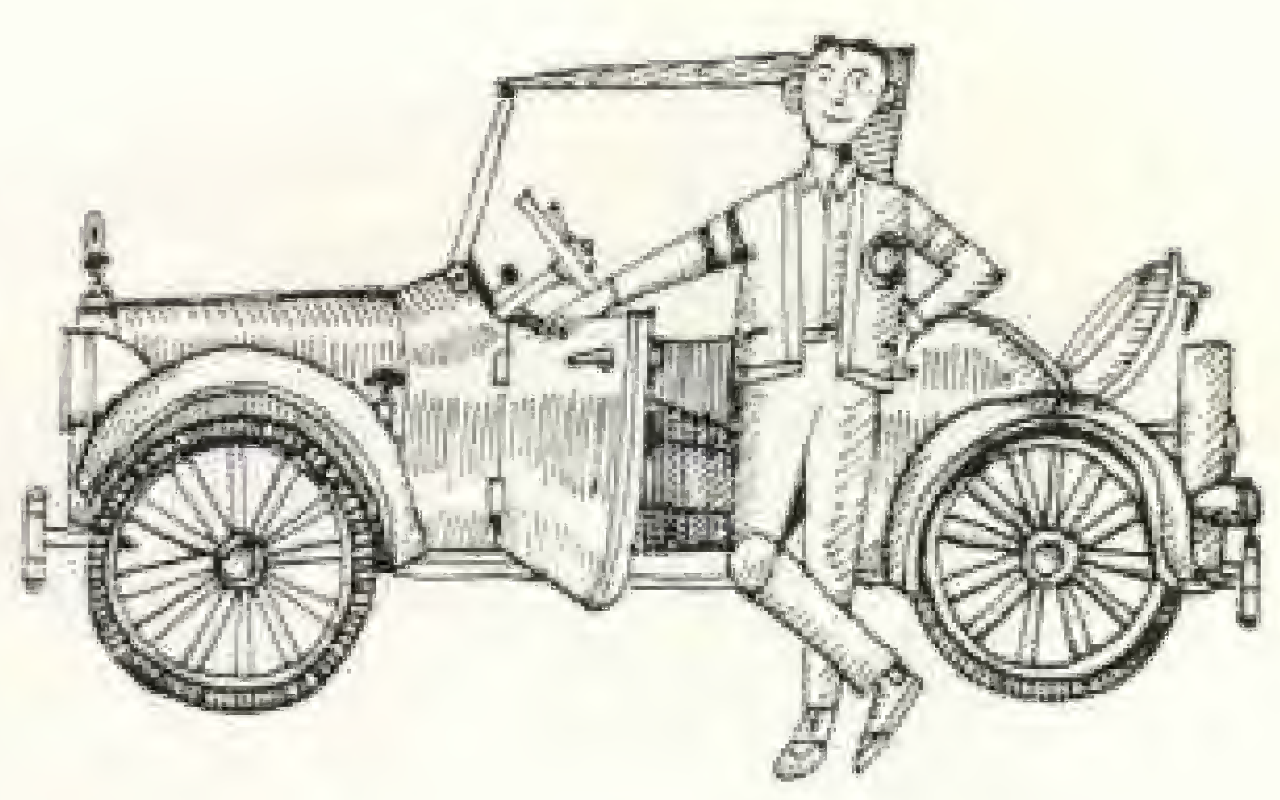

Question	Yes	No
Do you know how to brake on a slippery road?	☐	☐
Have you learned how to "drive ahead" and avoid potential trouble?	☐	☐
Do you make regular checks of your car's mechanical condition?	☐	☐
Do you always give the other fellow a break . . . including pedestrians?	☐	☐
Do you look at your rear-view mirror frequently to check the position of the car following you?	☐	☐
Do you refuse to use your car to "show off" your new driving skills or to "outwit" other drivers?	☐	☐
Do you know the dangers of mixing drinking and driving?	☐	☐
Do you let someone else take the wheel when you're tired or upset?	☐	☐
Do you stop rough or rowdy conduct among your passengers?	☐	☐
Do you give turning and stopping signals in plenty of time to warn the driver behind you?	☐	☐

Add up your "yes" answers. If there are ten, you've a perfect score. You have what it takes to be a safe, courteous, mature driver.

If you have six or seven, you are well on your way, but you need to do better.

Below six, buckle down. Improve your driving habits. Why risk getting into an accident or losing your hard-won license?

For more information, send for the Metropolitan Life booklet, "How To Be A Better Teen-Age Driver." It's an important guide for getting your license and developing your safety sense. Use the coupon below for your free copy.

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Please send me the free booklet, "How To Be A Better Teen-Age Driver."

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COUPON MAY BE PASTED ON POSTAL CARD

The low-fat, protein breakfast that fits so many modern diets

(and tastes good, too)

THE SPECIAL K BREAKFAST

4 ounces of orange or tomato juice—or half a medium-size grapefruit

1 ounce (1½ cups) Special K with 1 teaspoon sugar

4 ounces skim milk

Black coffee or tea

(Only 240 calories)

The Nutrition Story of Kellogg's Special K

One serving of Special K (1½ cups) with ½ cup skim milk supplies 14% of the recommended daily protein allowance for an adult man, and approximately these percentages of his minimum daily requirements as established by the Food & Drug Administration

Thiamine (B_1)	44%
Riboflavin (B_2)	60%
Niacin	51%
Vitamin C	35%
Vitamin D	50%
Calcium	22%
Phosphorus	22%
Iron	16%

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The newer knowledge of food (and of food's effect on the body) is carefully reflected in the Special K Breakfast, built around a unique cereal food—Kellogg's Special K.

Those concerned about the amount and type of fat in their diets can enjoy it without a qualm. A serving of Special K (1½ cups) with 4 ounces of skim milk contains only 0.24 grams of fat.

Weight-conscious folks will appreciate the fact that the Special K Menu totals no more than 240 calories. Yet, it provides the complete high-quality protein (and other essentials) needed in the early morning to get going. And keep going till noon.

And finally, the modern dieter knows that breakfast foods chosen must be appetizing. To the taste, to the eye, in the mouth.

Special K is, indeed, a delicious cereal. Crisp and light, enjoyable week after week, month after month.

Doesn't the Special K breakfast fit into your diet—or someone's in your family?

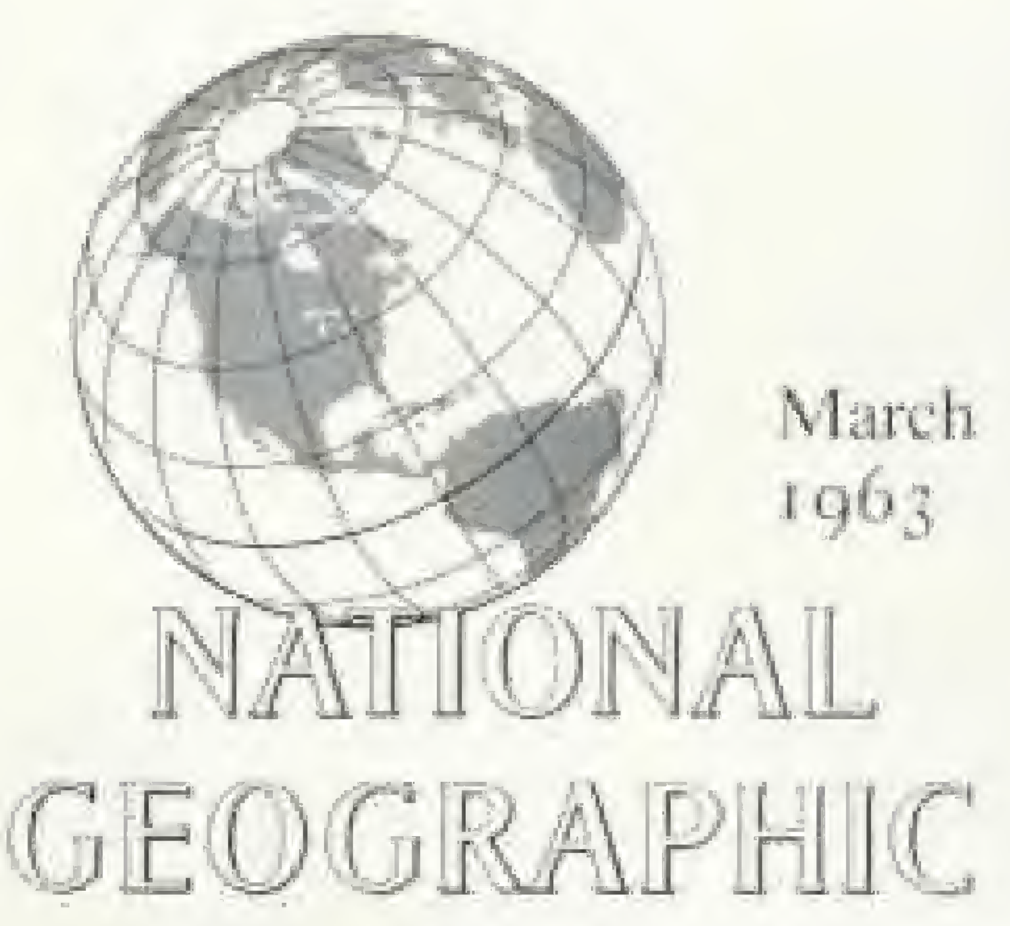
"The best to you each morning"

SPECIAL K

WHEN MY DAUGHTER Barbara was married, she moved to Phoenix, Arizona, and it seemed a long, long way to go from San Francisco. But she consoled me: "Look at it this way, Daddy. You're not losing a daughter—you're gaining spring training with the Giants."

Since I was then emotionally involved with the San Francisco Giants, who swing their bats every spring in Phoenix, the whole idea took on new brightness.

Now, two years later, I find I have not lost a daughter. I have gained the whole spectacular, overwhelming State of Arizona.



Arizona: Booming Youngster of the West

By ROBERT DE ROOS

Illustrations by National Geographic photographer ROBERT F. SISSON

State of Mind and of Majesty

After a 3,500-mile look at it, I can report that Arizona is an unparalleled experience—a state at once complex, casual, and simple, endowed with a handsome display of wonders.

It brims with energy and friendliness. The people love Arizona, and they have an endearing urge to make you love it, too.

"When I was on a local newspaper," said John Fahr of Tucson, "people would call in just to say how much they liked Arizona."

Arizona is beyond compare scenically, in terrain and vegetation. "Why, she's loaded to the sideboards and running over with scenery," said Harry Goulding, the gentle, perceptive Indian trader of Monument Valley.

The state shimmers with color: the pinks and blues, golds and greens of the desert; rivers the color of chocolate milk; red rocks rising from black sand; hills splashed with mineral purples, greens, and blues.

It has its own sounds: the banshee wail of wind in the buttes; the rumble as wheels roll over a cattle guard; the *"hoy yah, oh hah, hoy yah"* chant of Indian dancers; the hollow sound of men walking in boots.

There is no one Arizona. Physically, it is divided into three very different regions: the hot southern deserts; a mid-portion of snow-capped peaks and fir and aspen, where the land starts its ascent to the Rocky Mountains; and the high northern plateau mantled by juniper and mesquite (map, page 305).

All this is easily accessible. In winter, people in Tucson and Phoenix can swim in the morning, cavort on ski slopes in the afternoon, and be home for dinner. The Colorado River, Gulf of California, Lake Mead behind Hoover Dam, and a dozen other man-made lakes are there for boating and fishing. A tremendous new body of water, Lake Powell, will be created on the mighty Colorado River after the Glen Canyon Dam is finished in 1966.

Sunset and thunder squall paint fantastic sandstone buttes in Monument Valley, astride the Arizona-Utah border. This panoramic view captures massive Sentinel Mesa (left) and Brigham's Tomb (right, center). Totem Pole, shown on the magazine's cover, stands out of sight nearby. Prospectors and traders identified monuments by shapes. ▶

Laguna hoop dancers and Mexican Aztecs in peacocklike headdresses delight parade-goers at

Arizona also abounds in color of the intangible, romantic kind, a legacy from the early Spaniards, Indians, and gunslingers. Although the state is officially only 51 years old (it was admitted to the Union on St. Valentine's Day, 1912), it revels in a bloody, rip-roaring history. The past seems very close.

"I am 52 years old, not what I'd call elderly," said David F. Brinegar, executive editor of Tucson's *Arizona Daily Star*, "yet I've known every Governor of Arizona except one. That was George W. P. Hunt, the first Governor—and I shook *him* by the hand."

And consider Senator Carl Hayden, the Nation's senior legislator. He has been in Congress ever since Arizona became a state.

Long before the Pilgrims dreamed of Plymouth Rock, before Capt. John Smith or Virginia Dare appeared in our history, Marcos de Niza, an Italian serving Spain, entered Arizona. That was in 1539, a scant 47 years after Columbus reached the New World. In 1540, García López de Cárdenas, one of Coronado's captains, stood at the Grand Canyon, speechless before the awesome sight.

Centuries earlier, Arizona had been the home of prehistoric Indians who created highly developed cultures. Oraibi, in the Hopi

The Author: Robert de Roos, a free-lance writer and former newspaperman, contributed "California's City of the Angels" in the October, 1962, NATIONAL GEOGRAPHIC.

Flagstaff's Southwest Indian Pow Wow

Bells on her ankles, beads on her forehead, and a jaunty plume in her hair helped two-year-old Camille Lacapa, a Chippewa-Hopi, win the baby beauty contest at Flagstaff's Pow Wow last July.

Smeared with clay and white ash for their performance as clowns in a fire dance, Navajos assemble for the Flagstaff parade.

country, is the oldest continuously occupied town in the United States.

Descendants of these long-gone Indians still inhabit Arizona, which has more Indians than any other state. The state embraces the lands of the Hopi, Navajo, Apache, Papago, and ten other tribes. They exist like principalities: at once a pride, a problem, and a sting to the national conscience.

The Spaniards were followed into Arizona by the mountain men in pursuit of beaver pelts; then by Mormon settlers, Confederate veterans, gold seekers, and the gunslinging outlaws who made Tucson, Tombstone, Bisbee, and other towns, in the words of a man on the scene, "a paradise of devils."

Munching freshly roasted corn, a Navajo woman enjoys the carnival at Flagstaff's Pow Wow. Her heavy turquoise necklace is worth $300.

Writhing bull snakes clutched in teeth, bogus Indians dance to the beat of a tom-tom in Prescott. Smoki People, a "tribe" of white men dedicated to perpetuating Indian rites, yearly perform at a pageant in the dark of the moon.

Arizona was ceded to the United States by Mexico after the Mexican War. It was later enlarged by the Gadsden Purchase of lands south of the Gila River. Its first years under the United States flag were as part of the Territory of New Mexico.

Arizona wanted separate territorial status, but Congress failed to act. Sympathetic to the South during the Civil War, Arizona became a territory with the Confederacy in 1862.

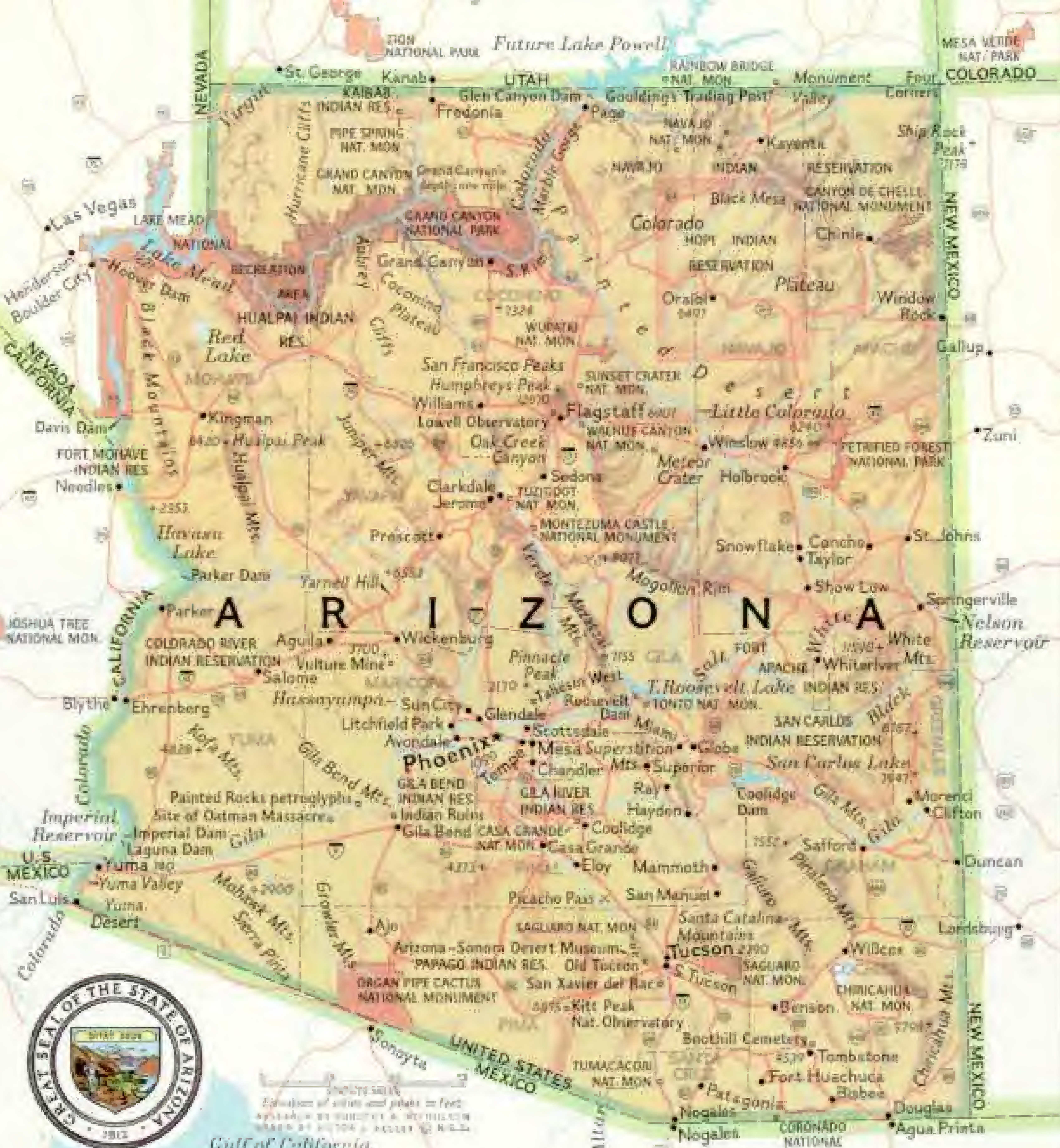
In one Civil War skirmish that bloodied Arizona soil, 12 Union soldiers from California attacked 16 Confederates in the Battle of Picacho Pass, 38 miles northwest of Tucson, in 1862. Three Union men died, three Confederates were captured. The next year Arizona became a United States territory.

The first capital was at Prescott. Then it moved to Tucson. In 1889, Phoenix became the permanent capital, a blow that Tucson feels to this day.

A Human Flood Keeps Coming

It was not until World War II that Arizona stuffed pants legs into cowboy boots and marched out to confront the 20th century. During the war, Arizona was discovered by tens of thousands of servicemen who trained on the desert slopes. After the war, thousands of them returned there to live.

It was not a flash flood. The settlers keep coming, to escape winter winds and snows, to find a place in Arizona's industry, to retire in a warm corner—and for health. A star-



Sun-drenched Arizona, sixth largest state in area, experienced a 74 percent growth in population between 1950-60. Phoenix, the capital, quadrupled its numbers to 439,170.

tling 25 percent of the families that settle in Arizona do so because some member is ill.

Between 1946 and 1960, according to the latest census, the state's population increased 111 percent—from 616,000 to 1,302,161.

But then, almost everything seems to grow fast in Arizona. Flower stalks of the century plant shoot up 12 inches in 24 hours; a steer in a feed lot puts on three pounds a day; fields of alfalfa yield eight cuttings a year.

Paul Fannin, Arizona's tall, handsome Governor, told me: "Our economic growth has been faster than our population growth. We lead the Nation in 10 of 12 important economic indexes, from income growth rate to increase in life insurance in force. We are second in the other two indexes."

Governor Fannin sat beneath a bronze replica of the great seal of the state. It depicts a reservoir bright in the sun, a steer, and a miner with pick and shovel. It bears the Latin motto: *Ditat Deus*—"God Enriches."

"This is still a frontier state," Governor Fannin said. "We've just begun to grow."

And a friend said, when I had been in Arizona only a short while, "You'd better publish fast—before everything changes."

Capital Rose From Indian Ashes

Phoenix takes its name from the mythical bird that is consumed by fire every 500 years, only to rise triumphant from its ashes. Founders predicted the city would "rise like a phoenix" from traces of prehistoric settlement by the Hohokam, "Those who have gone."

I had not been in Phoenix for 12 years, and I was amazed at its changes. I remembered a luncheon at the Arizona Club on the top floor of the Luhrs Building. Then all Phoenix spread below, a compact, properly delineated town, closely hemmed in by groves of date and citrus trees. Many of the downtown sidewalks were covered with wooden roofs. Phoenix had the look of a Western cow town.

Today the city seems to stream off in all directions (pages 342-43). It is not an illusion. In 1950 Phoenix occupied 17.1 square miles; now it covers 187.4 square miles.

Since 1948 more than 300 firms have settled around Phoenix, many of them from California. The giants are AiResearch (page 338), General Electric (page 339), Reynolds Metals (page 323), Sperry Phoenix, Motorola (page 338), and Goodyear Aircraft.

Lights wink on as dusk enfolds Tucson, grown from a mud-hut village to a city of 213,000.

To find out what attracts industry to Phoenix, I called on Dr. Daniel E. Noble, Executive Vice President of Motorola. He greeted me in his spacious office, decorated with pre-Columbian pottery.

"We're in competition for brain power, not labor, these days," he said. "We set up a plant here because we thought this was a place that would attract brain power.

"We were flooded with applications. Phoenix is a real asset in approaching scientists and engineers. We have a symphony, a good one. We have a dynamic and moving art museum, a good little theater, and a musical theater. And what is truly wonderful about Phoenix is the participation of the people."

Right in the forefront of this participation is Walter R. Bimson, Chairman of the Board of the Valley National Bank, Arizona's largest. One of his chief interests is the excellent Phoenix Art Museum.

"We suffered and died to get the museum going," he told me. He added that before the museum opened in 1959, its exhibits were valued at $3,000. Today its art works are valued at more than $3,000,000.

Banks are very visible and highly competitive in Arizona. Mr. Bimson's bank has led the expansion throughout the state. Arizona now has a bank for every 7,400 residents, a high proportion.

Before its economy began to burgeon, Ari-

Saguaro cacti on a hillside look across the valley to the Santa Catalina Mountains

zona called itself the Five-C State—for copper, cotton, citrus, cattle, and climate. The cynical added two more: cactus and cowboys. No less important were the three A's: arthritis, allergies, and asthma. Arizona was thought of primarily as a vast health resort.

But a simple AC—for air conditioning—now is an important factor in the state's life.

"The war and cheap air conditioning brought the boom to Arizona," I was told. "The 'swamp cooler'—a simple evaporative cooler that runs water over excelsior in front of a fan—cools 85 percent of Arizona."

Air conditioning has made Arizona a 12-month state. No longer do women and children flee the southern deserts in the summer.

Almost everything is air-conditioned: jails, buses, homes, offices, automobiles, supermarkets, and hot-dog stands. In Phoenix an entire shopping center is air-conditioned, including the malls. The grandstand at Greyhound Park is completely under glass, lest unconditioned air intrude.

Not everyone rejoices. A man in Tucson cracked: "I came here for sinus trouble, and after a year under air conditioning, I got it." I heard a visitor say, at an open window in Bisbee, "Boy, it's good to smell real air."

Scottsdale Nurtures Indian Art

Scottsdale, a red-and-white, board-and-batten town just east of Phoenix, prospers on tourists. But its mock-Western façade also attracts a good share of the shopping dollar from Phoenix and other nearby towns.

Many subdivisions are springing up. In some, two-bedroom houses, with a 15-by-30-foot swimming pool, sell for under $10,000. But luxury homes in the $100,000 to $250,000 range are common, too, in the Scottsdale-Paradise Valley area. Many new apartments rent for $400 a month during the winter.

Scottsdale has become a center of modern Indian arts. John and Virginia Bonnell pioneered production of modern silver in the old, simple designs. Their White Hogan ranks with the world's great silver shops, thanks to the artistry of its Navajo silversmiths, Kenneth Begay and Allen and George Kee.

Lloyd New (whose professional name is Kiva) and Charles Loloma are world famous: New, a quiet, talented man, for his leather, design and use of "clash colors" in textiles, and Loloma for his gold and silver work.

ARIZONA: facts and figures

AREA: 113,909 sq. miles; ¼ of area Indian reservations. **POPULATION:** 1,302,161 (1960); grew 553,000 since 1950. Leads states in number of Indians, 83,400. **NAME:** From Papago Indian, meaning "place of a little spring." **NICKNAMES:** Grand Canyon, Copper, Valentine State. **ADMITTED:** Feb. 14, 1912, as 48th state. **REPRESENTATIVES:** 3. **CAPITAL:** Phoenix, 439,170. **OTHER CITIES:** Tucson, Mesa, Tempe, Yuma. **LANDMARKS:** Grand Canyon of the Colorado, 217 miles long, cuts 3,500 to 6,000 feet deep; Hoover Dam, 726 feet high, forms one of the world's biggest man-made lakes; 15 national monuments. **TOPOGRAPHY:** Southern desert plains, diagonal mountainous belt, high northern plateau; highest point Humphreys Peak, 12,670 feet. **CLIMATE:** Dry, clear, sunshine 80% of the time. **ECONOMY:** Cotton, livestock, citrus, copper (leading U. S. producer), manufacturing, tourists. **STATE FLOWER:** Saguaro (giant cactus). **BIRD:** Cactus wren. **TREE:** Paloverde. **MOTTO:** *Ditat Deus*, "God Enriches."

I stood with Charles Loloma in his small shop on Scottsdale's Fifth Avenue. He held a meticulously painted Kachina doll in his right hand. In his left he held a black-and-silver bracelet accented by turquoise and coral. The bracelet was a strikingly modern design, the Kachina as ancient as the Hopi.*

"Different? Yes," he said. "But both are pure Indian, seen through Indian eyes."

Paul Huldermann, whose House of the Six Directions is one of the finest shops in Scottsdale, nodded as Loloma spoke.

"Most Indian art moves along traditional lines," he said. "The artists produce what buyers want. Here in urban Scottsdale, close to sophisticated customers, the Indian is branching out—using new materials and designs, but maintaining his Indian base."

Yes, Arizona changes. But there is an Arizona that does not change except under the slow mortification of the elements: alternating heat and cold, rasp of wind and water, lichens noiselessly fragmenting rock.

A brassy moon still rises over the gaunt mystery of the Superstition Mountains. Nothing can erase the improbable desert sunsets (pages 314-15). There will always be saguaros

*For this aspect of Indian life, see "Kachinas: Masked Dancers of the Southwest," by Paul Coze, NATIONAL GEOGRAPHIC, August, 1957.

Pima County Courthouse's dome of Spanish tile and its stucco walls contrast with the aluminum-and-glass façade of Tucson's tallest building, on Governor's Corner. Four flags have flown at Tucson: Spanish, Mexican, Confederate, and United States.

Mock gun fight erupts in the streets of Old Tucson, a motion-picture set now preserved

crowned with cream-colored waxen flowers, and towering buttes that send their sunset shadows for 35 miles across the plain. The emptiness of the land remains.

Almost everyone I met in Phoenix (they call themselves Phoenicians) advised me to leave town, and all had a favorite direction.

"Baby Rattlers" Guard Hunter's Door

I headed for Wickenburg, but was sidetracked to Gila Bend first. There I spent the day on the desert, exploring a prehistoric Indian village and visiting the Painted Rocks petroglyphs beside the Gila River.

Indian symbols and stories covered maroon rocks. There were emblems like swastikas, a rayed circle for the sun, and a spiral. The ancient artists had chipped lizards, bighorn sheep, and lions into the stone surfaces.

At Gila Bend I called on Lynn Cool, a lion trapper. In the concrete of his front walk he had impressed tracks of bobcat, buffalo, and javelina. I reached for the doorbell—then pulled back at twice the speed.

Under the bell was a box inscribed: "Look out for the baby rattlers." Inside the box I found a pair of celluloid rattles—those with which babies play. Old joke, but new to me.

Lynn Cool's living room was a clutter of his trophies. He is one of ten men who have shot the big ten of Arizona: javelina, lion, bear, bighorn sheep, elk, white-tailed deer, mule deer, turkey, buffalo, and antelope.

Mrs. Cool was cooking yucca fruit, as yellow as squash and shaped like a skinny carrot. It tasted somewhat like heart of artichoke.

KODACHROMES © NATIONAL GEOGRAPHIC SOCIETY

as a copy of the adobe pueblo of the 1860's

but the fruit left a lingering, bitter aftertaste.

"The Indians use yucca for just about everything," Lynn Cool said. "They eat it, use it for thread, and even make sandals and baskets out of it."

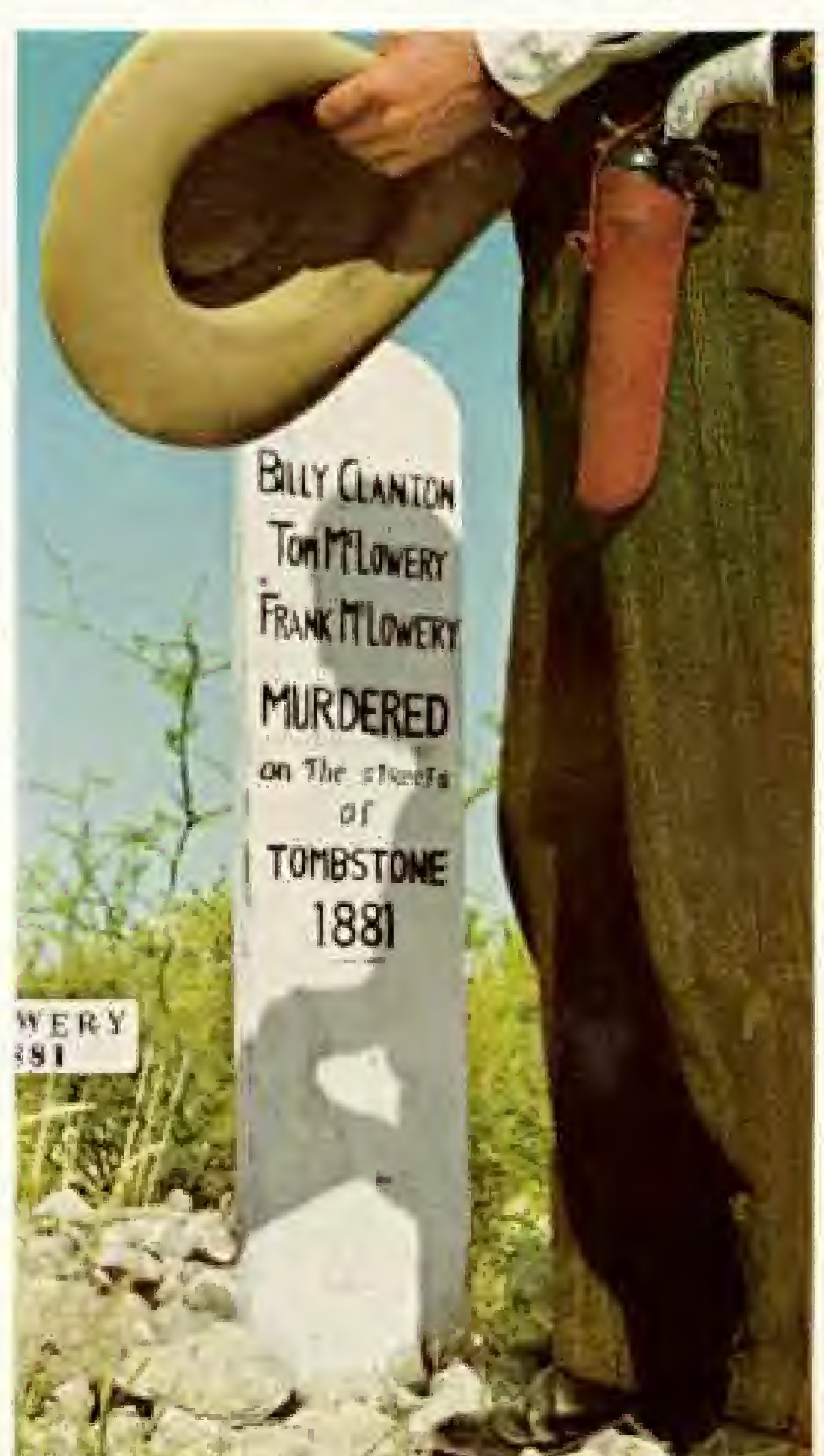
After tasting yucca, I can recommend it for thread and sandals and baskets.

The desert was in fine color. Green-barked paloverde trees blazed with yellow blossoms, the mesquite put out pale-yellow catkins, and the salt cedar was a spray of delicate ash pink.

Lynn Cool spun his four-wheel-drive truck off a rutted road into the bed of the Gila River, and we rode in a great sneezing of feathery dust until we nosed into a grove of mesquite. Cool stopped the jeep near a grave mound formed of black stones, and we got out to stand silently in the hot sun.

Fast draw. Fanning his .22-caliber pistol, an Arizona gunslinger blazes away in six-hundredths of a second. He uses blank shells.

Boothill cemetery in Tombstone marks the end of the trail for three men shot by Marshal Wyatt Earp, his two brothers, and Doc Holliday in the famous and controversial battle at the OK Corral.



A bronze marker told the story. Here six members of the Oatman family were massacred by Indians in March of 1851, when the Apaches were doing their best—which was very good indeed—to repel the white man.

A red-winged blackbird darted into the thicket. It seemed to be the only living thing within miles. Here, at this deserted graveside, Arizona history seemed very close.

Building Walls Assay at $25 a Ton

The first thing I saw in Wickenburg was a sign, "No fishing from the bridge." This was notable because there was not a drop of water here in the Hassayampa River. The second thing was a marker retelling the Indian legend that once a man drinks Hassayampa water, he will never tell the truth again.

Wickenburg clings hard to its old Western ways. Its life is casual, based on desert rides, rodeos (the horse population is 500, the people population, 2,445), deer and bird shooting, golf and tourists.

This community claims to have invented the dude ranch. It still calls itself "the dude ranch capital of the world," even though there are many more ranches in the Tucson area and near Patagonia in the southeastern corner of the state.

"My husband and my father rode the Southwest looking for the right place," said Sophie Burden, who runs the Remuda Ranch with her sons, John and Dana. "They stopped here because it's best for riding."

Dana Burden drove a kind of high-pocket station wagon toward the Vulture Mine, one of the richest of Arizona's gold finds.

"You have to drive fast on these washboard roads," Burden said, as I clung desperately to the jouncing seat. "It levels out the bumps."

I was grateful when we stopped at the mine, where in 1863 Henry Wickenburg found a hill of gold 80 feet high and 300 feet long. The Vulture Mine produced half a million ounces of gold (worth $17,500,000 today) before the lode was lost.

Dr. George Mangun now owns the mine.

"It used to cost $15 a ton to haul ore to Wickenburg," he said. "So, if the ore didn't assay $40 a ton or better, it was thrown aside. These buildings are built of rock that runs about $25 a ton."

We walked toward the A-frame of the mine, used to haul ore to the surface, and passed an old ironwood tree. A sign said: "Hangman Tree. Eighteen men were hanged here during the heyday at the Vulture."

"Most of them were hanged for killings or high-grading," Dr. Mangun said. "Some of the ore ran $100,000 a ton, and it was quite a temptation to the miners to lift a little. One old mining fellow used to complain about his rheumatism. It was so bad he could scarcely walk. One day he fell down, and when they helped him up, they found out why his rheumatism was so bad. His boots and trousers were loaded with ore."

Nothing much grows around Wickenburg, but intensive farming to the west, at Aguila and Salome, is turning the desert green. Lettuce, cotton, and safflower seed are the crops. The water comes from wells.

Yuma, to the south, on the Colorado River, "on the sunny side of the west," is the center of an agricultural boom (page 317). As urbanization takes over citrus acreage in other areas, Yuma's groves are expanding rapidly. More than 17,570 acres are now in citrus—most of them planted since 1952.

State Slopes Upward to Grand Canyon

North of Wickenburg, Arizona humps its back, and Yarnell Hill rises abruptly from the desert floor. The odd thing about Yarnell Hill is that you do not descend very far on its northern side. Instead, the countryside tilts gently, gradually rising toward the Grand Canyon, 140 miles away (map, page 305).

The road to Prescott runs through a dwarf forest of piñon and juniper, dark green against the yellow of the range grasses. Ponderosa pines appear as the altitude increases.

Prescott is a blue-jeans-and-boots town. Many men wear flowered frontier shirts and order their hats by the gallon. The quiet town is dominated by the granite courthouse in the plaza and the Arizona Pioneers' Home high on a hill.

When Arizona's first territorial Governor, John N. Goodwin, reached Prescott in 1864, he moved into an 8-room, log-sided mansion.

Mission San Xavier del Bac Calls to Mind Tucson's Hispanic Past

Father Eusebio Francisco Kino, Jesuit missionary and explorer, founded the mission in 1700 as one of a chain from northern Mexico to southern Arizona. Today it still serves Papago Indians on their reservation. Mission pupils and padre chat in the court.

Setting sun backlights giant saguaro cacti, symbolic of Arizona. Towering above feathery paloverde

Because the capitol was not finished, legislators held their first sessions in his home. The mansion, still sturdy, now houses a museum of local memorabilia.

The bones of Pauline Weaver, first white man to see the site of Prescott, lie under a granite boulder in front of the Governor's house. "Pioneer, Prospector, Scout, Guide, Free Trapper, Fur Trader, Empire Builder, Patriot," read the bronze words on his grave.

Pauline was named Paulino when he was born among the Cherokees in Tennessee in 1800, but he quickly and permanently became Pauline. He ranged all of northern Arizona. In 1862, he discovered gold near Ehrenberg on the Colorado—where Michael Goldwater,

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

trees, they spike a hillside in Saguaro National Monument, a 78,650-acre preserve near Tucson

grandfather of Senator Barry Goldwater, established a general store three years later.

I did not range all of northern Arizona, nor did I find gold. But what I did find is even more priceless. I rode through a pygmy forest, on what seemed to be the absolute top of the world, toward the town of Grand Canyon on the great chasm's rim. The land rose steadily as I approached the national park. I could appreciate the surprise early viewers of the canyon must have had.

Although I have seen hundreds of pictures and read much about it, my first view of the Grand Canyon was shocking.

There was nothing else in the world. As far as I could see to the left, to the right,

straight ahead, there was only the canyon.*

Once, long before, I had flown over it at great height. I knew the chasm goes on and on for 217 miles, that it is from 5 to 15 miles wide and a mile deep. Seeing it before me, I knew it to be immeasurable. It is not a place for statistics. It is an emotion (pages 334-35).

No one ever adequately describes the Grand Canyon. But the names given to the natural wonders are a clue to its mystic power: Holy Grail Temple, Zoroaster Temple, Krishna Shrine, Solomon Temple, the Temples of Isis and Osiris, Wotans Throne.

No one had ever told me about the trees, gnarled junipers, clinging to filigreed stone terraces. The trees are magnificent—twisted by the winds, hammered by storm, pressed under snows, until, in their age, they achieve a kind of miniature majesty.

In early morning darkness I walked toward the Shrine of the Ages on the South Rim of the canyon for Easter sunrise services.

The blanket-wrapped crowd sat on rock outcroppings. There were many babies, some in strollers, others plastered against their mothers in the damp-rag attitude of sleep.

The sky glowed yellow against the dark rim of the canyon. The eerie forms of eroded buttes and spires appeared gradually, like a photograph in a developing solution. Then the sun rose over the rim. It turned the tips of stunted pines a sparkling gold.

A chorus of 52 voices suddenly lifted in a great "Hosanna." Then there was silence. The cliffs revealed their contours, and the Rev. Frank L. Dickey, Jr., of the Grand Canyon Community Church, read the triumphant story of the Resurrection.

Monument Valley Glows With Fire

Some days later I visited Goulding's Trading Post, just north of the Utah-Arizona state line, in Monument Valley.

"No matter how much is written about it or how many pictures are taken, the valley never lets you down," said Harry Goulding.

We were looking eight miles across the

*See Louis Schellbach's "Grand Canyon: Nature's Story of Creation," in the NATIONAL GEOGRAPHIC, May, 1955.

Combing a cotton field in Yuma County, a mechanical picker does the work of 110 men in a day. Cotton is king of Arizona crops.

Parched desert blooms into fertile farmland. Irrigation canal snaking through Yuma Valley produces the magical transformation.

plain to timeless buttes glowing red and orange in lowering sunlight. The soil was so red it made the tough grasses look almost blue.

Harry Goulding is a long-legged Indian trader of 65. The Navajos call him "T-pay-eh-nez"—Long-man-with-the-sheep—in memory of the days when he ran sheep in the valley. He has been there 38 years.

"You must like it here," I said.

"Well, it gets to be a part of you," he replied. "When things happen here, they always happen big. When it rains, it'll drop an inch in 15 minutes.

"And you should see the electrical storms—there must be deposits in the valley that attract lightning. It'll come down, peck at the ground, then explode in blue flame."

There was a thunderstorm in the far distance, the rain glistened on the buttes. So definite was the line between sun and storm that I was reminded of an old Arizona saying: "A man can wash his hands in a summer shower and never get his cuffs wet."

Harry Goulding has poked into more canyons than any other man in Arizona. He took me through some of the 19,592 square miles of the Navajo Indian Reservation, which spills across into Utah and New Mexico.

The next day we drove out from his lodge past the towering forms of Mitchell Butte and Gray Whiskers—somber in the backlight of the morning—to the check-in station at Monument Valley, then down 400 feet on a winding red road.

A strong aura of mystery abides in this valley—in its silences, in the odd shapes carved by wind, water, and sand, in the improbable presence of the monuments themselves.*

You can see anything you like in these rocks: rabbits, boars, camels, Indians, roosters, witches, nuns, elephants, mules, penguins—each to his own taste.

Architectural forms suggest weathered columns of forgotten temples. Precipices hun-

*See NATIONAL GEOGRAPHIC, October, 1945, "Flaming Cliffs of Monument Valley," by Jack Breed.

Spawning ground of bold new architectural ideas, the former desert home of designer Frank Lloyd Wright serves as winter quarters of students enrolled by the Wright Foundation. Chief architect William Wesley Peters discusses a drawing of a Hawaiian hotel with some of the 50 trainees in their workshops at Taliesin West, near Phoenix.

KODACHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER JAMES P. BLAIR © NATIONAL GEOGRAPHIC SOCIETY

Like broken jackstraws, stone logs strew Petrified Forest National Park. Living trees in the Triassic Period, they were buried on flood plains 170 million years ago. Crystallized quartz filled wood cells and duplicated their structure like plaster in a cast. Stone became harder than steel.

Polished cross section reveals glowing colors locked forever in a log's stony heart.

dreds of feet high are chiseled by wind into lost friezes; ruined bas-reliefs of departed gods and men who were giants—figures just beyond the reach of recognition, a whole heroic history just out of grasp (pages 300-301 and 330-31).

In the sighing silence of the valley, you might even hear far-away trumpets and the barest echo of a cymbal.

"The valley is a Navajo Tribal Park," Goulding said. "The Navvies run it, and their rangers guard it jealously. They are always on patrol against vandals, and they can get mighty tough."

Later we drove for hours through the reservation. To me it looked empty. The domed hogans were plastered with the soil they stand on and were difficult to see. Occasionally we saw a two-horse farm wagon carrying an Indian family wrapped up in their blankets —and the always-present barrel of water.

"There are supposed to be 74,000 Navajos here," I said. "Where are they?"

Goulding waved his hand toward the horizon. "Well," he said, "this is a mighty big place. But I'll bet we won't be anywhere today that Navajo eyes won't be watching."

I was surprised, too, by the scarcity of wild things. We saw few rabbits, prairie dogs, or ground squirrels.

"About six years ago something happened

Mountaintop "B" Identifies Bisbee, Mile-high City in Cochise County

Air-conditioned by its altitude, copper-mining Bisbee stretches some two miles long but only a few blocks wide as it rises along both sides of a deep gulch. Many houses cling to terraces and are pitched atop one another like swallows' nests on a cliff. To save the postman weary steps, Bisbeeites daily trudge to the post office for their mail. The community of 10,000 is one of the largest in the United States without house-to-house delivery.

Molten glow reflects in the protective glasses of a Kennecott copper worker in Hayden. Hard hat is standard equipment in metal plants.

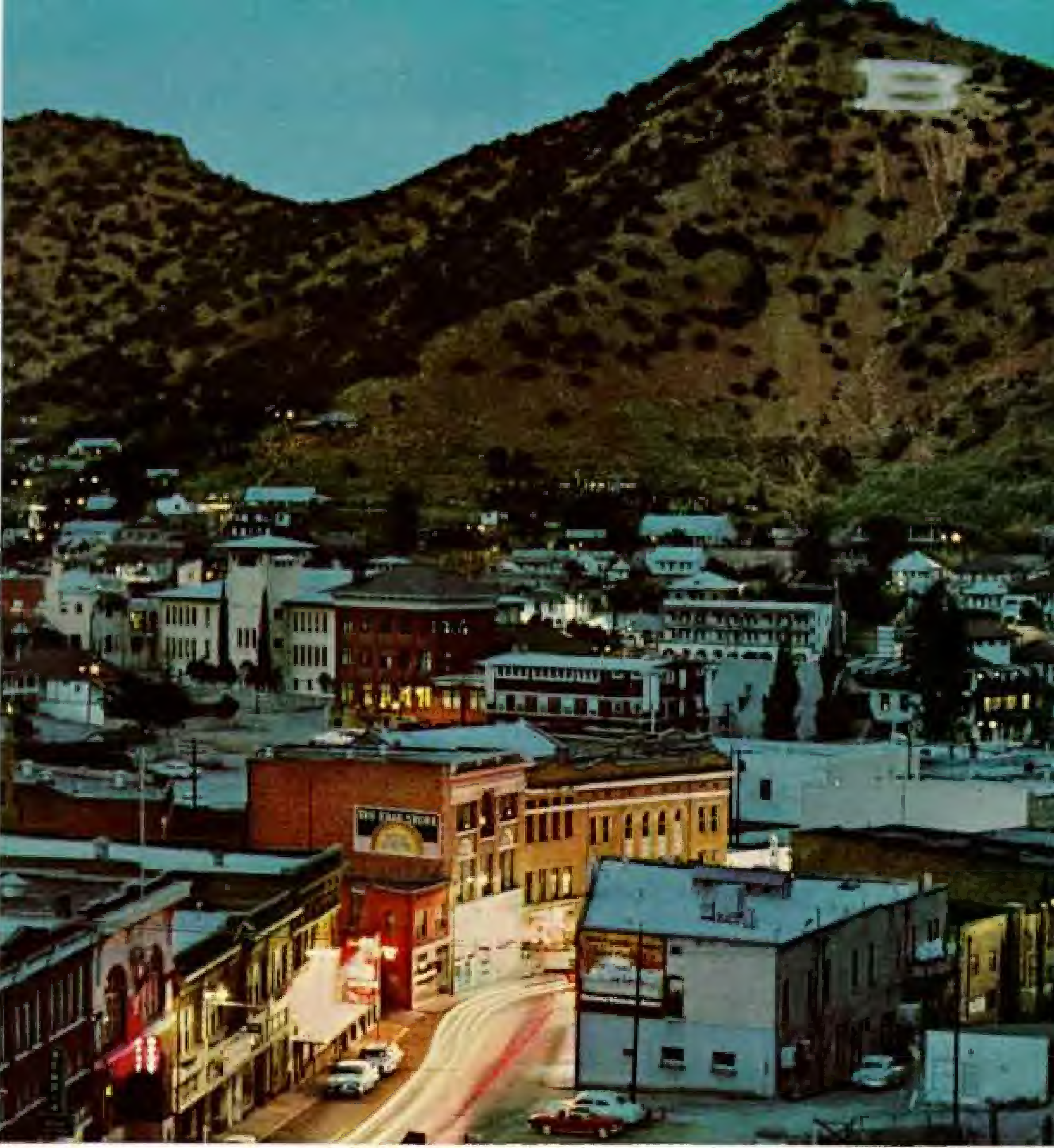
to the rabbits and small rodents," Goulding said. "They just didn't come out of their holes after their hibernation. There used to be a lot of coyotes, too, but they left when they didn't have anything to eat. If you do happen to see a rabbit, there'll be an Indian crowding him mighty close."

This is a harsh and brutal land, where the Indians live in scalding poverty, despite "general knowledge" that the Navajos are rich. Later I asked John McPhee, assistant to Paul Jones, Chairman of the Tribal Council, to explain the paradox.

"Fifteen years ago, the Navajo was one of the poorest tribes in the United States," he said. "Today it is perhaps the wealthiest, because divine providence gave it great oil and gas fields."

Uranium also yields big money. But instead of distributing income from these sources—more than $16,500,000 in 1961—the tribe spends it on long-range improvements in water supply, educational opportunities, and industrial projects to create jobs.*

*See "Better Days for the Navajos," by Jack Breed, NATIONAL GEOGRAPHIC, December, 1958.



"The tribe set aside $10,000,000 for scholarships," McPhee said. "Now 30,500 Navajos are in school, including 300 in colleges."

The Apaches, both the San Carlos and the White Mountain Apaches, are making a living these days, each with about 15,000 head of cattle (pages 326-27). The White Mountain Apaches pioneered burning underbrush to improve the range, and they have an intensive program to improve recreational facilities—for tourists—in the White Mountains.

But Indian prosperity is relative and limited. Most tribes eke out only a meager living by raising precarious crops of corn, beans, melons, and squash. Almost all Indians supplement their farm food by hunting.

Indians Scour Desert for Food

Prickly pear, mesquite beans, yucca, piñon nuts, and other seeds help stretch the menu. So important is the saguaro cactus to the Papagos of the southern desert that the day the fruits ripen is designated the first day of the New Year.

Many Indians winter in domed mud-and-timber hogans, or adobe cabins (page 333).

Copper Slag Cascades Like Fiery Lava

Arizona, the Nation's leading copper producer, turns out more than a billion pounds a year. Electric shovels, working in huge pits, gulp 11-ton bites of ore. Here a train of 15-ton slag pots dumps the waste into a ravine at Kennecott's plant in Hayden.

Bouquet of irrigation tubes took shape under the 4,000-pound pressure of an extrusion press at the Reynolds plant located in Phoenix. These unfinished aluminum tubes popped individually out of dies like bubble gum from a boy's lips.

In the summer, many of the tribesmen live in brush arbors or mound-shaped wickiups made of twigs.

Without an exception, everyone I talked to who *knew* the Indians thought highly of them. But there is still a prevalent attitude which holds the Indian in low regard.

"The problem is a lack of understanding and communication between the Indians and the white folks," Royal Marks, an attorney for three tribes, told me.

"It was always the white men's side of the story that was told in movies and novels," he continued. "How they were preyed on by the Indians, how the Indians shot the whites full of arrows, and burned their ranches. But people are now realizing that the invader was really the white man, grabbing property belonging to the Indian.

"The average Indian today, I think, still has suspicion toward the white man. The Indians live on their land and they love it. They feel that if they give even a long-term lease, they are going to lose the land."

Indians who serve in the Armed Forces return to their reservations with a broader outlook and modern ideas. Their influence is being felt in the tribal councils.

"All the tribes are making advances in adapting themselves to two cultures," Royal Marks said. "It isn't easy, and they are to be complimented for it."

But the Indians still must fight for a living in a land never designed to support an affluent society. I got a small taste of its harshness on my drive with Harry Goulding. The wind had been kicking up all day. In the afternoon it really went to work.

Red sand, driven as though it were water, flowed across the road in pink riffles and began to pile up in the ruts. I dozed for a few minutes, and when I awoke, the road had almost disappeared.

Now the wind was whirling the sand high

Lighthouse of the sky. Housing for the world's most powerful solar telescope nears completion atop 6,875-foot Kitt Peak. Eighty-inch mirror on the concrete tower will reflect sunlight down the 500-foot slanting shaft—300 feet of it below ground—revealing secrets about solar radiation, flares, and sunspots unresolved by smaller telescopes.

Halfway down the shaft, a workman checks rail alignment preparatory to installing a mirror mounting. Papago Indians, who own the peak and lease it to the Federal Government, call the stargazers "the men with the long eyes." Moon-bound astronauts will rely heavily on observations of dangerous solar radiation made at Kitt Peak.

in the air. Through it, the sun looked like a tiny, glowing coal of fire. Then it was snuffed out entirely, and we were in a whirling, whistling dusk.

"The old desert's got a stinger in her today," said Goulding.

The car porpoised up and down hills of sand, swerving and yawing like a boat at sea. The air was full of hurtling tumbleweed, like yellow cannon balls. In the queer half-light, we occasionally saw Navajo women and girls, their backs to the wind, watching their sheep. Their peach-colored, green, or blue satin skirts streamed out before them.

Suddenly we were in the sun again, and the wind dropped to a breeze. The evidence of the storm was all around us: Every plant had grown a lizardlike tail of sand.

"I'd hate to be a Navajo on a day like this," I said.

"No matter how tough things get, a Navajo sees the humor in it," Goulding said. "I think that's what kept them alive. They don't let anything get them down.

"The Indians are really a great race of people," he concluded softly. "They have qualities we need as a Nation."

Lava Scorched a Fire-hued Land

I continued by car from Monument Valley through the Painted Desert, where the country looks as though it were built of coursed brick one moment and like a Technicolor mirage the next. Then the road straightened for the long pull to Flagstaff, clustered at the base of the snow-covered San Francisco Peaks.

A 35-mile loop road took me through the two national monuments of Wupatki and Sunset Crater. More than 800 ruins

Close-up look at the moon. Air Force cartographers at Lowell Observatory in Flagstaff peer through eyepieces on a 12-inch and a 24-inch telescope and compare their observations to lunar photographs.

Mammoth moon crater, 70-mile-wide Gassendi, takes on light and shadow as Patricia Bridges airbrushes its relief features. To aid astronauts who may land on the moon, chartmakers are mapping the entire surface at a scale of 15.78 miles to the inch.

Apache cowboy sops up stew during the fall cattle drive. He tends Herefords in the White Mountains of eastern Arizona, where the Fort Apache Indian Reservation spreads over 1,664,872 acres of forested highland and rolling grassland.

Stout lariats induce a reluctant steer to cross a rain-slick road as Apaches move their cattle from high summer pastures to auction pens in Whiteriver. Cochise, Geronimo, Mangas Coloradas, and other Apache warriors roamed these hills a century ago.

KODACHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER ROBERT F. SISSON © N.G.S.

In a tableau reminiscent of the old West, Herefords stand in the cool water of the White River. Steers will bring top prices from buyers in Whiteriver, headquarters of the Fort Apache Indian Reservation. October frosts gild the cottonwoods.

of the ancient Sinagua have been found here. The largest is Wupatki itself, once containing a hundred rooms built of Moenkopi sandstone. Great cubical boulders of this rock lie about the site, looking as rich as chocolate cake.

The dirt road rolls through red-and-green land for a few miles, and then the country changes. The fields are covered with black cinders. Whole hillsides of cinders rise from the plain. Clumps of yellow grass on these slopes look like stars in a night sky.

Sunset Crater—named for the red-yellow band on the crater lip—is a black hill which erupted in 1064, the date determined by tree rings in beams of houses covered by lava. Amid 800 square miles of cinders, an angry black lava flow fills a narrow valley—a frozen river that once seared the countryside.

I was met in Flagstaff by Ted Babbitt, whose grandfather arrived in the town in 1886. Just 10 years earlier, local lore relates, a party of scouts peeled a pine tree and lashed Old Glory to its tip to celebrate the country's 100th birthday. The flagstaff became a landmark and gave the town its name.

"This is the most misinterpreted area in the United States," Ted said. "People come through here with water bags on their cars, prepared for desert driving. They're amazed to find pine trees and cool air."

Flagstaff is a hummer. Daily 35 trains rum-

ble through town, and a truck a minute passes during daylight hours. Many trucks are cement "tankers" en route from Clarkdale to Glen Canyon Dam, near the Utah border.

Ten thousand Indians converge on Flagstaff for the All-Indian Pow Wow on the Fourth of July. "It's a show for and by the Indian," Ted Babbitt told me. "Not even the Governor himself could parade unless he were Indian" (pages 302-03).

Flagstaff is a busy intellectual center—the home of Arizona State College, the distinguished Museum of Northern Arizona, an important Naval observatory, and Lowell Observatory. The astronomers flourish under the same conditions—an altitude of 7,246 feet, dust- and pollen-free air—that attract sufferers from pulmonary disease to Flagstaff.

Lowell Observatory is famous for its "firsts," notably for determining the temperatures of Venus, Mars, Jupiter, and Saturn, and for discoveries that led to the theory of the expanding universe (page 325).

But the most dramatic of the observatory's efforts was the prediction of the existence of Pluto and its subsequent discovery. In 1902, Percival Lowell, founder of the observatory, reasoned there should be another planet beyond Neptune. Astronomers worked for years to complete the mathematical proof, and in 1930 Pluto was caught on the photographic plates by astronomer Clyde Tombaugh.

Lowell did not live to see it. He died in 1916 and

Peering through fence slats, Navajo woman and child watch Indian cowboys compete in the Flagstaff rodeo. Riders vie for $10,000 in prizes.

Blast-off! Airborne Cowpoke and Bronc Part Company

Scarcely had this rider left the chute—one hand free, the other clutching rope—when his mount bucked. A second later, boots left stirrups and man met earth. Action took place at Prescott's Frontier Days rodeo, the Nation's oldest.

Arizonans and their visitors flock to some 125 rodeos held annually in the state. "Rodeo" derives from the Mexicans' word for roundup. They, in turn, took it from the Spanish verb *rodear*, meaning "to encircle."

Wrestling a steer, an Indian bulldogger grabs the horns, plants his heels in dirt, twists the head, and forces the animal to the ground.

lies buried near the telescopes on Mars Hill, 341 feet above Flagstaff.

After I had been in Arizona about three weeks, it occurred to me that—bemused by the exorbitant scenery and the exuberance of the people—I had not seen any copper.

Arizona has led the Nation in copper production for the past 50 years. From 1858 to 1960 the state's underground mines and open pits yielded 17,780,776 tons of copper, worth $7,072,681,000.

Some Arizona copper companies make a profit from ores averaging only twelve pounds of copper to the ton. For this they receive $3.72 at the current price of 31 cents a pound. A profit is possible because sulphide coppers are associated with gold and silver, and the return from the precious metals helps pay for the mining of the copper ore. (Annually, Arizona produces approximately $5,000,000 worth of gold and almost as much silver.)

Copper is responsible for some of the more improbable cities of the state, cockeyed cities built on roller-coaster hills. Jerome, once Arizona's fifth city, is now a ghost town, but Bisbee and Globe prosper.

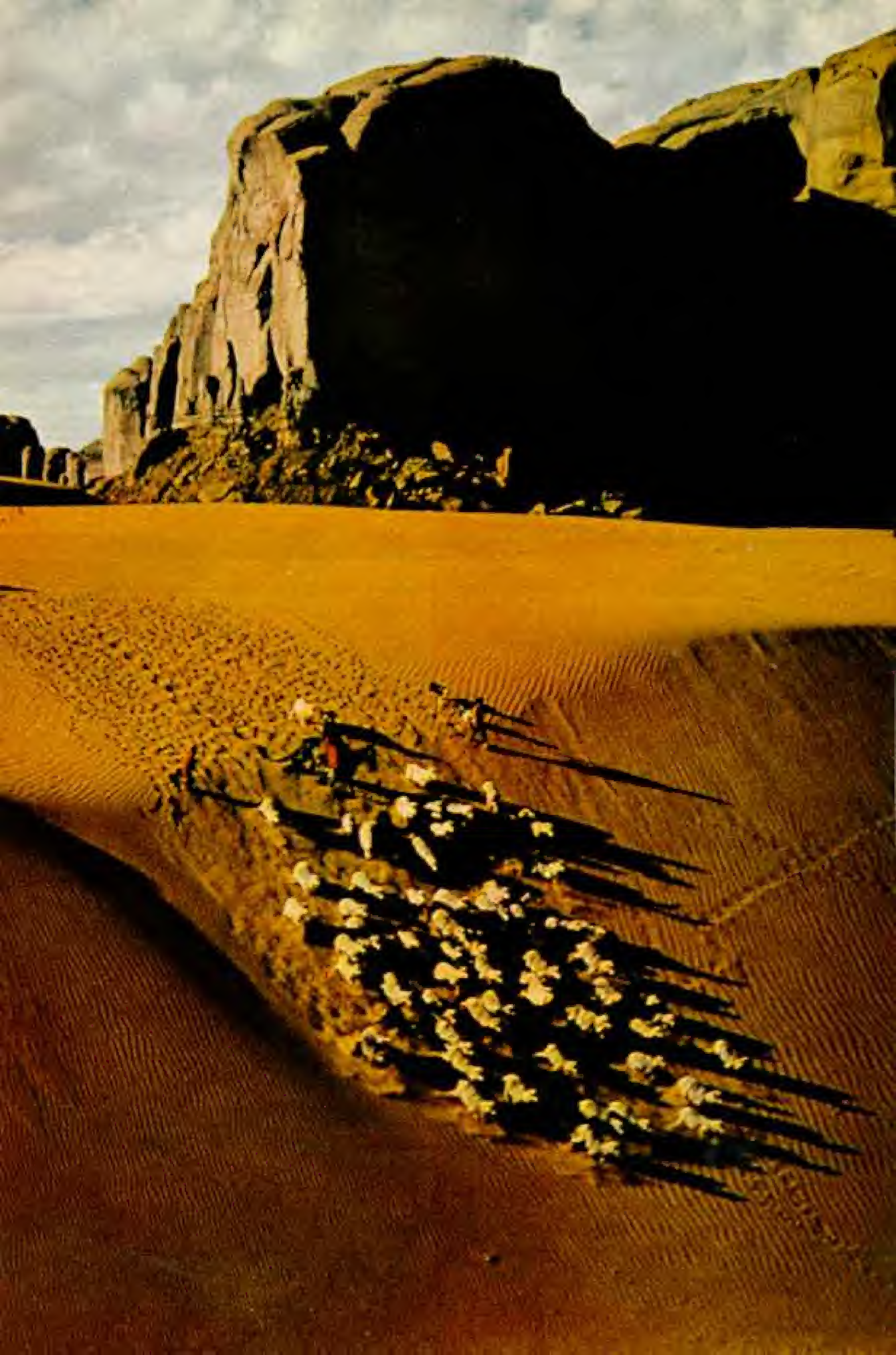
They say in Arizona that men tear down nature's mountains, run them through mills and smelters, and rebuild new mountains of the waste. This is particularly noticeable in Globe, where a black mound of slag juts into a residential section.

I met Norman Harrington of the Kennecott Copper Corporation on a dusty hill in Ray, the site of an underground mine established in 1900, now an open pit. He handed me a yellow badge and a hard hat, and we went to look for Stan Johnsen, the production foreman. We found him on one of the benches of the pit, just above a tremendous electric shovel which was methodically chewing up the hill in 11-ton bites.

The pit fell away in gigantic steps. Its sides were red, silver gray, and mauve. In the faraway bottom was a pool of sullen yellow water. Minerals had stained another pool deep, deep green. Tall boxlike trucks moved steadily about in the pit. Some crept toward the ore crusher; others plodded up a steep hill to dump waste rock.

Like a flash flood sweeping down flaming sands, sheep head for water in Monument Valley after a day's grazing on desert shrubs. Navajos herd their flock on foot and horseback across dunes shaped by the same winds that carved magnificent Spearhead Mesa (right) and distant Rain God Mesa.

KODACHROME BY W. ROBINSON © N.G.S.



KODACHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER JAMES P. BLAIR © N.G.S.

Navajo Surveyor Lays Out Streets in Window Rock, His Tribe's Capital

College graduate Harrison Yazhe offers evidence of the educational revolution that has swept Navajoland in the last decade. Trailer schools for youngsters and million-dollar boarding schools for teen-agers have sprung up on the 16,000,000-acre reservation, home of the largest tribe in the United States.

Arizona's Navajo population today numbers 74,000, a gain of 54,000 since 1900. Window Rock, in northeastern Arizona, derives its name from a wind-eroded sandstone arch.

"We mine 23,000 tons of ore a day," wiry Stan Johnsen told me, "and move twice as much in waste. All told, about 69,000 tons a day. We have a rule that nothing is allowed to interfere with the trucks. They have the right of way at all times."

When we drove in Johnsen's pickup to the crusher where the giants congregated, I began to appreciate the size of the ten-wheel trucks. They towered over our car. I felt a little like an ant among moving sugar cubes.

These trucks carry 56 tons in one load. Powered by two 335-horsepower diesels mounted side by side, they have automatic transmissions and power steering. Otherwise the drivers, who looked to me like midgets perched in the high cabs, could not handle such a mass of machine and ore.

"The tires cost $1,400 each," Stan Johnsen said. "That's $14,000 a truck right there."

"How long do the tires last?"

"Around 2,500 hours."

Later, I drove with Norman Harrington to the Kennecott mill and smelter at Hayden.

The ore from Ray—less than one percent copper, or about 18 pounds to the ton—arrives at Hayden by rail. As a first step it is crushed, in a turmoil of noise, to a diameter of three-eighths of an inch. I noticed that the dust from the crushers was carefully collected. "It's not just good housekeeping," Norm Harrington said. "There's copper in that dust."

The ore then goes to rod-and-ball mills for grinding into powder. After treatment by acids, it emerges as a dark-gray concentrate ready, after drying, for the hot furnaces.

We watched the final refining process. Great yellow-green flames rushed from the top of a furnace. A thin cerise-colored stream of molten copper poured out of the furnace into shallow molds.

When cooled, this is the finished Arizona product: an "anode" weighing about 700 pounds. The copper is about 99 percent pure. Later, at other locations, it is further purified electrolytically.

"Cousin Jacks" Burrowed Under Bisbee

Bisbee claims to be the copper capital of Arizona. It is one of the world's very few nonferrous mining camps that have produced more than a billion dollars worth of ore.

In the early 1900's, Bisbee flourished because of the copper that attracted miners to the town. Almost 4,000 Finns, Poles, Irishmen, Italians, and "Cousin Jacks"—men from Cornwall—worked the underground mines. While some of the stores and homes on the original town site are empty, the present-day town still has a prosperous look.

The Phelps Dodge Corporation, the giant of Arizona copper producers, owns almost all the copper land of the district, a hotel, the hospital, and three large stores. In Bisbee, it is known simply as "the company."

Bisbee grew where copper was found, along Tombstone Canyon. Homes cling to the steep sides of School, Quality, Laundry, and Chihuahua Hills (pages 320-21).

After dinner at the Copper Queen Hotel,

Traditional hogan, a mud-covered log hut, still houses many Navajos, although cement-block and frame homes have appeared in recent years. Door always faces the east, from which all good spirits come, including the sun, Navajos believe.

Navajos sit on the dirt floor, their guest on the bed, as John and Anna Cly entertain in their fire-lighted hogan. Cly has washed his long hair with yucca-root shampoo; he will tie it with string. Loom holds a rug being woven by Mrs. Cly.

 Snow-mantled piñons on the South Rim frame the Grand Canyon, earth's mightiest gorge.

Mile-high mesas hide the brawling Colorado River as it cuts a 217-mile gash in northern Arizona

I wandered up Brewery Gulch. The red-brick brewery, trimmed in weathered green copper sheeting, stood in empty majesty. The street curbs, more like retaining walls, stood five feet high. Steps were cut into the sidewalk as the street lurched up the gulch.

There was a hooting and hollering from a nearby dram shop. I hurried over, thinking I might see a rip-roaring Bisbee saloon brawl, as in the old days. Such are these tamed times, however, that I found the noise was made by a couple of ladies cheering on a shuffleboard game.

Mission of the Cat and Mouse

The most graceful reminders of the Spanish regime in Arizona lie south of Tucson, in the ruined church of Tumacacori and the serene Mission San Xavier del Bac, both on the sites established by Father Eusebio Kino, the Jesuit priest-explorer.

Tumacacori is now a national monument. The National Park Service has stabilized rather than restored the church, doing the work with understanding and love. A model shows how the structures looked when they were in use, and a small museum places Tumacacori in historical perspective.

San Xavier serves, as it has for 165 years, as the mission church for the Papago Indians. It is among the best examples of Spanish colonial architecture in the Nation (page 312).

Seen across the dun-colored desert, bright, white San Xavier gleams like a jewel. Two terraced towers, one unfinished, flank the 52-foot-high dome, a tribute to the skill of the builders. It was built of burned adobe brick and lime plaster, and, possibly, without scaffolding.

The façade frames old oak doors. High on the façade is the figure of a mouse; opposite, a cat.

I looked around and found Brother Austin, a Franciscan in brown habit and sandals.

"Somebody told me the Indians believe that when the cat catches the mouse, the end of the world will come," I said.

Brother Austin's eyes twinkled. "It would certainly be the end of the world for the mouse," he said.

He pointed to the door handle. "Notice that this is shaped like a snake. Inside, there is another figure of a mouse. We don't know why."

Sign Keeps Old Rivalry Warm

Tucson has always regarded Phoenix as an arrogant parvenu and carries on a commercial, cultural, and just-on-general-principles rivalry with the capital. Ironically, Tucson's tallest building is topped with a sign reading, "Phoenix Title," and it hurts Tucson no less than a dagger in the back.

"We're going to put up the tallest building in Phoenix and put 'Tucson' on top of it," I was told.

"Phoenix has changed, but Tucson still retains

(Continued on page 341)

Minnesota? No, Arizona! Sportsmen fish for trout through the ice on Nelson Reservoir in the White Mountains

Bathers in blue jeans scoot down slick Slide Rock in Oak Creek Canyon, near Sedona, where many Arizonans on holiday camp among flaming red rocks that rival the beauty of Grand Canyon. "Pants don't last too many trips," says photographer Sisson.

Masked technician in protective gloves welds a wheel for a turbine generator designed for use in space probes. He works behind a Plexiglas chamber at the Garrett Corporation's AiResearch Division in Phoenix. Inert argon gas in the chamber protects rare metals.

Flooded lawn reflects Motorola's military division headquarters in Phoenix, hub of the state's booming electronics industry. Periodic flooding keeps lawns green the year round.

Threading wires finer than human hair, General Electric employees "sew" the core-memory planes of electronic computers in a Phoenix plant. Each board holds more than 4,000 doughnut-shaped, pinhead-size magnetic cores; four wires go into each core. A single computer requires more than 350,000 different parts and 3,500 man-hours for its manufacture.

Falcon missiles for the U. S. Air Force receive final touches on an assembly line at Hughes Aircraft plant, Tucson. "Remove before flight" banner tags the protective cap of the missile in foreground. Supported by thin wires, the Falcon moves on an overhead rail (not shown) to another part of the factory.

Boosted by 5,000-pound rocket thrust, dummy pilot and seat soar 400 feet as engineers of Rocket Power, Inc., test their new Zero-Zero catapult escape system near Mesa. Devices free the "man," open his parachute, and lower him gently to earth.

KODACHROMES BY NATIONAL GEOGRAPHIC PHOTOGRAPHERS ROBERT F. SISSON (ABOVE) AND JAMES P. BLAIR © N.G.S.

Water sports in the front yard. Many residents of Phoenix no longer spend hours sprinkling their lawns; controlled inundations by the Salt River Project do the job. Water, flowing through open ditches and pipes, is turned on and off at scheduled intervals.

Green-gravel lawns dress homes in Sun City, a retirement community that opened in 1960 near Phoenix. Developers are confident that the town of 6,000 will expand to 10,000 in five years or less. Arizona's 65-and-over population rose 104 percent between 1950 and 1960.

its personality," I heard. "Tucson is like a colonial Spanish town in the days of sail, with the king 5,000 miles away."

There's truth in that. Tucson, settled in 1776, relishes its age and Spanish background. Streets are named Paseo Redondo, Alameda, Granada. A school is named Ignacio Bonillas, and a pupil's first task is to learn to pronounce it: eeNASeeoh boNEEyas.

Sharing in Arizona's boom, the modern Tucson community has swollen from 45,454 to 212,892 people since 1950, and it has expanded from about 9 square miles to more than 70. It is the hub of a rich copper district, a market center, and the site of a large Hughes Aircraft plant that makes Falcon air-to-air missiles for the Air Force (page 339).

But a main Tucson "product" is sun. As one Wyoming coed wrote, "It's fine, I guess—just one darned delightful day after another."

The warm, dry climate of Tucson is ideal for sufferers from asthma and arthritis, and many dude ranches prosper in the balmy winter climate.*

However, Tucson's real pride is the University of Arizona, long noted for its fine Department of Anthropology, among others. It is a cultural leaven for the whole community. The energetic leadership of President Richard Harvill has changed the university's entire complexion in the past decade. The science curriculum and research program have expanded twentyfold. Electrical engineering and fine arts are booming, as is the new Oriental studies program.

The university has a lunar and planetary laboratory and has gained strength in astronomy. Its program is greatly stimulated by the establishment of Kitt Peak National Observatory, on the Papago Indian Reservation (page 324). Scientists first noticed the 6,875-foot peak while scanning photographs taken by a Viking rocket in 1955.

Desert Museum Teems With Life

I drove 15 miles west of Tucson over a bucking, twisting road through a magnificent stand of saguaros. The giant cacti are so close to the road that their supplicating arms make them look like grotesque hitchhikers.

Set in this forest is the Arizona-Sonora Desert Museum, one of the world's foremost "living" museums.† William H. Woodin, the young Director, met me near the entrance, where chuckwallas, whip-tailed lizards, and other creatures frolicked in the sand.

"This is much more than a usual museum," he said. "It is part zoo, part botanical garden, and part conservation institution. Unlike many museums, most displays are alive."

In a low adobe building, snakes, centipedes, scorpions, and small rodents were on display. The museum buys 70,000 meal worms and 1,000 crickets a month for such charges.

Along "animal row," bears, a family of javelinas, Mexican wolves, margay and ring-tailed cats, a beautiful jaguar, and four varieties of skunk seemed happily at home.

A dozen or so desert tortoises clambered around a sand-filled pit. "Visitors welcome inside this enclosure," said a placard.

"People find it hard to believe they can get right in with the tortoises," Bill Woodin grinned. "I guess they are used to being kept out of such places."

University Enrolls 16,000 Students

I visited Arizona State University at Tempe to see Dr. Herbert Stahnke, world renowned for his work on venomous animals. I was early, so I wandered about the grounds.

It was a revelation. Before World War II, Arizona State College—as it was known then—was a sleepy place, with only three buildings for its 1,250 students. On the day I was there, the campus swarmed with students; more than 16,000 are now enrolled. Everywhere I looked I saw new buildings.

The Life Sciences building forms a hollow square, around a re-created patch of desert that serves as an ecological laboratory.

I looked through a big observation window at hummingbirds and doves, jack rabbits, tortoises, squirrels, and soft-shelled turtles in a little pond. Two chuckwallas stood rigid sentry duty on a rock pile.

"We've seen the soft-shelled turtles eating pigeons here," Dr. Stahnke told me when I commented on the laboratory. "They lie just under water. When a pigeon comes to drink, they grab its head and hold it under water until the bird drowns. To my knowledge, it's the first time that's ever been observed."

I mentioned my own disappointment in not having seen much life on the desert.

"You could probably go out into the desert for years and not see a rattlesnake," he laughed. "Arizona has 18 kinds of rattlers, but the population is low. And, of course, most desert life is nocturnal."

"I am nocturnal," I assured him.

*This dude-ranch country is described in "From Tucson to Tombstone," by Mason Sutherland, NATIONAL GEOGRAPHIC, September, 1953.

†See "Arizona's Window on Wildlife," by Lewis W. Walker, NATIONAL GEOGRAPHIC, February, 1958.

Telephone in the swimming pool symbolizes the luxury of estates in Paradise Valley, near Scottsdale. Suburbia's developers, thrusting ever deeper into the countryside, offer houses with backyard pools for as little as $10,000. Air conditioning has conquered the desert, once a wasteland where only the tough or lucky could survive.

Citrus grove on the outskirts of expanding Phoenix produces its most profitable yield,

"Go out some night; drive slowly, lights dimmed—you'll see plenty of action."

That night I ranged the desert beyond Scottsdale with my headlights on lower beam, driving at seven miles an hour. This went on for a long time, and the only gleaming "eyes" I saw were the bottoms of beer cans.

But when my engine and lights suddenly conked out and I was plunged into the desert night, the desert came alive. I heard—or thought I did—the rustles, rattles, scrapings, slitherings, and mutterings of gila monsters, rattlesnakes, scorpions, centipedes. . . .

The night was full of these evil sounds, and I thanked my stars for a cowardly heart that had kept me on a paved road.

In a little while a car came along, and Herman "Skip" Schmidt gave me a ride back to town. It is not often that the man who rescues you from a desert also suggests a good restaurant, but this one did.

"Just drive out this road for another five or six miles," Skip said as he dropped me off in Scottsdale. "Then turn off toward Pinnacle Peak. It's all marked. Name of the place is the Pinnacle Peak Patio. Steaks two inches thick, broiled over mesquite. Plenty of beans and a big salad."

A few nights later, I picked up my daughter Barbara and her husband Mike and headed for the place. Everything was just as Skip Schmidt had promised. There was the good smell of steak broiling, pretty waitresses in Western garb, and occasional whiffs of mesquite smoke. We ate at outdoor tables.

Pinnacle Peak was a rugged shadow against the flaming sunset sky. A tall saguaro was silhouetted at exactly the proper place.

Over coffee cups we watched, not saying much, as the fiery sky ran the spectrum into peaceful, purplish dusk.

It was enough, I thought. It *was* enough to make a man call a newspaper just to say how much he liked Arizona. THE END

a crop of houses. Land that once sold for 25 cents an acre now brings $5,000 to $8,000

This wealthy Latin land, target of Communist agents, tries democratic ways after 130 years of oppression, but pockets of poverty mar a boom economy

Venezuela Builds on Oil

By THOMAS J. ABERCROMBIE
Foreign Editorial Staff
Photographs by the author

TANKS AND ARMORED CARS clanked and rumbled ominously along the empty streets around Plaza Bolívar. From the jammed sidewalks silent crowds watched expectantly through a picket fence of bayonets. It was Inauguration Day in Caracas, but the city had the look of a bastion under siege.

I fought my way toward the Capitolio—housing the national legislature—through a compact cross section of Venezuela's people: the mestizo laborer, the fashionable señorita, the fat shopkeeper, the lean, white-collared priest, the soldier in olive drab, the small boy clutching a tiny flag. All milled around uneasily. Their anxious faces reflected a growing tension.

After decades of heavy-handed dictatorship, Venezuela was swearing in a new, freely elected President, Rómulo Betancourt (page 357).

It was a triumphal moment for this short, studious-looking man who had spent years in prison and exile fighting the iron autocrats and army rule that strangled the country for more than a century. But in Venezuela,

Ribbons of light trace the swirl of traffic beneath twin towers of Simón Bolívar Center, Caracas. Government offices occupy skyscrapers and glass-walled wings. The center epitomizes transformation. Fifteen years ago Caracas slept in the embrace of a colonial past; today it booms, as new buildings flank new avenues and newcomers swell the metropolitan population to 1,356,000.

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

where presidents' lives are frequently imperiled, it was an hour of danger.

As we elbowed through the crowd, my companion, a Venezuelan newspaperman, uttered a short, humorless chuckle.

"Those people back there were betting," he explained. "They were betting on how many steps the President will take before he is shot."

But cheers, not gunfire, broke the morning-long silence as Betancourt appeared, wearing the red, yellow, and blue sash of office. He mingled with now-jubilant crowds, shaking hands with some, waving to the rest.

"Let us realize that we must build our fatherland," Betancourt said in an appeal to the people, "and that we have the abilities and the extraordinary resources of wealth to do it."

That was February 13, 1959. As this is written, nearly four years later, President Betancourt's coalition government is still building Venezuela—and is proving that democracy can work in a country where no freely elected president has ever served his full term of office. The government has weathered violent Communist-led rioting and sabotage, abortive military uprisings, and attempted right-wing coups, plus a nearly successful attempt on the President's life with a radio-controlled bomb.

Recently I flew, drove, canoed, and hiked some 6,000 miles through Venezuela and found it, as President Rómulo Betancourt

Cosmopolitan complexity invades Caracas. Marker warns of no parking at any time. Awning and bulb-lit arrow advertise a pharmacy. Young man hurries to an appointment.

White-shirted workers gather in Maracaibo to hear President Rómulo Betancourt (page 357). Their

had declared, a wealthy country indeed.

Here, in a country roughly the size of Texas, Arkansas, and Louisiana combined, I crossed a lake of oil, climbed a mountain of iron, paddled a dugout up a river of diamonds, and dived into a sea of pearls.

In an isolated pocket of the Andes I heard the Spanish of Cervantes spoken in a Castilian village little changed since the days of Spanish rule. Stone Age Indians befriended me in the green jungles of the Sierra de Perijá. Farther south, in a setting of primeval splendor, I journeyed through the grassy plains of La Gran Sabana to the world's highest waterfall, Angel Falls (map, pages 350-51).

Gateway to Venezuela's wonders is Caracas. Haughty, sophisticated, she stands in contrast to the rustic land that nourishes her.

Recent austerity programs may have momentarily slowed her tempo, but a healthy flow of oil revenue rushes through her arteries. Caracas is still a boom town deluxe.

"My city," one Caraqueño told me, "is like my wife: beautiful, gay, noisy, lovable—and terribly expensive!"

Oil Money Modernizes the Capital

Before 1940, it was a small city of whitewashed stucco and red-tiled roofs, dozing in Spanish-colonial charm, unnoticed by the world. Then, sparked by the demands of World War II, Venezuela's rich oil fields began pumping at a record flow. Now royalties pour over a million dollars into the treasury

banners petition for higher wages, broader credit, and less expensive medicines.

Images out of childish imagination decorate the walls of ventilation ducts in Caracas's Simón Bolívar Center. Adult artists reproduced prize-winning designs of grade-school youngsters.

Free-form acoustical panels float above the 3,000 seats of the Aula Magna (Great Lecture Hall) of Central University in Caracas. Architect Carlos Raúl Villanueva (foreground) supervised design of the university's ultramodern buildings.

Geometric patterns enliven a wall of the auditorium. Red-and-black library at right can hold a million volumes.

Massive Apartments in Caracas Rise a Few Steps From Shanties

President Betancourt's government has spent $213,300,000 for housing to replace the packing-crate and sheet-iron *ranchos*. When this development opened, workers could buy apartments in 10 years with a shanty as down payment and monthly installments of $9 to $24.

every day. Caracas sprouts skyscrapers and spreads out into the valley.

Dominating the city's skyline is Simón Bolívar Center, a 30-story government office building complex whose twin towers straddle a six-lane, multilevel highway that slices the old city in two (page 345).

At noon many people in Caracas go home, and sometimes the traffic around the center reaches battleground proportions. Horns honk, tempers and radiators boil. I weathered one such ordeal seated beside a Venezuelan friend, architect Enrique Siso. On one quarter-mile stretch we had time for two cups of coffee sold by jug-toting vendors along the street.

"We Venezuelans like our siestas," admitted Enrique, "but we start to work early in the morning and work until dark to make up for it." The Venezuelan readily mixes Latin tradition with Yankee efficiency.

Stopping at the well-stocked Auto Mercado, a modern supermarket in the plush suburb of Las Mercedes, I saw Venezuelan housewives browsing among

(Continued on page 353)

KODACHROMES BY THOMAS J. ABERCROMBIE, NATIONAL GEOGRAPHIC STAFF © N.G.S.

Venezuela: "Terrestrial Paradise," "an Other World," Wrote Columbus

He barely touched this land more than twice the size of California. Columbus never explored his Eden or imagined all its diversity: snow-capped Andes in the west, riverine jungles in the south and east, and vast plains in the heartland.

Venezuela lies 600 miles from both the strategic Panama Canal and troublesome Cuba. Sabotage directed from Cuba has threatened Lake Maracaibo's vital oil fields.

Oil fields · Airfields · Oil pipelines · Railroads · Roads in red · Soundings in feet · Elevation of cities and peaks in feet

© N.G.S. Drawn by Victor J. Kelley Compiled by John F. Wood

Caribbean Sea
WINDWARD ISLANDS
Grenada (United Kingdom)
Aves Islands
La Blanquilla
Los Roques Islands
Orchila
Margarita
Juangriego
Pedregales
San Juan
Pampatar
Punta Piedras
Porlamar
Cubagua
La Tortuga
Tobago
TRINIDAD AND TOBAGO
Port of Spain
Trinidad
San Fernando
Gulf of Paria
Güiria
Río Caribe
Carúpano
Cumaná
Puerto La Cruz
Barcelona
Caripito
Pedernales
Maturín
ORINOCO DELTA
Tucupita
Uracoa
Guarucara
Barrancas
Manoa
Amacuro
Puerto Cabello
La Guaira
CARACAS
Higuerote
Los Teques
Maracay
San Francisco de Yare
Ocumare del Tuy
San Juan de los Morros
Onoto
Anaco
Cantaura
El Chaparro
El Tigre
San Tomé
El Pao
Zaraza
Valle de la Pascua
Las Mercedes
Calabozo
LLANOS
EZUELA
Palúa
San Félix
Puerto Ordaz
Minas del Pao
Ciudad Bolívar
Orinoco
San Fernando de Apure
Apure
Caicara
STATE
Ciudad Piar
Cerro Bolívar
Guasipati
Tumeremo
Santa Juana
La Paragua
El Dorado
Cuyuni
BRITISH GUIANA
Parguaza
Puerto Páez
Caura
Paragua
Canaima
Angel Falls
Churún
Puerto Ayacucho
GUIANA HIGHLANDS
La Gran Sabana
Urimán
Evenequén
Morganito
Santa Elena
Icabarú
Aratañá
Sipapo
Ventuari
Santa Bárbara
Orinoco
BRAZIL
Pueblo Viejo
Capibara
Boca Mavaca
Orinoco
Mavaca
El Mango
Negro
Santa Isabel
Caribbean Sea
Maiquetía International Airport
La Guaira
Macuto
FEDERAL DISTRICT
CARACAS
MIRANDA
Simón Bolívar Center
Central University
Las Flores
Las Mercedes
La Carlota Military Airport
La Vega
Officers Club

shelves laden with such familiar products as *Café instantáneo* and a detergent called *Don Limpio*—"Mr. Clean."

And, tucked into many shopping carts, I saw traditional Venezuelan *hallacas* (tasty tamales of meat, beans, and spices wrapped in banana leaves)—quick frozen.

In Caracas I boarded the cable car that whines up Pico Ávila, between the Caracas valley and the sea (next two pages). Near its crest I checked into the gleaming $10,000,000 Hotel Humboldt, built by Venezuela's last dictator, Gen. Marcos Pérez-Jiménez.

Caracas Contrast: Wealth and Poverty

From the 14th floor of this tower of glass, I looked straight down on La Guaira, 6,000 feet below, the country's largest seaport. Out my bedroom, on the other side, Caracas lay in the shadows of dusk, a sprawling metropolis of twinkling valley suburbs laced together with brightly lighted expressways.

The next morning the Humboldt's manager, Marcel Frei, led me on a tour, pointing out the hotel's indoor swimming pool, penthouse bar, tennis courts, and even a skating rink. But something was missing.

"The hotel has everything—everything, as you can see, except customers," lamented Sr. Frei. "It's too inaccessible for all but the most determined tourists, and maintenance costs a fortune."

I later learned that the government was forced to close the luxury hotel.

Despite a recession due to cutbacks in oil explorations, Caracas remains an expensive city. A new two-bedroom apartment rents for as much as $200 a month. Food—even the local beef—costs more in Caracas than in other South American capitals.

In disturbing contrast to the city's opulence are the slums of packing-crate and sheet-iron *ranchos* that scar the steep hills around the city. One-fifth of the capital's population lives under such conditions.

I climbed the narrow zigzag sidewalk up through one such miserable maze overlooking Las Flores and the heart of the city beyond.

There I talked with Emilio Ortega, a short, powerfully built mestizo laborer who brought his bride to Caracas from the State of Apure in 1955. Six years and seven children later, the Ortega family still lives in this one-room, dirt-floored shack.

Emilio noisily tossed a few rocks to a collection that weighted down his corrugated metal roof. The clangor brought three-year-old Antonio to the doorway. In his arms he cradled one of their four chickens.

"When I first came to the city, I could make 10 bolivars a day," Emilio said. About two dollars, I calculated. "Now I am lucky to earn that much in a week."

I asked if he planned to return home to the llanos, the great Venezuelan plains.

"Señor," he replied, "a poor man in Caracas may have very little, but out on the llanos? Nothing!"

Under a pre-Betancourt public housing program, more than 50 low-cost apartment buildings—including some colorful 15-story, domino-shaped *bloques*—were completed in 1956. The present government has built new, improved housing. But slums continue to exist as more hopeful job hunters flock to Caracas from depressed rural areas (page 349).

Only recently the country has felt the stabilizing effect of a growing urban middle class. Previously the wealthy upper class of Venezuela had ruled by violence and oppression.

Bolívar Freed Land From Spain

Christopher Columbus, probably the first European to sight the Venezuelan coast, touched the delta of the Orinoco River on his third voyage in 1498. He described the new land as a "Terrestrial Paradise" and compared it to the Garden of Eden.

The conquistadores who followed marched inland to western Venezuela in search of gold and silver. They settled down to cultivate the fertile Andean valleys. Cacao, indigo, sugar, and cotton flourished.

By the late 1700's these colonists were beginning to feel less like Spaniards and more like Venezuelans. Inspired partly by the American Revolution to the north, uprisings began, led by the new country's first patriot, Francisco de Miranda. But not until 1821 did Venezuela shake off the Spanish yoke; then Simón Bolívar, a wealthy aristocrat from Caracas, defeated Royalist armies on the

On His Knees, a Candle-bearing Caraqueño Prays in a Good Friday Procession

On Holy Thursday, 1812, earthquakes tumbled the walls of the Convent of San Francisco at left. Repaired, the building subsequently served as the home of the Central University; today it houses national academies. Venezuela's Capitolio appears at right.

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

plains of Carabobo not far from Valencia.

Bolivar, the Liberator, was overwhelmingly elected President of the Greater Colombia Federation, which included what is today Venezuela. He turned the administration over to the vice president.

"I am only good to fight," he wrote, "or at least to march with soldiers."

Bolivar and his sword marched on to free much of northwestern South America. But for more than a hundred years Venezuela suffered under despotic tyrants.

Today the Betancourt government works vigorously to meet the people's pressing needs. It builds new schools and hospitals and trains teachers, doctors, and nurses. It campaigns against adult illiteracy and pushes a vital four-year economic development program. The Alliance for Progress, established by President Kennedy, is helping.

Nation Ranks First in Oil Export

Venezuela still lives on oil. It leads the world in oil export and is third in production, after the United States and the Soviet Union.

Three hundred miles west of Caracas, on

Blue-white in haze, Caracas spreads out from its twin towers (right, center), engulfing

torrid Lake Maracaibo, I toured the spectacular offshore oil fields as guest of the Creole Petroleum Corporation (pages 360-61). A subsidiary of Standard Oil of New Jersey, Creole runs the biggest show on the lake. Its near 2.1-billion-dollar investment makes it one of the biggest United States companies abroad.

As we sped through a steel forest of oil derricks, our launch spread a drab wake across the oily waters of Lake Maracaibo. The waking sun still yawned yellow, a glowing doubloon in a tarnished silver sky.

My companions were "roughnecks" who commute from shore each day to explore and exploit the richest oil deposits in the hemisphere, western Venezuela's spectacular Bolivar Coastal Field. Beside me sat Rafael Mateo, a burly driller proud of his two decades' experience on Maracaibo.

"The land around the lake has been subsiding for millions of years," Rafael explained. "Dikes we've built along the shore have reclaimed swampland."

Though called a lake, this is really an extension of the Gulf of Venezuela (map, page 350). Some 450 years ago, when Spanish ex-

the valley and leaping nearby hills. Cable car climbs up 7,087-foot Pico Ávila

VENEZUELA: facts and figures

IN 1922 OIL DRILLERS brought in the first gusher at Lake Maracaibo. Today oil revenues make Venezuela, by contrast to the poorer neighboring Latin American lands, a 20th-century El Dorado—the fabled land of gold sought by Spanish conquistadores.

OFFICIAL NAME: Republic of Venezuela. **AREA:** 352,143 sq. miles. **POPULATION:** 7,788,000. **LANGUAGE:** Spanish. **RELIGION:** Largely Roman Catholic. **ECONOMY:** 44% of workers in agriculture, 11% mining and manufacturing, 3% petroleum. Produces coffee, cacao, sugar cane, corn, cotton, cattle. Leads world in oil export; ranks third in production. Rich iron ore deposits; also diamonds, gold, coal. **MAJOR CITIES:** Caracas (pop. 739,255), capital; Maracaibo, seaport and oil center; Barquisimeto, trade center. **CLIMATE:** Varies with altitude; steamy lowlands, 75°-80° F. year-round in Caracas, frigid on higher Andean slopes. Rainy season May-November.

plorer Alonso de Ojeda sailed his caravel over these waters, he found only a few Indians, living in thatched huts set on stilts out over the water and poling dugout "gondolas." These settlements so reminded him of Italy's famed city of canals that he named the new land Venezuela: "little Venice."

De Ojeda, seeking gold, never suspected that he sailed over another kind of treasure. On December 14, 1922, Royal Dutch-Shell's Los Barrosos No. 2, an oil well near Lake Maracaibo, blew in at a depth of 1,500 feet and began gushing 100,000 barrels a day, tossing pieces of the derrick 200 feet into the air.

The boom was on. Competing oil companies soon developed techniques for drilling far out over the water.

Gas Pumped Back Under Lake

Seven miles from shore we churned past a gigantic gas injection plant perched atop a platform the size of a football field.

"Before we built these plants," said Rafael, "billions of cubic feet of gas were burned off and wasted each year. Now some of it drives gas-fueled turbines that pump the rest back into the ground. This way we help to maintain underground pressures that keep the oil flowing longer."

We pulled up to barge No. 221, a giant floating drilling station complete with machine shops, locker rooms, and a heliport, which was butted fast to a 120-foot derrick.

Rafael's crew swiftly coupled a new drilling bit onto the end of a 90-foot section of pipe. The drill pipe dangled over a hole already more than 5,000 feet deep.

Hand on the throttle, foot on the winch brake, Rafael lowered the drill pipe through a heavy rotary table into the casing. When the first section was down, another one was quickly wrung to it with motorized pipe wrenches.

"*Abajo!*" . . . Lower away!

So it went, until the new bit was twisting through shale a mile below us.

Oil Diver Probes a Murky World

I wondered how the men could move so quickly in the enervating June heat.

"You should be here in August," laughed Rafael. "You burn your fingers just taking off your hard hat."

"If you want to cool off, come with me, señor," offered deep-sea diver Angel Lugo.

Crisscrossing the murky lake bottom, approximately 4,000 miles of coated pipelines route the crude oil shoreward to storage tanks. Sr. Lugo was preparing for a routine dive to check for leaks. He offered me a spare mask connected by a long rubber hose to an air compressor on his barge. I think he was surprised when I accepted; I had used this Milwaukee-made equipment before. Adjusting the faceplate, I followed the diver into the black water.

We pulled ourselves 65 feet down one of the derrick's concrete legs to the mucky bottom. With visibility less than a foot, I could see only the faint blur of my companion's bubbles as he swam along. He stopped often to press his mask against the pipe. After 15 minutes I began to feel uneasy in the cold and darkness. Lugo finally jerked his thumb toward the surface. Having sampled an oil diver's murky world, I welcomed the noise and the 95° heat on deck.

"Even with all its special problems, drilling on the lake is easier and cheaper than bringing in many inland oil wells," explained Sam Mercer, a tall Oklahoman who skippers a rig-mover in Creole's 300-boat maintenance fleet.

We were heading back to shore with the drilling crew. The oil workers, now absorbed in newspapers brought out by the launch, looked like commuters anywhere.

At many rugged inland sites, it's another story. I had heard about the hazards oilmen faced in attempting to exploit promising deposits between rich Lake Maracaibo and

(Continued on page 362)

KODACHROME BY THOMAS J. ABERCROMBIE, NATIONAL GEOGRAPHIC STAFF © N.G.S.

Horse of liberty on Venezuela's coat of arms prances above President Rómulo Betancourt (center) at his 1959 inauguration. He has served longer than any freely elected president in the nation's history.

Desertlike dunes near Coro attract the acrobatic young, who race and tumble in the soft sand. Early Spanish explorers, marching this way in 1527, established a colony close by.

Swirl of cape deflects the charge of a bull during a *corrida* in the Nuevo Circo de Caracas. Bullfights, orga-

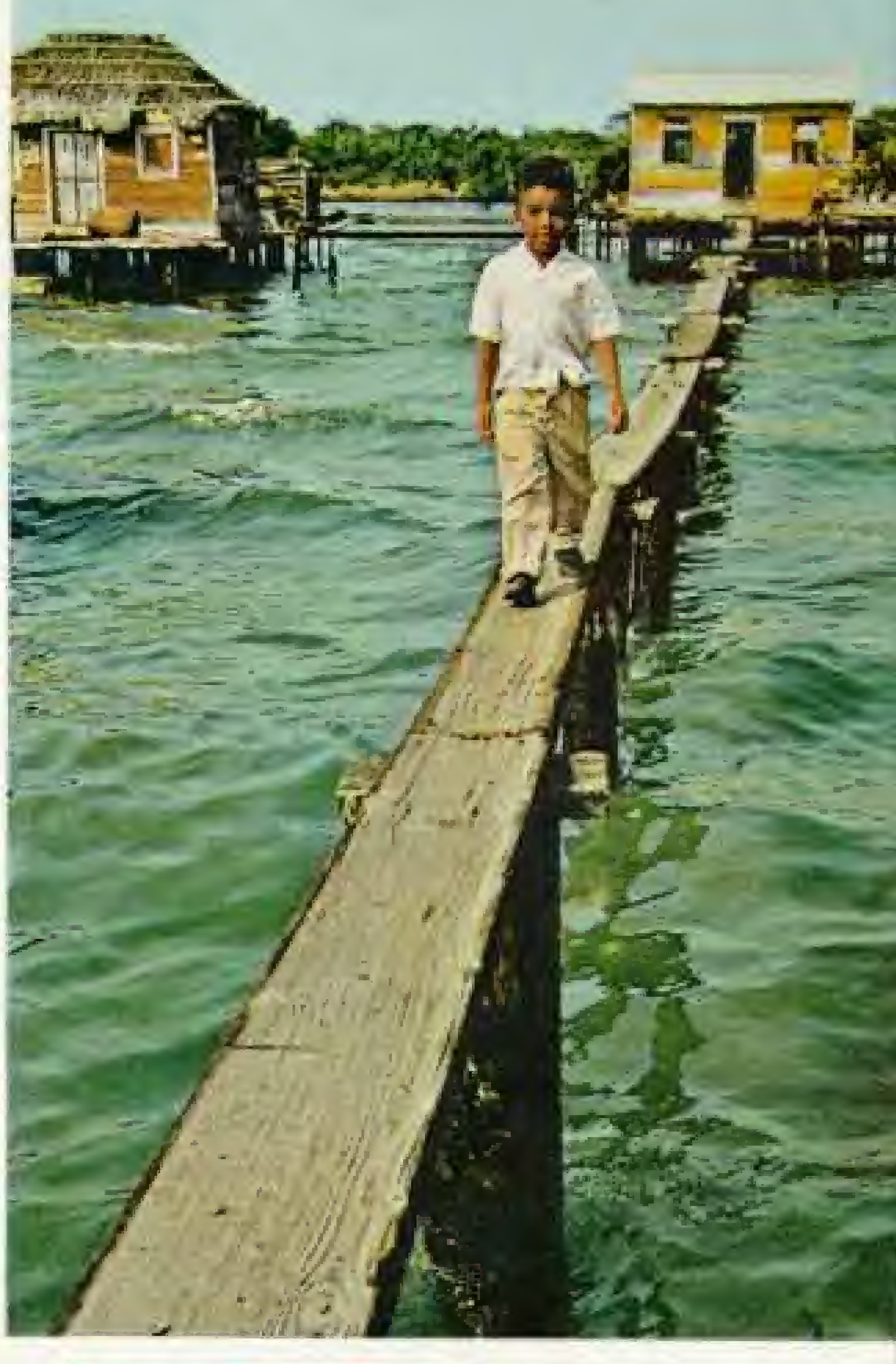
KODACHROMES BY THOMAS J. ABERCROMBIE © N.G.S.

Blowgun and poison darts arm a Piaroa hunter for forays into the Orinoco River jungle. The Indian shares the palm-thatched, peak-roofed house with others in his community.

Vignettes of Venezuela: primitive to ultramodern

Dark beauty of an art lover contrasts with a grotesque painting of a woman in the Museum of Fine Arts, Caracas. The museum's collection includes works by famous international artists such as Alexander Calder and Henry Moore.

nized between November and February, sometimes benefit charity. The author saw one given for Venezuela's Red Cross.



Catwalk makes a street and piles support homes on Lake Maracaibo. Such a settlement inspired a Spanish explorer to call the land Venezuela (little Venice).

Masquerading as a bull, a devil dancer cavorts to the rattle of a gourd on Corpus Christi Day in San Francisco de Yare. Though he wears a cross, the dancer symbolizes evil. He ceremoniously cringes at the sight of sacred images.

Cantilevers of concrete transform a home into an airy aerie: a show place in the Bello Monte section of Caracas.

Oil Rigs Spiking Lake Maracaibo Siphon a Treasury of Black Gold

Spaniards searched Venezuela in vain for the golden city of El Dorado, but geologists early in the century hit the jackpot with the discovery of oil. Sitting atop more than six percent of the

world's known petroleum reserves, Venezuela is the largest oil exporter and, with an output of 3,190,000 barrels a day, is third only to the United States and the Soviet Union in production of oil. During last fall's Cuban crisis, Communist saboteurs blew up four of the Creole Petroleum Corporation's power stations, temporarily knocking out a sixth of the country's producing capacity.

the Sierra de Perija, in western Venezuela.

Prospectors were cautioned about the fierce Motilone Indians who inhabited the region. Oilmen and missionaries who tried to deal with them got the same reply—a shower of long arrows made of black palmwood.

But oilmen armored their trucks and boats with heavy wire mesh and three-inch planking and pushed into forests. They cleared large areas around the drilling sites and posted armed guards. A few wells were brought in, but several workers were killed.

Was the time yet ripe, I wondered, to try visiting these little-known Indians?

"The Motilones?" barked Sr. Clemente Villa-Mas with disbelief. "To go into Motilone territory would be *suicidio!*"

Sr. Villa-Mas should know. Leading a jungle construction crew, he was attacked 18 times in seven months while building a road between two oil camps in the jungle.

"Peace Bombs" Pave Expedition's Way

We talked in modern Maracaibo's Hotel del Lago. In this champagne-and-cut-glass atmosphere, it was hard to imagine a Stone Age culture thriving only 100 miles away.

"Once, going up the Catatumbo River in a launch, a friend sitting next to me suddenly slumped over," Sr. Villa-Mas related. "A six-foot shaft had penetrated the boat's wire mesh and gone through his chest. We never saw the Indian who fired it.

"We cut off the ends of the arrow with a hacksaw as we sped back to our camp at El Rosario. A helicopter flew the wounded man to Casigua, where a doctor removed the stub from his ribs, and saved his life.

"That," he concluded quietly, "is the welcome one can expect in Motilone country."

I called on an old friend, Dr. Roberto Lizarralde, an anthropologist with the Venezuelan Indian Commission and an expert on Venezuelan Indians. Bob and I had explored the upper Orinoco together in 1959.

I was in luck. Bob had made several reconnaissance flights over Motilone country, mapping the area for a possible reservation.

"We dropped 'peace bombs' on them," said Bob. "Bundles of clothing, machetes, and cooking utensils. Often the Indians would wave at our helicopter, and gradually I grew to recognize familiar faces among them.

"On my last flight," Bob continued, "I chanced a quick landing in the clearing around one of their communal houses. They showed no hostility—just great curiosity."

"But could we go and live with them safely?" I asked cautiously.

"Let's try," he replied.

Our helicopter flew southward from the Tucuco Capuchin Mission over small cattle ranches crowding the jungle. My pocket map showed the Motilones' plight. With oilmen's roads creeping up from the south, with the lake on the east and the mountains to the west, the Indians were trapped. Would they understand we were not their enemies?

"Motilones!" Bob shouted, pointing. We would soon find out.

From 400 feet a thatched *bohio*, or longhouse, resembled a giant haystack heaped in an oval clearing (page 364). Paths radiated like spider legs from 12 doors. Bronzed figures waved wildly. They seemed unarmed.

Encouraged, we settled into the clearing. The big rotor slowly stopped. For a moment no one moved.

Suddenly three Indians rushed toward us; one flashed a long knife over his head. I swallowed hard—but the crisis soon was over.

"That machete is one of the gifts I dropped them," said Bob. It was just the enthusiastic Indian's way of asking if we had any more such prizes.

Motilone Dictionary Starts with *Meemee*

"Our toughest job will be language," Bob had said before we left. "We don't know one word of their dialect; so I am going to compile a dictionary."

We gave small knives and salt to the men and beads to the women and children. The Indians reciprocated with bunches of tiny, tasty bananas.

"*Meemee! meemee! meemee!*" said the man with the machete, as he popped a whole banana into his mouth.

"Eat," Bob responded.

"Eat! Eat!" they repeated, watching cu-

Grinning Hunter Attacks Army Ants With His Mighty Bow and Arrow

Visiting the Motilones in their jungle home west of Lake Maracaibo, the author expected hostility, but tribesmen, who had attacked oil prospectors in the past, offered food and shelter in their communal hut (page 364). Little Kaira, wearing a coin necklace, adopted the visitor and taught him warrior words and ways.

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

Dawn and the sound of Indian laughter brought me reassurance about these fierce people—a sense of ease I felt for the rest of our eight-day stay with them. We posed no threat to their beloved jungle; they shared with us their food and shelter.

The Motilones are small people, with healthy cocoa-colored skin drawn tightly over well-muscled frames. The tallest man we saw stood under 5 feet 8 inches in height.

The women wore a short skirt, woven from wild cotton; the men, a small, square loincloth. But everyone wore necklaces of iridescent beetle wing-covers or buttons ripped from the clothes dropped by missionaries.

Indian apartment house, seen from the air, resembles an ant hill. The windowless thatched *bohio* shelters a community of 70 Motilones.

At home in a hammock, a mother (left), father, and child rest at day's end. These Indians, so long untouched by the world, must now face the 20th century.

Bustle of manioc hangs from the tumpline of a Motilone girl carrying food from field to home.

riously as my friend wrote in his notebook:

Meemee: to eat.

By dusk we had a 30-word vocabulary and enough bananas for a month. That night we swung restlessly in hammocks. Our reception was encouraging, but the atmosphere inside the smoky, crowded bohio was forbidding.

Beside me a sick man alternately gasped with fever and shivered with chills. Under his hammock a tiny warming fire illuminated bleeding gashes that covered his body. Bloodletting was the only cure he knew for this malady. I gave him aspirin from my packsack. His expression said thanks.

"*Sashini, sashini,*" he moaned, rubbing his chest, and before going to sleep Bob made another entry in his notebook:

Sashini: pain.

Above us armies of rats and cockroaches rustled the palm thatch on their nightly rounds; dying fires flickered and crackled.

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

Women busied themselves smoking fish or sweeping with wild-turkey-feather brooms. One, with a child at her breast, wove palm-fiber baskets. I watched members of one family huddle in a doorway, picking vermin out of each other's hair. They popped the mites into their mouths with relish.

Near my hammock a new-found friend, Kaira, a small boy of 6 or 7, stalked "big game" with a miniature bow and arrow (page 363). *Zing!* The tiny arrow shot into the ground. A parade of army ants broke ranks and scurried to avoid the warrior's wrath.

"Tchee," said Kaira, showing me one of his tiny missiles. Bob's notebook opened.

Tchee: arrow.

One morning, after a breakfast of sweet manioc and avocados, men sharpened long spears. Then they left the hut, followed by many of the women and the older children. We trailed behind with our cameras.

"They're going fishing," said Bob. "During the dry season the rivers are down and the fish are easy to spear."

We struggled to keep up with the Motilones. They skipped over fallen tree trunks and down slippery gorges as effortlessly as the green-throated hummingbirds that regularly crossed our path. After an hour's hike we were wading knee-deep in cool, clear water, gulping its freshness from cupped hands.

I looked up to see young Kaira eying our manners disapprovingly. Suddenly, he pulled two broad leaves from a nearby streamside bush, folded them deftly, and then handed us a pair of perfect drinking cups.

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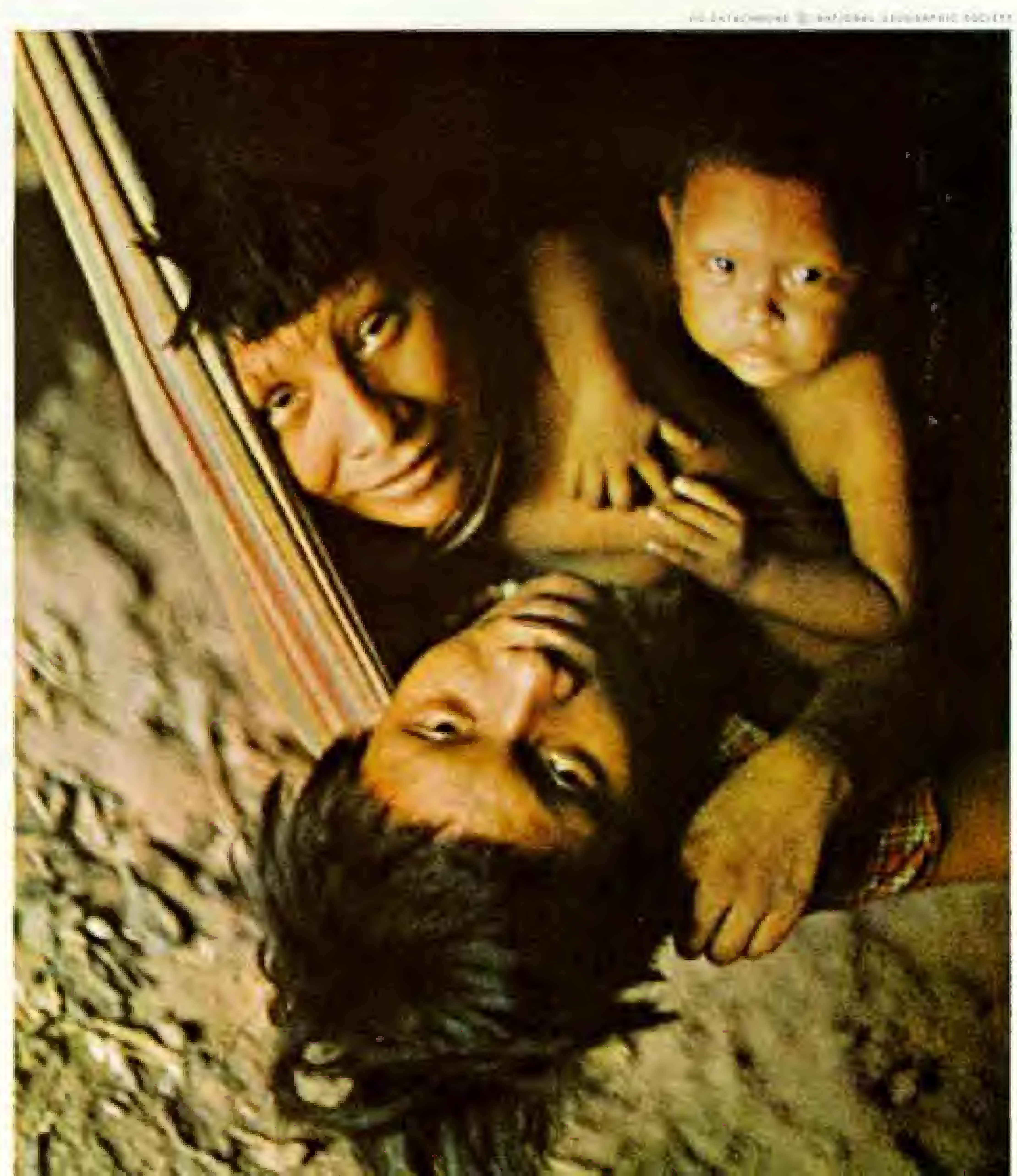
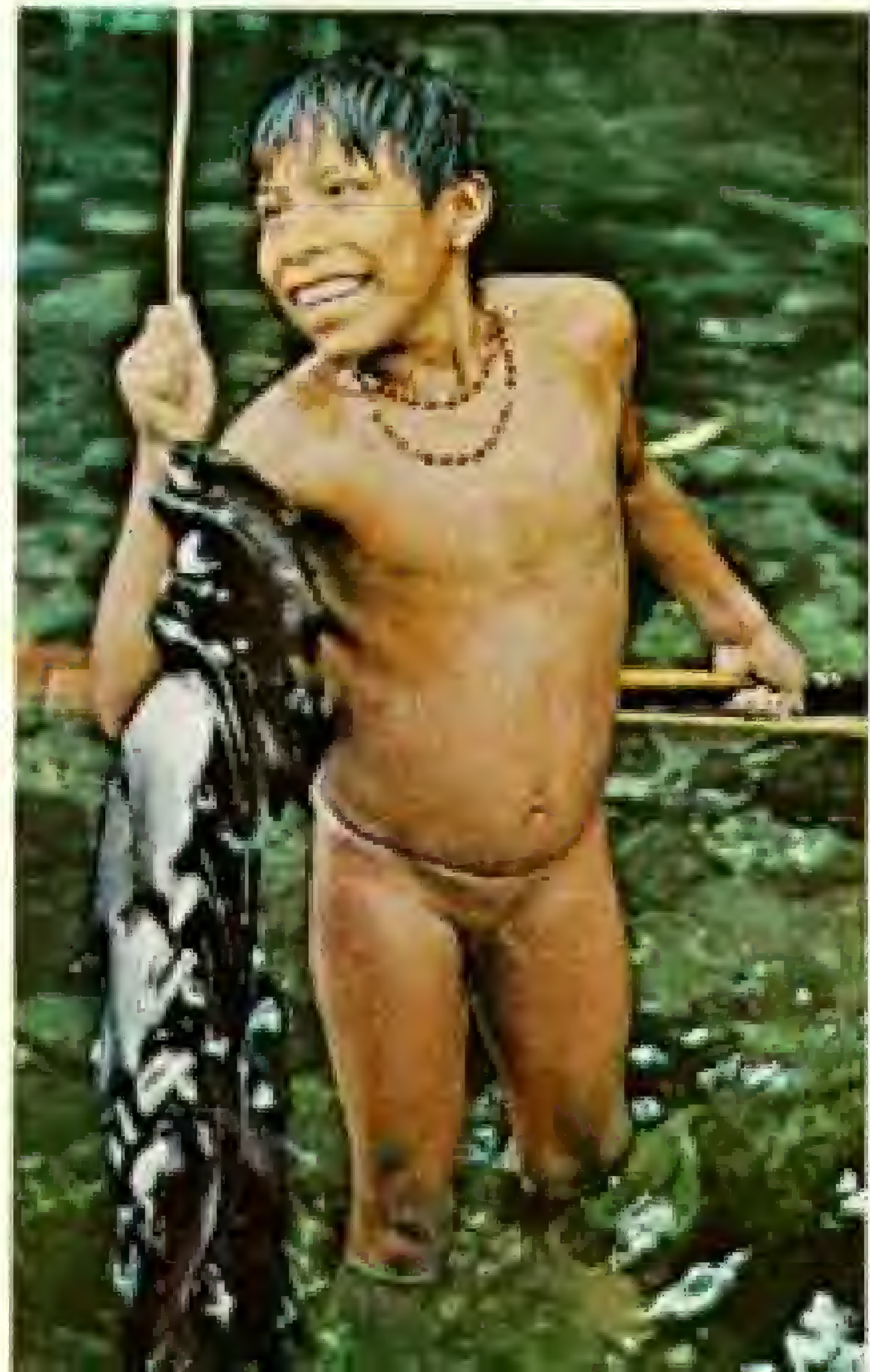




Ballet in a River: Indians Whirl and Stab

Setting the stage, Motilone fishermen dam a stream with rocks and plug cracks with large jungle leaves, leaving fish to struggle in downstream shallows.

Men hold spears at the ready for the sight of fins, then impale fish.

Dinner on a string invites a flashing smile of triumph. These fish are known as characins.

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

We laughed. "He must think we're terribly uncivilized," Bob said. To the Motilones, so well-adapted to their rugged environment, we bumbling newcomers were the "savages."

Now the men rolled boulders into a slanting line across the rushing stream. Women and children filled the chinks with smaller stones. Ajokduna, the fishing party's leader, appeared with a towering load of leaves. These were stuffed between the stones. Below the completed dam, the water dropped; fish began to dart and thrash.

The Motilones were ready. They seized their long spears and splashed into the water. "*Katú!*" they shouted, "Fish!"

The fun began. *Ching! Ching!* Two fish in two seconds. Upstream, Ajokduna had three on his spear and one dangling in his

Glaciers Slowly Cascade Down Pico Bolivar; Climbers on Pico Espejo Survey Their Goal

Bolivar's jagged summit (left) looks formidable, but even a novice can make it up and back in a day. Starting from Mérida, he takes the world's longest, highest cable-car ride, 7¾ miles, to Pico Espejo, at right. A well-marked trail then leads to 16,427-foot Bolivar, the penthouse of Venezuela.

Ropes ensure safety as Lynn Abercrombie, wife of the author, scrambles up Pico Bolivar.

teeth. The happy fishermen stopped only to sharpen weapons. Within half an hour the women were pulling the last fish out from under submerged stones.

From leaves and vines young Ajokduna assembled neat shoulder packs for carrying the generous catch back to the hut.

A few days later we left the Motilones. Threatening spring rains urged us on.

Ajokduna accompanied us to the Ariguisa River, 40 miles south of the civilization he feared. Then he melted quietly back into his forest with one last word: *"Kasakee!"*

Bob made the final entry in his dictionary. No matter what the language, one cannot mistake a word of farewell.

Just recently, many Motilones have yielded to civilization—and its diseases. Half our friends have died from measles. But some Motilones remain isolated.

After weeks in the torrid Maracaibo basin, I set out for the Andes and found their crisp, crystal air a welcome tonic.

Mérida Thrives in Andean Isolation

Coaxing a borrowed jeep up scenic switchbacks, I followed the tumbling Motatán River through misty Timotes and rain-drenched Chachopo. Through Mucuchíes Pass scattered snowflakes whitened the Andes.

I coasted down the lush Chama valley, green with terraces of cane and coffee, into Mérida, one of Venezuela's most beautiful cities. It stretches out atop a long, mile-high

mesa carved by two roaring rivers in the shadow of Pico Bolivar.

Although isolated from the mainstream of Venezuela's commerce, this provincial city of 46,000 bustled with prosperity. Trucks, overflowing with cacao, produce, and cackling chickens, jostled for parking space at the market. Visitors snapped the 157-year-old Cathedral, or watched early-afternoon clouds blot out distant peaks. Students of the University of the Andes studied on park benches or debated politics over steaming espressos in nearby coffee houses.

The breathtaking scenery of Mérida's mountain setting kept drawing my eyes away from streets and people.

"You must not leave without climbing Pico Bolivar," urged Dr. Carlos Chalbaud, former president of Mérida's Alpine Club. "We can run up and back Sunday!"

Tackle a mountain three miles high in one day? It seemed like a large order for me, whose climbing experience had been limited to a few Appalachian trails.

Cable Cars Conquer Three-mile Peak

The answer was Mérida's newly completed cable car system, highest and longest in the world. Together with a band of excited tourists, we boarded a small red coach that followed stout three-inch cables outward and upward from the city's steep ramparts.

We hummed along very smoothly over busy farms squeezed into the narrow Chama

Serenity of isolation imbues a pig-tailed teen-ager with beauty. Living in mountain-locked Los Nevados, she sees no automobiles or electric lights and few visitors. Centuries-old pattern of Andean life, keyed to seasons and soil, satisfies all her wants.

Hand-woven poncho warms a boy who walks his dog on a sidewalk in Los Nevados. The cliff-hanging village has but one street.

KODACHROMES © NATIONAL GEOGRAPHIC SOCIETY

canyon. A thousand feet below us men drove oxen, children played with hoops, and women washed clothes in the streams.

In the middle of a steep mountainside forest, we changed to a yellow car and continued our climb. Below us bucare trees, their orange blossoms blushing through beards of Spanish moss, yielded to the broad-leafed *yagrumos* and stately laurel groves. Under our blue third-stage car, dense forests thinned to patches of Australian conifers.

At the end of the line, 15,629-foot Pico Espejo, we began our climb (page 368). My lungs ached from lack of oxygen, but the well-marked trail was easy, with little ropework.

Before noon we crouched on a small, slanting wedge of rock, the highest in Venezuela's crown, 16,427 feet above sea level.

Westward loomed vast mountains in Colombia, 100 miles away; northward, the Maracaibo basin lay hidden beneath a pool of mist. Behind me stretched Venezuela's endless green plains, the llanos, now pocked with the season's first clouds. Tiny villages dotted rumpled valleys around us.

"Each of those pueblos is a remnant of colonial times," said Dr. Chalbaud. "People still speak the Spanish of Cervantes. To us it sounds as quaint as Shakespearean English does to you."

Village Greets First Norteamericano

Back at the Pico Espejo cable car station, I met Miguel Castillo, a mustachioed mountain farmer from Los Nevados, a three-day mule ride from Mérida over the cordillera.

"These new cable cars bring Mérida within a day's travel, but we are still very isolated,"

Waltzers swirl at a fiesta in the home of Los Nevados's mayor. The dance climaxes a plowing bee. Candle on the mantel burns before pictures of the Virgin.

Cavalry sword serves as Mayor Cupertino Cerpa's badge of office.

said Miguel. "Many of our children have never seen an automobile.

"I have an extra mule; come with me tomorrow," he offered. "I'll show you the most beautiful village in the Andes."

It was midafternoon before Los Nevados finally came into view, clinging to the steep hillside below us. We led our weary mules past a patch quilt of newly plowed fields, stitched together with rows of flickering poplars, then down the nearly vertical main street to Miguel's small, square house.

We sat on a wooden bench, the only furniture in the whitewashed living room. Señora Castillo poured coffee and we were joined by a committee of the town's elders, dressed in bright-red ponchos.

Outside the wooden-grilled windows, wide-eyed, rosy-cheeked children gathered to peer at and discuss the strange-talking intruder.

"The schoolmaster has called a holiday," explained Sr. Cupertino Cerpa, the village alcalde (mayor). "Except for the priest, who comes to say mass three or four times a year, visitors are rare. You are the first Norteamericano to come to Los Nevados."

The village has no electricity. At eight o'clock in the evening its streets were empty and its houses dark. By the light of a candle stub Miguel led me to my room.

"Tomorrow we hold a *cayapa*—a plowing contest—at my brother's farm. There will be six teams of oxen on the hill, and afterward, a fiesta."

After breakfast of corn mush and potato soup, Miguel and I hiked out to the steepest wheatfield I have ever seen.

"*Heeeeah! Heeeeeeah!*" sang the drivers,

prodding reluctant ox teams with long poplar poles. Wooden plows turned the rocky soil in neat rows across the slope (opposite). Young boys followed, scattering seed into the furrows.

Los Nevados grows no cash crops. Except for produce carried over the mountains on muleback as barter for kerosene or sugar, the village consumes all it grows.

Candlelight cast dancing shadows at the fiesta that evening. Women wore their brightest silks; their pigtails flapped under black sombreros to the rhythm of the *joropo*, Venezuela's national dance. The schoolmaster played a clarinet; Miguel's brother sawed at a violin, and a small boy skillfully strummed a four-stringed instrument.

The alcalde filled my glass with potent home brew. "I've been outside many times," he said, "but I always come back."

We toasted the newly sown crop.

"We may not have automobiles, juke boxes, or Coca-Cola," continued his honor, "but here a man lives close to the soil. That, señor, is where God meant him to be."

Short Flight Spans Centuries

In Venezuela's land of contrast, I quickly flew from a remote primitive village to the swank resort island of Margarita, a cluster of emerald mountains ringed with wide beaches of glittering coral sand.

I stayed at the modern Bella Vista Hotel, nine stories of concrete and glass looming incongruously over the stucco city of Porlamar.

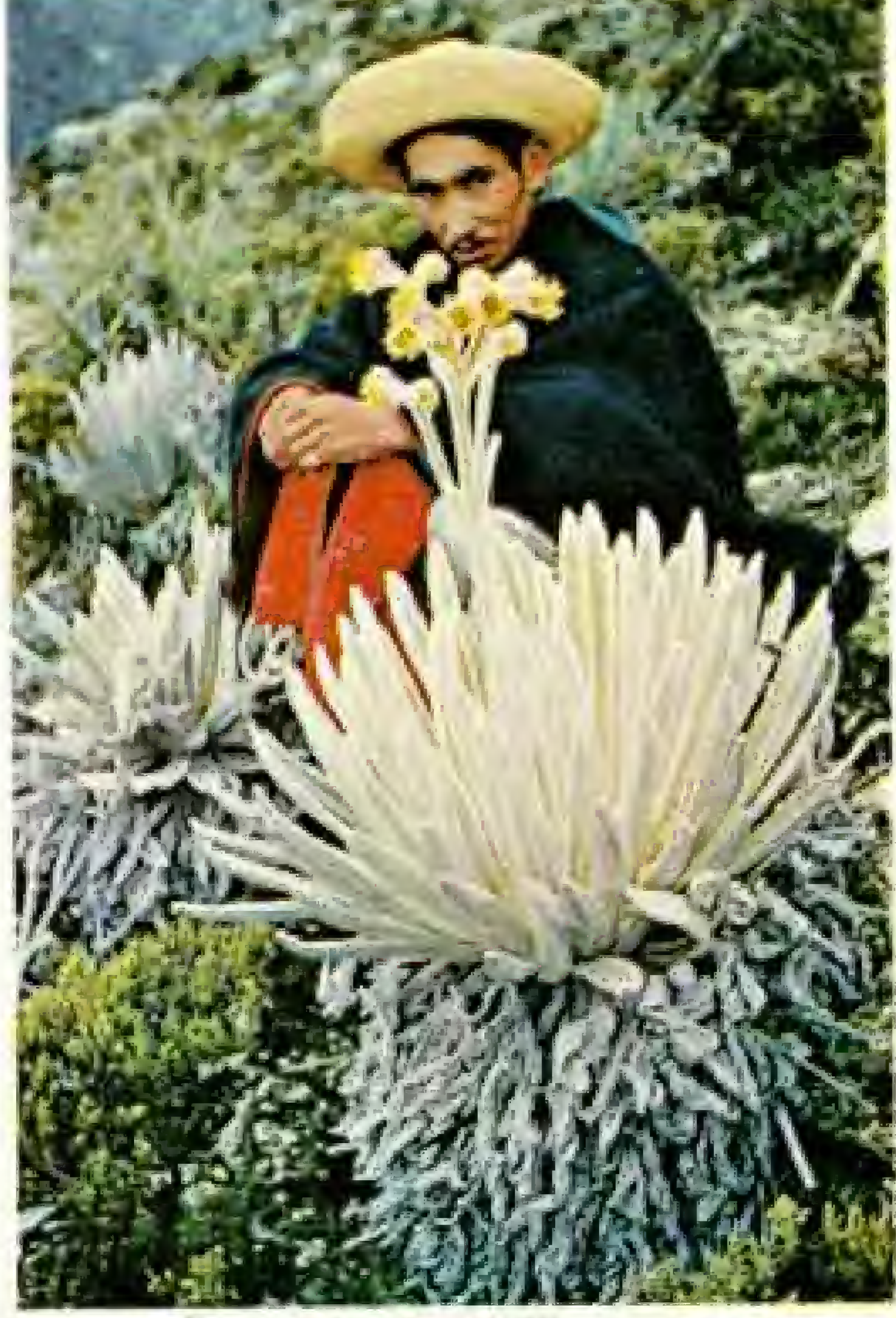
Before I could blot my name on the register, I was barraged with a verbal tour of the island in machine-gun French by M. Jean DuPont, a squat, irrepressible expatriate from Monaco.

"*Margarita . . . très historique . . . beaucoup de forts anciens. . . .*" I caught a few words as we squeezed into his Volkswagen.

"Island's main occupation is fishing . . . but each town has its own

No roads lead into the mountainous village of Los Nevados (left). Only rough trails cut the awesome slopes.

Plodding at ox-pace behind a wooden plow, the farmer tills his steep field. He and his neighbors grow nearly all their food. A small surplus rides out on muleback to be bartered for kerosene and sugar.



The velvetlike pile on leaves and stem protects the *frailejon* plant from Andean cold. Mountaineers use the pile to heal chapped lips. When fully developed, the flower-bearing stalk of some species is burned as fuel.

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special local industry. . . ." My French was coming back.

"San Juan is famous for its beverages; Pedregales makes pottery. Porlamar builds boats. And then there are the pearls. . . ."

"Yes, the pearls! That's why I came to . . ."

But we were already approaching the 17th-century fort overlooking the port of Pampatar. High up on the rocks a battery of rusty 16-pounders still commanded the harbor.

M. DuPont swept his hand about him grandly. "Somewhere here lies the treasure of Pierre Dautan, the great 17th-century buccaneer. But where? Even with the maps he left, no one has ever found it."

All day long the redoubtable Monegasque led me in spirited attacks on fort after fort. On film, at least, we captured them all.

Porlamar Ladies Smoke Huge Cigars

The next morning I met my friend on the dock at Porlamar. He had exchanged his Volkswagen for a motor launch and a yachting cap. Now he was *Captain* DuPont.

The tiny harbor teemed with fishing boats, all overflowing with the morning's silvery catch. An old woman waded out to buy whole basketfuls which she, in turn, hawked to housewives along the crowded shore.

"*Cuantos? Baratos!*" "How many? Cheap!" she cried in a hoarse voice while puffing a huge stogie. Other women, too, brandished cigars. To my amazement, they smoked them backwards, with the lit ends in their mouths.

Captain DuPont explained this strange custom as he started the launch. "The cigars last longer, and they don't waste any smoke."

We set a course for Cubagua, a low, scorched wash of sand eight miles south of Margarita. On the way we passed a squadron of lateen-riggers, the remains of a once-proud pearling fleet. Gone were the pearl divers—off to the Guiana Highlands searching for diamonds. Today's pearlers use dredges.

"Welcome to Cubagua," shouted Sr. Pedro Carmel-Rodriguez, as we made fast to the pearlers' small dock.

Pedro's squinted eyes had sought pearls for 50 of his 71 years. A fisherman's life and diet kept him spare; the salt, sun, and sea left his face as rough as the oyster shells he opened. He smiled. "If you're looking for a fortune from pearls, you're 450 years too late!"

Cubagua had seen better days. We walked through the ruins of Nueva Cádiz, one of South America's earliest towns. Adventurers from Hispaniola founded it around 1520, inspired by Columbus's romantic tales of a "Terrestrial Paradise" where natives wore necklaces of pearls.

For the next 20 years Cubagua was anything but a paradise under the tyranny of the pearl-greedy settlers. Using drags and nets, the Spaniards exploited the beds ruthlessly, and the pearling industry gradually withered.

The town had declined by 1541 when, as Pedro said, "God reached the end of His patience." A hurricane devastated the colony.

At Pedro's shack, in the shade of a tattered tarpaulin, his sons patiently pried open fresh oysters beside a mountain of empty shells. A few *perlitas*, pinhead size, were all they had to show for a day's labor.

"The season is short and the sea is not so generous any more," Pedro apologized. "But come out with us tomorrow. Maybe you will bring us luck."

Pedro's sons hauled on the dredges while he tended the chugging diesel and I bailed the bilges of the creaking 20-foot boat. All hands sorted the conglomeration that spewed out on deck. We filled sacks with oysters. Starfish, shells, or, now and then, a baby octopus we plopped back into the sea (page 386).

I put on my mask and fins and made several dives into the oyster's remarkable realm, looking for a pearl of my own. In 40 feet of water I swam through clumps of waving fan coral guarded by striped sergeant major fish and schools of silver minnows.

Clay Pot Yields Fortune in Pearls

On one dive a bizarre four-eyed butterfly fish followed me inquisitively as I wrenched oysters loose from the bottom and stuffed them into my swimming trunks.

Pedro's oldest son, Ortero, taught me to open the oysters quickly by cutting the foot. The odds were against me, but I pried and prodded. Beginner's luck! I cut open a pearl-bearing oyster. The pearl was no bigger than a dewdrop, but of perfect form and deep luster. My extraordinary fortune prompted tales of lucky finds. Pedro topped them all.

"Six years ago I was working with the archeologists from Caracas, exploring the ruins of Nueva Cádiz," he said. "While digging under the doorway of one of the houses, I found a large clay pot." Although they had heard the story a hundred times, the others stopped shelling to listen.

"I scraped the dirt away carefully and it was full of pearls, none smaller than a grape! That jar held 13½ pounds of pearls, worth more than three-quarters of a million dollars!"

(Continued on page 381)

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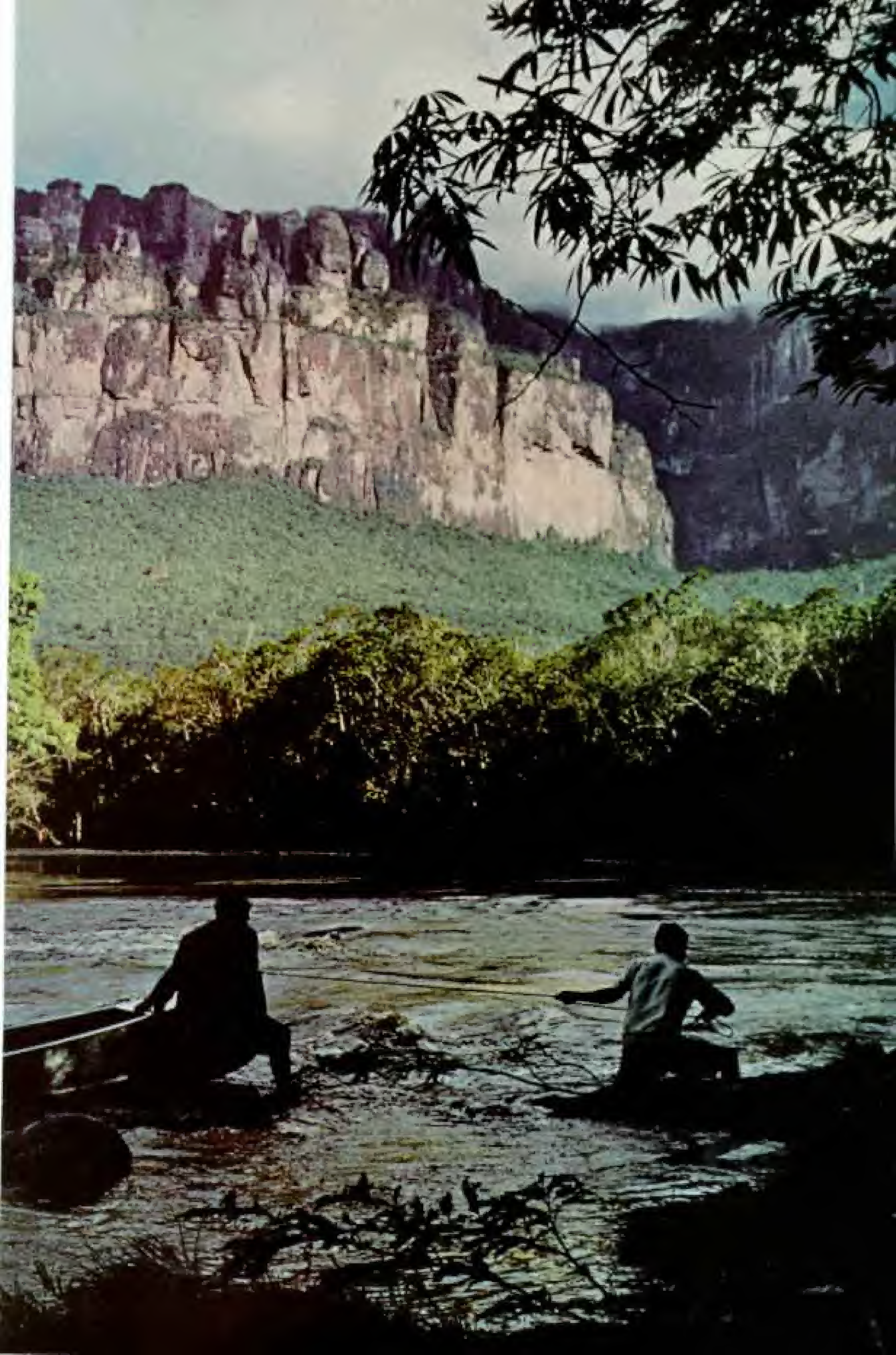
Goajira Indian woman and her suitor meet at Paraguaipoa on market day. She dresses in voluminous robe, flowered kerchief, and pompon slippers; he covers his loincloth with a European shirt. For protection against sun, they blacken their faces with vegetable pigments and fat. They herd pigs, goats, and sheep on the dry Goajira Peninsula.

Indians Drag a Canoe up Churún Rapids in La Gran Sabana's "Lost World" ▶

Like a monstrous fortress, the granite cliffs of Auyán-Tepuí mesa rise a sheer half mile above the jungle. In the science-fiction novel *The Lost World*, Sir Arthur Conan Doyle imagined such a tableland still inhabited by dinosaurs and pterodactyls.

For four days the author and his guides paddled and pushed their aluminum canoe up the rain-swollen waters of the Carrao and Churún Rivers. Their goal: a glimpse of the long, lovely leap of Angel Falls, highest in the world (pages 378-80).



Roaring out of Auyán-Tepui's wall, Angel Falls plummets 3,212 feet, twice the height of the Empire State Building

But, alas, the pearls belong to the government. They lie locked up in a museum vault, and Pedro is still a poor fisherman.

To photograph a display of fine gems, I went to Sr. Rafael Avila, who, with his brother Juan, runs South America's biggest wholesale pearl business (page 387). His pièce de résistance was a pink-white beauty as big as a hazel nut. For $5,000 he would wrap it up for me.

Señor Avila spoke glumly about the future of Margarita's pearling industry. "The beds are always overfished," he lamented. "Every year the pearls are smaller, and so is the market, with competition from Japan's cultured pearls."

But the islanders are already working a new bonanza. Each year more and more vacationers from Caracas discover Margarita's rich offerings of beauty and history. As I prepared to leave for the mainland, Captain DuPont summed it up sagely:

"A boatload of tourists, monsieur, will always be more profitable than a boatload of oysters!"

Angel Falls Plunges Into "Lost World"

South of the broad, brown Orinoco River, stretching toward the Equator, lie the trackless Guiana Highlands, Venezuela's lesser known side, where a scant 5 percent of her population occupies nearly half the country's total area. Here lies Sir Arthur Conan Doyle's mysterious "Lost World," inhabited until recently only by Indians and a few gold and diamond hunters.

This moat of wilderness and a brigade of churning rain clouds guard the mystic mountain of Auyán-Tepuí, a fortress whose stone escarpments rise a sheer half mile. From one of its rocky crags the world's highest waterfall, Angel Falls, plunges more than 3,000 feet in secret splendor.*

The falls was discovered in 1935 when the late Jimmy Angel, an American soldier of fortune, flew his silver monoplane up the treacherous Carrao searching for gold. Many have seen the cataract since, but few have reached it by river.

At Canaima, a pleasantly rustic outpost, I met "Jungle Rudy" Truffino, a lean, leathery man who could guide me there. Rudy, I was told, knows the Churún canyon as well as any man alive.

"I've taken more than one shower under Angel Falls," admitted Rudy. But he cautioned: "The rainy season is on us now, and the rivers are running hard. It won't be an easy trip."

We pushed off from Canaima in Rudy's outboard-powered aluminum canoe, lightly loaded for a fast trip. With us came two Indians to set up camp and help drag our canoe through the rapids (pages 376-7).

On the second morning out we veered from the calmer Carrao River into the twisting canyon of the Churún. Towering, flat-topped mountains enveloped us, shutting off the rest of the world.

As we wound upstream into this primeval labyrinth, the river became even more violent. Rains, too, joined the battle against us; whenever we weren't pushing or dragging our bobbing craft, we were bailing.

Morning Mist Veils Cataract

Early on the fourth day we beached our canoe near the base of the 3,212-foot Angel Falls. The Indians would go no closer to Auyán-Tepuí: To them it was a mountain home of devils. Rudy and I climbed inland through the slippery jungle to a hilltop looking out into a gigantic hollow.

Walls of purplish rock rose out of sight into low-hanging fog. Rushing water seethed under what seemed to be heavy rain in the center of this cauldron.

But Angel Falls was nowhere in sight.

Within an hour rising mists revealed the mountain's secret. A thousand feet above us sunlight touched a white shaft of tumbling water. By noon the last clouds parted, revealing the whole splendid spectacle.

Bursting from great holes approximately a hundred feet below the edge of the cliff, a river roared out into space, falling 2,648 feet—half a mile—in one long leap. Before reaching bottom, much of it disintegrated into mist and spray (preceding pages).

Altogether we traveled for one week through the area without meeting another soul. "Enjoy it while you can," advised Rudy, who loves the wild country. "Civilization moves closer every day."

About 100 miles northward the taming of the Guiana Highlands had begun.

There along the banks of the Caroni, frenzied treasure hunters were flocking to the latest diamond boom. Around one

*See "Jungle Journey to the World's Highest Waterfall," by Ruth Robertson, NATIONAL GEOGRAPHIC, November, 1949.

THIS PAGE FOLDS OUT

sweeping bend, the wild river has been piling up black diamond-rich gravel for countless centuries.

When I arrived by jeep in the heat of the early afternoon, the site was a swarming free-for-all. City dwellers, some from Caracas 400 miles away, dug their hasty, random holes beside the neatly squared ditches of the professional diamond hunters (opposite).

Tenderfoot and Sourdough Dig for Diamonds

Women, children, old men—often whole families—worked the dry streambeds, carrying the gravel to the river for washing. They loaded it into boxes, baskets, and buckets—anything they could find. One bizarre team shoveled the dusty black paydirt into the back seat of their Chevrolet sedan.

One gray-bearded miner on the riverbank reminded me of a Yukon sourdough, as he sifted his pile of precious grime through a big, circular *surucu*, or strainer.

"This is not my lucky day," he complained. "Up since dawn—and only two stones." He packed up his tools and trundled back through the acacia trees to his digging. Somehow I found it hard to sympathize with a man who had just found two diamonds, even though they might be worth a mere $30 or $40 to industry. Few gem-quality stones are found.

Far out on the raging river, miners in diving suits were having better luck. They worked from a raft of giant log canoes lashed together and anchored in the current (below). I rented a small dugout and paddled over to the strange flotilla to watch the operation.

On one raft, shaded by a tarpaulin, two men took turns cranking a giant coffee-grinder pump. Out of the churning water came a heavy bag of muck followed by a clumsy apparition in a threadbare diving suit.

I helped the men twist off the antique copper helmet. Inside was Quentin Fernadi, a veteran of ten years of diamond diving in the Guiana Highlands. We talked while he rested from his fifth dive of the day.

"This strike is richer than any on shore," he said, showing me a leather poke full of unpolished gems that he carried with him, even in his diving suit. "But the water is

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treacherous—two men have already drowned. We earn our extra stones!"

Not all of the Highlands' treasure lies sparkling along the riverbanks.

About a decade ago steel companies began exploiting rich deposits of iron here. They built railroads, docks, airports, even whole cities; they continually dredge the 215 miles of the Orinoco River navigable by ocean-going ore ships. Today Venezuela's iron industry ranks second only to its oil.

Miners Tackle an Iron Mountain

At Cerro Bolivar, the Orinoco Mining Company—a subsidiary of United States Steel—is busy making a molehill out of an iron mountain. This once-green hill, seven-and-one-half miles long and 2,600 feet high, has been stripped to its bare red flesh by an army of giant machines that carry away 55,000 tons of ore a day. Here I met Fred Hendershot, Orinoco Mining's senior engineer in charge of mine planning.

Get-rich-quick Fever Drives Caroni River Diamond Diggers

With luck, prospectors in La Gran Sabana can earn $50 a day. Man at left shovels dirt and stones into a sieve; his partner will carry it to the river for washing (bottom, right).

Nest of three sieves rides the head of a miner. Wire meshes vary from coarse on top to fine on bottom, where diamonds are trapped.

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Glitter in the wash keeps men at the backbreaking task of straining gravel. Few stones of gem quality are found; most diamonds go into grinding tools for industry. But hope of a rare big strike lives on because in the early 1940's the area did yield the famous 155-carat Liberator diamond.

Miners' canoes hover over a diamond strike in the turbulent Caroni. Divers in old equipment risk their lives plunging 50 feet to the muck bottom.

"The nickname, 'Iron Mountain,' is a little deceiving," Fred explained, as we drove up the steep red road to the summit. "It's not solid ore, but more like a big marble cake. Our job is to find the chocolate."

Near the top he stopped and picked up a heavy handful of silvery-purple ore.

"Our deposits rank among the richest in the hemisphere, and in some zones extend a thousand feet deep. The best areas of hematite are 67 percent pure iron."

Below us a huge electric shovel with a bucket the size of a small house was scooping up the hillside, nine cubic yards at a time, and dumping it into waiting railroad cars. Where direct loading was impractical, 50-ton dump trucks relayed the ore to the train. Two giant truckloads filled a gondola car.

Three times daily a train, nearly a mile long, pulls out of the switchyards on a breathtaking ride down the mountain to Puerto Ordaz, 90 miles north. I boarded the evening train's diesel locomotive, behind Mario Zacharias. Some engineers don't like the idea of rolling down a three-percent grade with 105 cars of iron pushing them, but Mario was as fearless as Casey Jones.

"Don't worry, señor, we have three different braking systems on these trains," he said. Two toots from his whistle, and we coasted forward into the night. Behind us a shower of sparks

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Steam-shovel operator strips benches of an iron mountain. Fifty-ton truck hauls ore.

Massive cuts scar the face of Cerro Bolívar, burial mound of some 400 million tons of high-grade iron ore. Loaded trains, 105 gondola-cars long, brake down the mountain for Puerto Ordaz, 90 miles away.

half a mile long streamed from under the train. A thousand wheels screeched protest as Mario braked constantly, keeping the speedometer needle at a steady 20 miles an hour down the mountain.

"I did have one scare two years ago," Mario confided at the end of the run. "The air brakes on the lead engine froze. The train skidded all the way to the bottom of the mountain before coming to a stop. The friction wore four inches of steel off the engine's wheels, leaving it with 12 'flat tires.'"

Near Puerto Ordaz I saw a $400,000,000 government-built steel plant. And here I felt that I had somehow come full circle in Venezuela. The mills were extruding seamless steel pipe for the vast oil fields I had toured in the beginning on Lake Maracaibo.

The plant, running on new hydroelectric power from the Caroní River, then was using steel ingots made abroad. This past year, however, new Venezuelan blast furnaces began smelting Venezuelan ore. This year, too, the Reynolds Metals Company plans to build a reduction plant to produce aluminum.

On July 2, 1961, President Rómulo Betancourt laid the cornerstone for the new city of San Tomé de Guayana, planned for 250,000 at the junction of the Orinoco and the Caroní.

"We are looking," he told his people, "at the future Ruhr of Venezuela."

This vast industrial complex seemed a far cry to me from the ghostly ruins of Nueva Cádiz, or rustic Los Nevados, where fiestas are held by candlelight.

Venezuela has come far even from that day, a scant four years ago, when silent Caracas crowds watched their President enter the Capitolio—and wondered if he would make it alive. I recall now that, despite the heavy uncertainty in the air, his step was steady and purposeful.

The same can be said of the strides Venezuela is making today. THE END

Pearlers Empty Nets; Oyster Haul Is Scant

Waters off Margarita Island once yielded fortunes in pearls. Columbus, sailing nearby, saw Indians wearing pearl ornaments but failed to investigate. Spanish adventurers who followed greedily raided the beds, using Indian slaves as divers. Today a remnant of the pearling fleet dredges overfished beds.

Luminous prize from an earlier harvest is the diameter of a *real*, a Venezuelan coin (actual size). These natural pearls are irregular in shape, whereas cultured pearls tend to be more symmetrical.

KODACHROMES © NATIONAL GEOGRAPHIC SOCIETY

Flaking with age, a colonial cannon testifies to long-ago dangers that threatened Juangriego on Margarita Island. Once pirates raided the town, confiscating riches in pearls. The Spanish fort, bristling with cannon, often drove them away. Now the government-restored bastion survives as an antique, and the wealth of Juangriego is a dream of the past. But the beauty of the bay, luring travelers, promises new prosperity.

Bathers beware! A sign on Haulover Beach near Miami, Florida, warns of invasion by the Portuguese man-of-war.

Fish-eye view shows a man-of-war sailing the surface and trailing venomous tentacles from its bubblelike float. The photographer dived into the sea off Fort Lauderdale, Florida, to make this remarkable shot of *Physalia physalis*. Its darting escorts, juvenile yellow jack and dark-spotted man-of-war fish, tolerate the physalia's poison.

The Deadly Fisher

By CHARLES E. LANE, Ph.D.
Professor of Marine Science, the University of Miami

MY OFFICE WINDOW frames a colorful Florida panorama on Virginia Key: blue sky, sparkling waters of Biscayne Bay and the open Atlantic, and swaying coconut palms on sun-drenched ribbons of beach. Two or three times a year I notice excitement among the swimmers and sun bathers, and can even hear screams of alarm.

None of us at the University of Miami's Institute of Marine Science has to ask what has happened.

They have come again, and somebody has been stung. Chances are the victim will be brought to the laboratory for treatment. *They*—the villains intruding upon this scene of fun and relaxation—are Portuguese men-of-war, which look like gay balloons drifting at the whim of the wind. Science knows them as *Physalia physalis*, from the Greek for "bladder." Despite their festive appearance, these brilliantly colored voyagers rank among the most unpleasant of seagoing creatures.

The invaders, with sails "set" to catch the breeze, arrive in squadrons, fleets, or vast navies.*

From them, luckless bathers receive injections of a poison similar to the king cobra's venom, and at least

*See "Man-of-War Fleet Attacks Bimini," by Paul A. Zahl, NATIONAL GEOGRAPHIC, February, 1952.

Hulls half buried in the sand, stranded men-of-war litter a beach in the Bahama Islands. Strong winds spell disaster for the slimy craft. Ebb tide leaves them high and dry. Gas-filled floats explode like muffled firecrackers if someone steps on them. Stingers retain their potency long after the transparent floats have withered in the sun. Dr. Paul A. Zahl, of the NATIONAL GEOGRAPHIC Senior Editorial Staff, studies the wrecked armada.

Forceps and rubber gloves protect author Charles E. Lane from a venomous man-of-war found on Key Biscayne, Florida. Sometimes vast numbers wash up on Florida's coast. Fragile bubbles identify other castaways.

A professor of marine science at the University of Miami, Dr. Lane has studied physalia since 1956.

Fiery welts and searing pain attest the virulence of man-of-war venom. Collapse and coma may follow. These angry welts disappeared after six weeks.

75 percent as potent. Like cobras, men-of-war discharge a neurotoxin—a protein substance that deranges the nervous system.

To the small fishes and planktonic animals that form the physalia's diet, the sting means sudden death. Laboratory tests indicate that a thimbleful of physalia venom could kill 1,000 mice within a few seconds. Rats, rabbits, frogs, fiddler crabs, and even a dog also have succumbed quickly in the laboratory.

If a man-of-war had the cobra's muscular power and venom capacity, ocean bathing would be eliminated along some of our finest beaches. Luckily for salt-water swimmers, the man-of-war injects relatively little toxin. Human fatalities from *Physalia physalis* stings have been rumored but never authenticated. Even so, persons blundering into the sinister violet-tinted curtain of tentacles will not soon forget it. Victims feel as though they have been attacked by swarms of angry bees or showered with red-hot darts.

Within minutes, as the neurotoxin goes to work, blood pressure drops alarmingly. Breathing becomes difficult, the pulse rapid and feeble. Some sufferers lose consciousness. Many require adrenalin injections to restore blood pressure and stimulate heart action.

All these symptoms closely parallel those of cobra victims—with the all-important difference, of course, that the latter may die.

The physalia harbors no malevolence in its bizarre make-up. All it wants is to forage unmolested. But when it contacts a strange object, be it man or fish, its sensory apparatus signals "Here is something to eat." So it stings.

Together with sharks, barracudas, and other deep-sea denizens that bite, sting, or stab, men-of-war must be counted among the risks man faces when he ventures out of his own element into that of the lower animals.

Today, as a result of six years of study by the University of Miami's Institute of Marine Science, with the support of the U. S. Public Health Service since 1957, we have uncovered new facts about the man-of-war and have a much better understanding of how this remarkable animal works. Ultimately, science

KODACHROME BY FLIP SCHULKE © NATIONAL GEOGRAPHIC SOCIETY

Bucket in Hand, the Author Bears Down on a Grounded Man-of-War

Lacking power to propel itself, physalia drifts at the whim of wind and current. Sail crest enables the balloonlike seafarer to tack downwind. Extended tentacles serve as sea anchors. Men-of-war seasonally invade Florida beaches and stray as far north as Cape Cod. This casualty washed ashore at Crandon Park Beach on Key Biscayne.

may find some medical use for physalia toxin, as has been the case with other venoms.

At present, however, physalia toxin is nothing but bad news for mankind. Witness a recent encounter between a man-of-war and a Miami construction worker who was Aqua-Lung diving and spearfishing. Surfacing after a dive near Fowey Rocks, the man came up under a large physalia. Fighting free of the clinging tentacles, he was hauled writhing into a boat and rushed to a hospital.

On the 13-mile dash to Miami, the victim endured intense pain and lapsed into shock. At the hospital he was given the standard treatment for physalia stings: alcohol baths for the wounds, which he had received on chest, shoulders, and arms. We have found in the laboratory that the toxin is destroyed by reaction with alcohol. But six weeks passed before masses of angry, reddish weals disappeared from this victim's body (page 390).

Swimming off Crandon Park Beach on Key Biscayne, a colleague of mine on the University of Miami faculty was stung by a physalia and staggered ashore to collapse unconscious. He, too, suffered many hours of pain.

These were extreme cases, so unusual as to attract wide notice. Most of the millions of people who enjoy Florida beaches never see a man-of-war at close range, much less suffer a sting. Lifeguards stand ready to give first aid, and on days of heavy infestation signs warn bathers to stay ashore (page 388).

Beware of Beached Man-of-War

A Dade County, Miami, Park and Recreation Department pamphlet titled "I Hate Men-of-War," tells how to avoid physalias and what to do if stung. It especially warns against touching dead, beached men-of-war (page 391). The tentacles can still sting.

Hazards attend even the fun of building castles or being buried in the sand. Ever notice an itchy feeling after such pastimes? Undoubtedly it is caused by contact with broken bits of physalia tentacles.

Our laboratory tests have proved that the venom retains its potency even after being dried and stored in a freezer for six years.

Would-be bathers, dismayed by the sight

of men-of-war gleaming on sea and sand like bright bubbles, can console themselves: Matters could be much worse. Suppose they had chosen northern Australia for a vacation. In those waters lurks the lethal sea wasp *(Chiropsalmus quadrigatus)*, related to the physalia. Men stung by sea wasps have died within three to eight minutes.

Other relatives with high standing as nuisances include the sea nettle *(Dactylometra quinquecirrha)*, which swarms in Chesapeake Bay and other eastern seaboard waters during the summer. Lacking the man-of-war's sail, the sea nettle travels mainly with currents. It stings painfully but not dangerously. Both Atlantic and Pacific coasts have the velella, or by-the-wind sailor, often mistaken for a small man-of-war but less powerfully armed.

Physalia usually remains well offshore. There it cruises the warm waters of the Gulf Stream system, a vast, heaving pasture teeming with small prey to be stung to death and eaten. Onshore winds and currents drive physalias into shoal water and onto beaches.

Like an iceberg, the physalia conceals its longest and most dangerous parts beneath the

Buoyant bubble trails threadlike fishing tentacles. A large man-of-war can extend its tentacles 100 feet, or shorten them to a few inches within seconds.

Not one individual, but hundreds: Physalia consists of a colony of individuals living together for mutual aid. One organism forms the float, or pneumatophore. Another organism, dangling fishing tentacles, captures food. Feeding polyps—the gastrozooids—ingest it. Another kind of polyp performs the task of reproduction. Break up a man-of-war colony, and its individual members die.

PHOTOGRAPHS BY FLIP SCHULKE (BELOW) AND CHARLES E. LANE © N.G.S.

surface of the sea. Swimmers and sailors see only its iridescent lavender-blue flotation bladder, or pneumatophore, shaped rather like a distorted football (page 392).

Atop the bladder rises the tiny mainsail, a graceful rayed crest of pliant membrane. With this airfoil held erect, the creature ghosts along before the breeze or, some authorities believe, even makes good a quartering course across the wind. To early mariners plying Portuguese waters, the physalia, sailing along with the wind, suggested a galleon under way —hence the popular name.

Unseen, below the float, trails the man-of-war's armament, its fishing tackle—a fearsome array of thin, tenuous tentacles studded with thousands of stinging batteries.

Portuguese men-of-war first appear on south Florida beaches in late fall. Untrained observers probably could not guess the identity of these first arrivals, very little larger than a grain of wheat. Even at this early stage, however, they possess all the equipment of the mature animal. Within a month the physalias have grown until the average float may measure an inch or more in length.

Lethal Armament May Extend 100 Feet

By late winter the animal reaches maximum size—the float averages eight inches; tentacles may stretch 100 feet. In late April or early May, physalias disappear. Next fall their offspring repeat the life cycle.

Although the physalia has simple needs and an uncomplicated way of life, it appears to the scientific observer as a mechanism almost as complex as a space vehicle. Each man-of-war is a colony consisting of many parts. Each component represents a distinct individual. Upon the efficient performance of each part depends the life of the colony as a whole.

Consider the physalia's most prominent feature, the gaily tinted bladder. Somewhere in the animal's mysterious insides a generator operates to keep the pneumatophore filled with a carbon-monoxide-rich gaseous mixture for buoyancy. Some students believe the physalia can valve out gas, as does a balloonist. It could then sink below the waves and escape storm-induced turbulence.

At sea and in our laboratory tanks we frequently have seen men-of-war pitching and rolling from side to side, bathing the entire bladder. Edmond L. Fisher's remarkable photograph, made in the Gulf Stream off the Florida coast, captures a physalia righting itself after such acrobatics (page 389). This maneuver keeps the float moist and may play a part in gas secretion. Another benefit may be the partial absorption of destructive ultraviolet light by the thin film of sea water spread over the bladder's exposed surface.

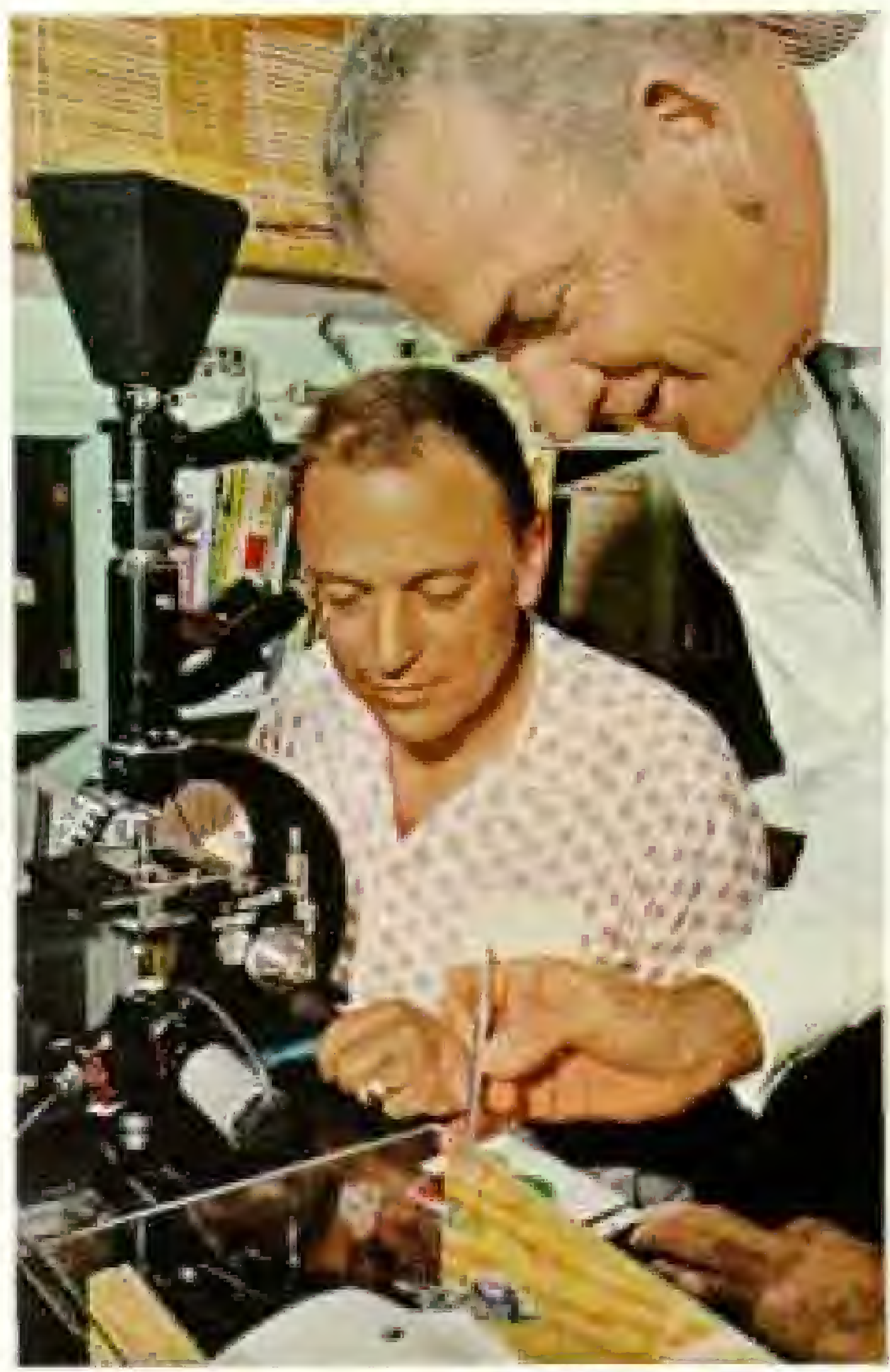
Below the bladder dangle many fishing tentacles, and various kinds of brilliant polyps. Each kind has a special function. Some polyps capture food; others ingest it; still others attend to the reproductive processes.

Physalia can contract its hundreds of long fishing tentacles from many feet to a few inches in seconds. As winds and currents drive the colony through the water, the tentacles twist and writhe, reaching for food.

Each fishing tentacle bears myriad nematocysts, or stinging capsules, armed with neurotoxin and the mechanism for its injection. Hundreds of nematocysts are housed

Living seine seizes dinner for a hungry man-of-war. Beadlike batteries of stinging capsules kill the victim, photographed twice life-size.

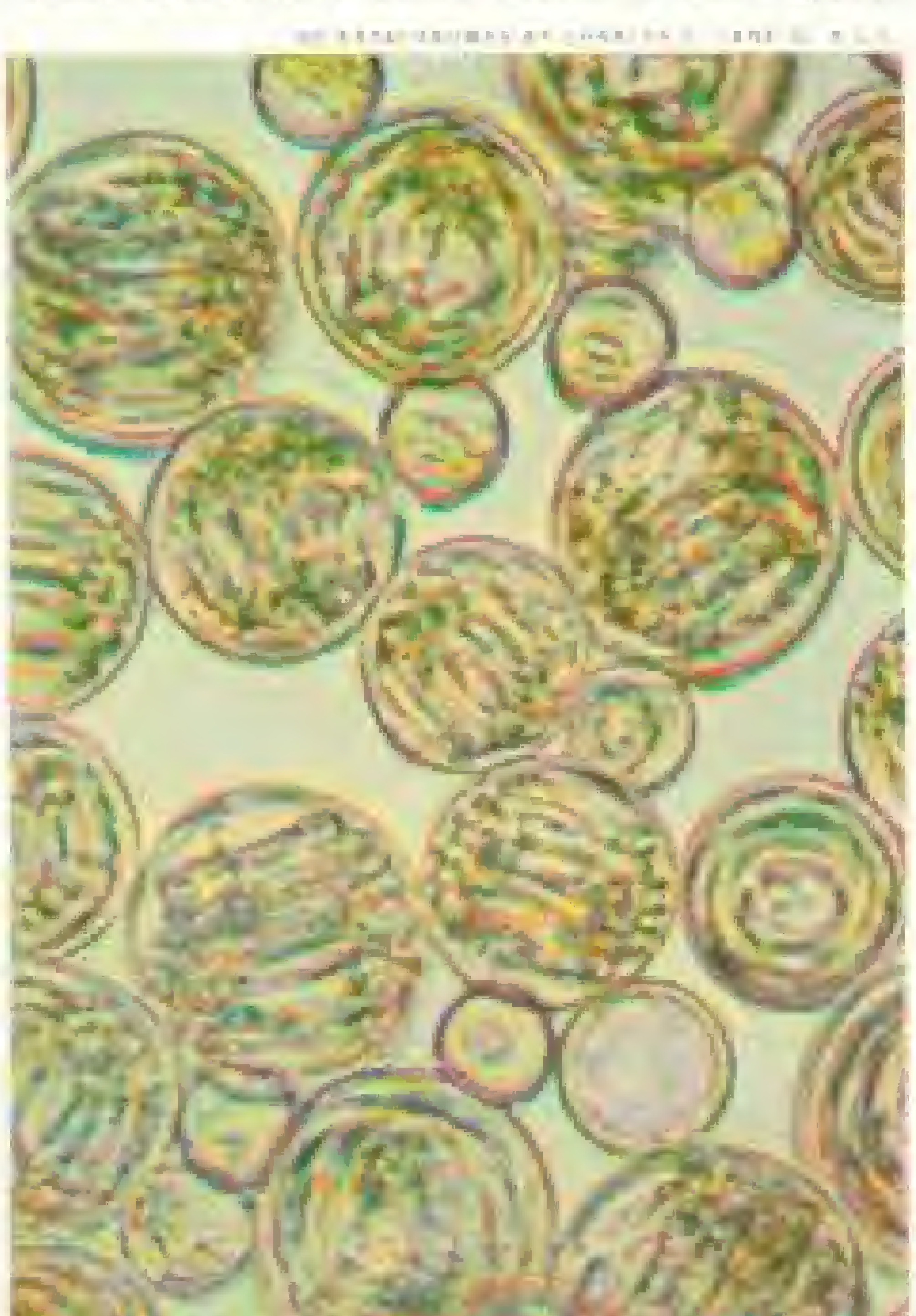
Doomed guppy, magnified ten times, rises toward the feeding polyps as physalia contracts its tentacles.



Gelatinous blobs of physalia tissue await microscopic examination by a University of Miami graduate student. Dr. Lane (forceps in hand) combines teaching with research.

Harpoonlike stinger, magnified 4,000 times, shoots from its circular sheath to pierce a victim and inject poison. A nematocyst discharges only once; immediately a new cell replaces it.

Death-dealing capsules with stingers coiled inside await a victim's touch to start firing.



in each of the beadlike batteries spaced closely along the tentacle.

Under a microscope a nematocyst appears to contain a single coiled internal tube. When stimulated by contact with prey, the capsule may undergo a change in permeability. Water enters, internal pressure increases, and the tube uncoils, much the way a child's paper blowout uncurls with a puff of breath. Simultaneously, the tube bares an array of microscopic spines, spikes, hooks, and barbs, which form a tangle to prevent the prey's escape.

The tube terminates in a hollow tip pointed like a hypodermic needle. Uncoiling occurs with enough force to drive the tip through a surgical glove, as we in the laboratory have learned to our regret. Completely extruded, the tube may be several hundred times as long as the diameter of the capsule whence it came. Poison flows through the tube from within the nematocyst cavity.

Once a fish or smaller organism swims into the trap, the tentacles contract and the food is lifted to the base of the colony just under the float. There another specialized kind of polyp, the gastrozooid, takes charge.

As the food draws near, the gastrozooid begins to writhe and twist as if in search of something; its mouth relaxes and expands. The mouth engulfs the food organism if it be sufficiently small, or fastens to the surface of a large morsel, and ingestion begins.

Small Fish Live With Deadly Host

Several small fish tolerate physalia's poison. Among these are the juvenile yellow jack (*Caranx bartholomaei*) and the man-of-war fish (*Nomeus gronovii*). They swim among the deadly tentacles, perhaps attracting larger prey into the trap, and feed on crustacea caught by the physalia.

Tests in our laboratory show that nomeus survives an injection of ten times the amount of physalia toxin that kills larger fish. Yet no real friendship exists between the two species. In our tanks we have seen the fishes biting off bits of a physalia float and tentacles.

We know of only two other creatures that feed on physalias: loggerhead and hawksbill turtles. These big reptiles have been seen eating their way through flotillas of men-of-war, closing their eyes as they bite into bladders, and swimming along with tentacles streaming from their beaks.

How little nomeus and the turtles survive such a fiery diet is a question perhaps one day to be answered in our study of the mysterious Portuguese man-of-war. THE END

SIKKIM

Enmity between giant neighbors, India and Red China, threatens the independence of a tiny kingdom in the clouds

By DESMOND DOIG

"DON'T PUT A FOOT past the cairn of stones at the top of the pass," a Sikkimese official grimly warned me. "Better, in fact, that you stay well this side. And, if you see any Chinese, run for it!"

Cold mountain air bit deep into my body as I drove a jeep toward the crest of 14,200-foot-high Natu Pass, on the border between Chinese-occupied Tibet and Sikkim. Ahead lay one of the most sensitive, strategic points in all the troubled Himalayas.

Little Sikkim, smaller than Yellowstone National Park and with fewer than 165,000 people, is trapped by geography between two

huge, quarreling neighbors, India and Red China. By treaty, India bears responsibility for Sikkim's defense, and my permission to visit Natu Pass had come from New Delhi, through the Ministry for External Affairs. Chinese troops had not yet attacked India, but the high pass definitely had become the front line of a defense area (map, page 407).

No man-made barrier at Natu can divide the supernal beauty of the setting. Ahead of me lay the deep, lost valleys and the brown, treeless plateau of Tibet, dominated by the glittering thrust of Mount Chomo Lhari. At my back and on each side rose the massed mountains of Sikkim, brushed with snow and dappled with cloud shadow.

"Stay well this side. . . ." The remembered words stopped me short of the cairn. I had no desire for any more encounters with Communist Chinese on the Sikkim border. Back in 1958, when I had accompanied Indian Prime Minister Nehru to Natu Pass, we had been met by Chinese troops, all young, all grim, all looking trigger-happy. From high rock pinnacles, other Chinese soldiers looked down like statues hewn from stone.

In bidding Mr. Nehru farewell—he was crossing into Bhutan via the Chumbi Valley

Indian spotted deer gaze across mist-filled valleys and cloud-veiled mountains from the royal deer park above Gangtok, capital of Sikkim.

in Tibet—I unwittingly stepped on Tibetan territory and was thoroughly photographed by a Chinese official wearing an out-size sunbonnet. He could have arrested me for illegally entering Tibet. Since then I have felt like a marked person, with a dossier in Peking.

I know the horror loosed upon Tibet by the Chinese, for I have many Tibetan friends. Some I shall never see again. Others, who escaped but may not return to their country, carry the bruising memories of an appalling tragedy. To be a captive of the Red Chinese in Tibet would be worse than dying.

Yet I still had two compelling reasons for returning to Sikkim: To me, it is an enchanted land of enchanting people; and there is always the fear that the India-Red China conflict will change it beyond recognition.

Legally, this tiny kingdom is a protectorate of India; and India, which maintains a resident political officer in Gangtok, the capital, is responsible not only for the country's defense, but for its foreign affairs and communications as well.

Ever since the Red Chinese swarmed south into Tibet in 1950, they have posed an alarming threat to Sikkim. For through the tiny

The Author: Desmond Doig, a British officer with the famed Indian Gurkhas during World War II, is assistant editor of the Calcutta *Statesman*. He writes authoritatively on the Himalayan rooftop countries. The NATIONAL GEOGRAPHIC published his article on the tiny Kingdom of Bhutan in September, 1961. In Sikkim, while guest of the Crown Prince, Mr. Doig obtained for this article several photographs taken by his royal host.

Red coral beads, gleaming pearls, and agatelike black-and-white *dzi* encircle the neck of a Sikkimese woman of Tibetan extraction. Necklace supports her charm box of gold, turquoise, rubies, and diamonds; it contains a relic of a holy man.

Donkey train plods up the Natu Pass road with oil and grain for Tibet. Lady Louise Hillary, wife of Everest's conqueror, heads back from the Tibetan border. Soon after the picture was taken, Red Chinese massed on the other side of the pass and blocked the age-old trade route. India's ambassador in Washington, B. K. Nehru, has described this road as "probably the easiest invasion route" from China into India.

KODACHROMES BY DESMOND DOIG (ABOVE) AND WILLIAM HUBBELL © NATIONAL GEOGRAPHIC SOCIETY

kingdom—which rises from a tropically luxuriant south to snow-clad wilderness in the north—passes the shortest route from Communist Chinese-occupied Tibet to the plains of India.

So, at the lofty pass, my mind dark with foreboding, I bade a lingering farewell to a sweeping panorama of mountains and sky and emerald lakes cupped in the towering folds of rock walls.

"The water flows from the mouths of snow lions," said a Sikkimese standing near me, and the scene was improbable enough to lend belief to this popular fantasy of a gentle, credulous people.

"Where are the snow lions?" I asked.

"They hold up the earth and live in the mountains. Only the most holy of men can see them."

"What are these lions like?"

"White with blue manes. Fire belches from their mouths. They are troubled by no insect."

"Not even fleas?"

"Not one."

"Has anyone seen them?"

"I know of none," replied the solemn Sikkimese. It was safe to assume that neither he nor I knew of men of sufficient godliness.

As on previous visits, I had entered the land of snow lions from India, across an old suspension bridge arched over the Tista River (map, page 406). It trembled at each

MOHAN PRADHAN © NATIONAL GEOGRAPHIC SOCIETY

Glass and plastic bracelets from India fascinate Nepalese girls in Gangtok bazaar. Sikkim's own wares consist largely of canned orange products and Scotch-type whisky.

Mule Caravan Winds Through Gangtok's Twisting Bazaar

This hilly city of seven thousand has no TV or radio station, no railroad, daily newspaper, or airport. Poles carry telephone and power lines. Galleried stores on steep slopes have street-level entrances several stories apart.

passing of a jeep or bullock cart. Our crammed antique bus made it shake alarmingly. Along its rusted cables fluttered prayer flags, pious offerings to gods and spirits.

As if asserting its authority, the country proclaims itself from a modern police barracks with swept-up turquoise-colored roofs. "Sikkim," says a large concrete sign. Around it a Sikkimese policeman with a gentle hillman's heart has planted marigolds.

Rangpo, the first village inside Sikkim, takes its name from the Rangpo River. It has an old wooden-stockaded market; a distillery run by a Parsee from Bombay, who claims his product equals the finest Scotch; and a copper mine, little more than a series of holes in the mountainside. Virtually the whole ridge is copper, and the seams show like rusty avalanche scars among the trees. The Government of India has launched a mining corporation, in partnership with Sikkim, hoping to boost the country's meager income.

Copper abounds throughout Sikkim. When I was a guest of the Crown Prince, Palden Thondup Namgyal, in Gangtok, he told me of great boulders of almost pure copper littering remote areas of his country. Copper coins have been struck here for two centuries, and the famed Sikkimese arrows that routed many enemies had copper-alloy heads.

"The arrows were so made that they could not be removed from their victims without

leaving a terrible mess," the Crown Prince said. "One of my ancestors invented them."

The 39-year-old Crown Prince was educated in the British manner and has the suave polish of the old Indian Civil Service. He is an authority on all things Sikkimese, and delighted me with the most unexpected information and colorful random detail.

An army of the past, he related, always included a doctor; astrologer; lama, or priest; and diviner. The country's first ruler, by legend, was a youth with webbed hands and feet and blue skin. The fine for killing a bachelor, a butcher, or a servant was 30 ounces of gold. For slaying a gentleman owning more than 300 servants, the fine was 200 ounces.

I asked the Crown Prince why he did not write a history of Sikkim.

"I intend to have one done," he replied. "I've already found the writer." The privileged author is Miss Hope Cooke of New York City, an American debutante whom the Crown Prince is soon to marry (page 406). They met in Darjeeling, India. His first wife, a Tibetan noblewoman, died seven years ago, leaving him two sons and a daughter.

His new wife's writing will undoubtedly include the peoples inhabiting the valleys between some of the greatest peaks on earth, which tower over northern Sikkim: Siniolchu; Simvo; Pandim; Kabru; Chomiomo; and 28,208-foot-high Kanchenjunga, the "Great Snow of the Five Treasures" (pages 424-25), topped in the world only by Everest and K2.

These snow-crowned peaks are regarded as the abode of gods, Sikkim's protecting deities. Therefore the country's ruler, the Maharaja Sir Tashi Namgyal, permitted a British expedition to ascend Kanchenjunga in 1955 only on condition that the summit be left untrodden. The climbers kept their pledge; they did not scale the last five feet.

In Gold Brocade Gown, the Maharaja Leads a Procession on His Birthday

Spectators near Gangtok throng a hillside as Sir Tashi Namgyal, the 70-year-old Maharaja, marches to open a sports festival. His Highness's sumptuous ceremonial garb belies his family's modest wealth. Crown Prince Palden Thondup Namgyal walks at right; his children by his deceased wife flank their grandfather. Uniformed Indian police commissioner attests his country's influence over Sikkimese military and foreign affairs. High priests of Lamaism wear red. Yellow-topped umbrella denotes the presence of royalty and top-ranking lamas.

KODACHROME COURTESY THE GOVERNMENT OF SIKKIM © N.G.S.

Communist China's infiltrations into India menace Sikkim. Semi-independent Sikkim and Bhutan command the crest of the Himalayas, India's natural bastion. With little defense of their own, they rely on India to protect them. Last fall Chinese spearheads driving into India's Assam and Ladakh threatened to encircle the princely states. Previously, while neutralist India watched uneasily, China built its sky-high military highway to Sinkiang across Tibet and a neck of Ladakh, a part of Kashmir.

"Do you think they really stopped short of the very top?" the youngest princess asked me, over a palace lunch of Tibetan-style noodles, sour cheese and chilies, stewed fern, and bamboo shoots with pork. I think she disbelieved because calamity followed the climb. The Red Chinese made their first probing moves across India's border.

To see Kanchenjunga from base to summit, I journeyed to a resthouse called Singhik. There I watched dawn seep into the valley over which the sacred mountain stands sentinel. The sun separated black earth from steel-gray sky, set fire to the highest peaks, and then raced like a flood of subtle color across the ridges and through the trees. At last, night was left only in the deepest gorges and in forest glades from which birds rose screaming to meet the day, as if terrified by the conflagration.

Beside the old resthouse stands a new school. The morning I visited it, the children looked somewhat unkempt, and my companion, a Sikkimese official, delivered a lecture

Crown Prince and American fiancee tour National Geographic headquarters in 1962. They examine a layout of this article, including a large photograph of the boy on page 416. Prince Thondup, a widower, met Hope Cooke at Darjeeling, India, in 1959.

SIKKIM: facts and figures

LOCKED in by snow-capped Himalayan peaks, Sikkim (pronounced sik' im) lives beneath foreboding shadows cast by Red China.

Bordered by Nepal, India, Bhutan, and Tibet, Sikkim lies on the shortest route between the Tibetan plateau and India's plains.

While much of it is barren, mountainous, and capped in perpetual snow, Sikkim is also botanically one of Asia's richest areas. About 4,000 flowering plants and ferns—including 400 orchid varieties—flourish there.

OFFICIAL NAME: Sikkim. **GOVERNMENT:** Kingdom, protectorate of India, has political parties but no constitution. India is responsible for defense, international affairs, and communications. **AREA:** 2,745 square miles. **POPULATION:** 162,189, 75 percent of Nepalese origin, the rest Lepchas and Bhotias. **LANGUAGE:** Several Himalayan dialects, also English. **RELIGION:** Buddhism. **ECONOMY:** Agriculture. Principal export, the herb cardamom. **CROPS:** Rice, pulse, oranges, wheat, barley, apples. **NATURAL RESOURCES:** Copper. **CAPITAL:** Gangtok (pop. 7,000). **CLIMATE:** Tropical—up to 5,500 feet, temperate—5,500 to 12,000 feet; alpine—12,000 to perpetual snow line at 16,000 feet. Highest peak is Kanchenjunga, 28,208 feet.

on cleanliness. Then he suggested a half-hour break. The hint was taken. The children splashed and scrubbed in an icy stream until I feared they would all die of pneumonia.

The new school symbolizes the modern Sikkim which, sandwiched between India and China, tries hard to preserve a character, a culture, and a tradition very much its own.

Sikkim, though without a constitution, has its own parliament and its own political parties. Indeed, political dabbling has become something of a status symbol, which is not surprising in a small country so vulnerable to political pressure from two sides.

Northward, trampled Tibet rebuilds with impressive speed—a calculated move by the

Shaven-headed boy lama, who outranks his tutors, is believed to be the reincarnation of an earlier lama. He is being groomed to lead an important Sikkimese monastery—a role formerly filled by Prince Thondup until his elder brother died in a plane crash and he became heir to the throne. Today the Prince has largely assumed administrative control of the state.

Red Hat Lamas of Gangtok Parade Past the Triumph-over-demons Shrine

Gilded sun cradled in crescent moon surmounts the *chorten,* a Lamaist shrine familiarly known as the Stone Horse. Dangling prayer flags, the votive offerings of visitors and lamas, give their messages to the winds, which whisper them to the cosmos. Bamboo flagstaffs are left untrimmed.

EKTACHROMES BY WILLIAM HUBBELL © NATIONAL GEOGRAPHIC SOCIETY

Red Chinese to make a bright impression along their new 800-mile border with the three Himalayan Kingdoms of Nepal, Sikkim, and Bhutan.

There is famine in Tibet, but the Chinese try to camouflage it with window dressing: radios, schools, roads, mobile cinemas, dispensaries and hospitals, excellent seed, fertilizer, good cheap cloth, and colorful prints of Buddhist gods and saints.

From the south presses India. Ever since an armed Chinese incursion into Sikkim near the Jelep Pass in 1960, Indian troops have occupied parts of the country in strength.

Sikkim's continued autonomy is due largely to two forces. One is Indian Prime Minister

Nehru, who considers Sikkim an example to the world that a powerful country can let a small neighbor exist without undue interference. Often he has stressed that India has no desire to absorb its northern neighbor.

The other force is Sikkim's royal family. There is widespread love for the old Maharaja. To many of his subjects he is Denjong Chogyal, or "King of Sikkim." Denjong, in literal translation, means "hidden valley of rice," the ancient name of Sikkim. Deep in the still-simple hillman's heart is a primitive loyalty to the tribal chief.

Hillmen Distrust Lowland People

Like hillmen everywhere, the Sikkimese considers himself superior to men of the plains and tends to be suspicious of lowland India. But the recent unified stand of all Sikkimese political parties to oppose the Chinese if they attack the kingdom should quiet those who doubt Sikkim's loyalty to its protector. The Crown Prince has initiated a civil defense corps and has called upon his people to help India. Below Sikkim, in the region around Darjeeling and Kalimpong, hillmen have rallied to join the Indian defense.

Most of Sikkim's 2,745 square miles are mountainous. More than half the nation is also barren, inhospitable land which supports nothing but yak herds and wild sheep. Everest is barely 80 miles away. But these unfrequented slopes just below the snowline—near where the legendary Abominable Snowman is said to prowl, and where Indian troops camp in icy isolation along the Tibetan frontier—are rich in flowers: primula and dwarf rhododendron, velvety iris and azalea, and a profusion of alpine flowers.

In the south, where there are trees, there are orchids: rock orchids cascading like rainbow-tinted waterfalls; colorful tree orchids that vie with the country's incredible butterflies; and exquisite ground orchids thrusting above the green fabric of the forest floor.

(Continued on page 415)

Dancer's beflowered antlers symbolize Buddha's previous reincarnation as a deer.

Brightly clad lama (right) reads Buddhist scriptures at Gangtok's New Year festivities. His companion, who masquerades as a Black Hat warrior, commemorates an ancient predecessor's assassination of an evil king in Tibet. Soot on cheeks disguises the warrior, as it did the slayer, and protects him against the evil eye.

Pure Flames of a Straw Shrine Burn Away the Old Year's Evils

Climaxing two days of New Year dances, Red Hat lamas symbolically destroy the world's troubles in purifying flames. Spectators shrink from the heat.

Heads swollen like cartoon characters, benevolent demons rush down the steps of the palace monastery in Gangtok. Black-faced Mahakala, Lamaism's chief guardian deity, and his attendants wear headdress skulls that evince the kinship of life and death. Leopard skin covers Mahakala's throne. Thunderbolt symbols adorn the dancers' collars. Familiarity with horrors, lamas believe, enables worshipers to brave the terrors of death.

Snuggling male (left) and female clowns entertain spectators. Called *acharyas*, the masked clowns depict wise men who distract demons until good spirits prevail.

Fuming muzzle-loader signals the New Year's start in Gangtok, and the palace band begins to play.

These Lepcha instrumentalists—woodwind, gong, and two drums—accompany the Maharaja on his travels.

Climbing through clouds in the Natu Pass, porters carry automobile parts from India for assembly in Tibet. The red flag demands right-of-way and rallies the bearers, who briefly rest their loads on bamboo supports. Little man stenciled on the case means "This end up." All trade between Sikkim and subjugated Tibet has now been stopped.

Red yak-tail plumes bob as mules cross a central Sikkim bridge that can carry safely only three at a time. Caravan bears rations from Gangtok to road workers. Until a few years ago, the sole motorable road into Sikkim stopped at Gangtok, and only a few trails were passable by pack animals, the others requiring human burden bearers.

The forest itself is beautiful, terrifyingly luxuriant. As it breathes, lives, decays, and devours itself, it spawns exotic creatures: the leaf butterfly, which wears jewels furtively on the inside of its wings; the copper-green dove; the hump-backed musk deer, the sedate stick insect, and the languid python. And many other things I cannot classify: things that rustle, dart, and explode with color and sound.

Wealth abounds in this beauty. Sikkim now exploits its forests for valued timber, and wild orchids could one day furnish a million-dollar-a-year harvest, with markets in the United States and Europe. But Sikkimese are prouder of their oranges, abundant in the lower valleys. The government Agriculture Department calls them the world's sweetest oranges, a claim I will always enthusiastically support.

In the picking season the roads teem with men carrying enormous baskets of oranges to the government canning factory. Wayside shops are piled high with golden fruit.

This is a time for celebration. In smoky villages under a sky filled by an orange moon, people dance and drink and laugh. In one night the pay for a month's hard work can be frittered away. Somehow the orange moon and the pungent smell of fruit compensate. So does love.

"I have eaten of fruit from many trees," goes a calypsolike song sung by the men, "and there are sweeter fruit yet to taste tonight." The women sometimes sing a taunt: "Return at the next harvest when you have become a man."

Ears muffled in fur, a Sikkimese boy nibbles a Tibetan cookie. His Western corduroy is not a rarity among school children. Front flap of his brocaded cap is tucked in.

Bracelets flashing, kindergarten girls dance in Namchi, southwest of Gangtok. Education is not compulsory; most Sikkimese children live on farms far from school.

Refugee Tibetan girls enjoy a lunch provided by American visitors. Some of them orphans, the others children of faraway road workers, they attend school in Gangtok.

Sikkim's people are a mixed lot: handsome cream-skinned Lepchas, the original inhabitants; burly Bhotias, who migrated from Tibet centuries ago and are considered true Sikkimese; ever-smiling Nepalese—now the majority—who were first settled in Sikkim by the British when they ruled India. Then there are the swaggering Tibetans, who bring to Sikkim the uninhibited color of their turquoise earrings and ornaments of jade and coral as they come and go over the Natu Pass (page 401).

Tibetan Trade Cut Off by Reds

Once the Tibetans came to Sikkim free and moneyed. They rode horses decked in gaudy saddle rugs and scarlet pompons of yak hair, with bells and saddles worked in silver and gold. Or they walked behind mule caravans with a lordly swagger, swords stuck jauntily into their leather belts. They whistled and yip-yipped as they came, and the mountains rang with their good cheer.

Now they still smile easily and stick out their tongues in greeting. But they are a sad lot, bereft of money and belongings, selling their earrings and daggers, and even their prayer beads. Mostly they come from refugee camps in India to earn their bread at road building (pages 422-3). The slender caravans of mules from Tibet no longer clatter down the high road to Gangtok, 15 miles from the border.

The end of the Tibetan trade has been a severe blow to Sikkim. From Tibet came salt and musty-smelling bales of yak wool.

To Tibet from India went cloth and gasoline, sewing machines and clothes, wheat and canned food—and phonographs and jazz records to set booted Tibetan feet dancing far away in saintly Lhasa. Motor cars were imported too, and dismantled in Gangtok to allow porters and mules to carry them piecemeal over the high passes (preceding page).

Millet Beer Quiets Lepcha Infants

Sikkim's Lepchas are dignified, well mannered, and as shy as fawns. Fable has them descended from bamboos—and they are as graceful. In a poetic self-assessment of their sparkling good humor, they say that their laughter wafts heavenward, where it freezes to become stars.

Left to themselves, the Lepchas would risk

Shy Lepcha children ride a homemade cart. Wheels, axles, and axle pins are wooden.

KODACHROMES BY STEPHANIE DINKINS (LEFT) AND DESMOND DOIG © N.G.S.

drinking themselves into extinction. In northern Sikkim a teacher said that even his youngest pupils at times come to class intoxicated.

"Lepcha children are brought up on a millet beer called chang," he said. "Often it is all the parents have at hand. Besides, it keeps the infants quiet."

I asked all his pupils who drank chang to raise their hands. Almost everyone in the class did, apprehensively, as if admitting to a sin. The youngest was a girl of five.

For years the Lepcha birth rate has been diminishing. Excessive drinking could be a reason. Could the undernourishment of poverty be another?

"No, the Lepchas are not in poverty," the Crown Prince told me. In fact, many of them are rich, because of a natural phenomenon—cardamom. The thing grows like a weed.

Sikkim is among the world's largest growers of cardamom, an herb of the ginger family. The seeds are exported to flavor curry powders and bread, cakes, and cookies. In forests cardamom grows up to 12 feet (page 427).

Once I sat with the Crown Prince, watching a storm approach. "That's hail," he remarked, pointing to the swollen, bruise-blue belly of an advancing cloud bank. Sure enough, hail soon ricocheted off the tin roof of the palace and bounced like table-tennis balls on the lawn. As suddenly as the cloudburst came it passed, climbing over the valleys towards the northern ranges.

The Crown Prince watched its direction. "Good," he said at last. "It missed my cardamoms." For a moment the country's next ruler was no more than a Lepcha farmer. Then he called for champagne.

Princess Comforts Tibetan Refugees

The palace at Gangtok looks like a British colonial cottage, embellished with painted Sikkimese carving about the front windows. Rugs brighten the floor, and a smell of incense from an upstairs chapel hangs in the grand stairway and hall.

The eldest Princess, Pema Tsedeun, or Princess Kukula, as most people call her, has an office in a corner of the palace. Sitting before a typewriter and surrounded by dozens of files, the Princess struggles valiantly to help the Tibetan refugees in Sikkim. She issues rations in a market warehouse, and squats on the palace lawn to distribute clothes.

She visits the exhausted, sick, and disillusioned in a wool shed turned into a combination hospital and transit camp, and listens to refugee problems from the front seat of her jeep.

Maharaja Talks to Spirits

Kukula's father, the 70-year-old Maharaja, devotes much time to painting. He is an artist of great originality, and his scenes of mountains and Tibetan deities are filled with sacred symbols (page 421). He told me that he once had to repaint a picture of Kanchenjunga because the lamas had declared his blacks and deep greens to be inauspicious.

His Highness confesses to seeing visions and communicating with spirits. He rather wistfully said to me that the spirits no longer come to his bedroom window of a morning. He banished them from his presence because the business of entertaining spirits is a serious mental strain, calling for intense concentration hour after hour.

The Maharaja is a man of such sincerity and almost saintly innocence that no one possessed of any sensitivity would wish to discredit him. Besides, much in Sikkim appears to exist on an unfamiliar spiritual plane of which we know little or nothing. I think

PHOTOGRAPH BY STEPHANIE DINKINS © NATIONAL GEOGRAPHIC SOCIETY

Mourners Carry a Cloth-draped Bier up a Foggy Mountain for Cremation

Parading to the pyre, a mile away, the funeral attendants accompany lama musicians who bear instruments especially consecrated for the occasion. After this cremation at Gangtok, the deceased's ashes were mixed with clay, shaped into hundreds of small images, and placed in a memorial chorten.

that I, myself, may have seen a spirit, or ghost, or call it what you will.

I awoke in a palace guest room one night with the strong sense of another presence nearby. With a start, I made out a figure moving across the room; before I could speak, the apparition vanished in the gloom. I did not sleep the remainder of the night. "An inquisitive old night watchman padding about," I told myself. But was it?

At breakfast, when I mentioned the matter to the Maharaja, he knew instantly what I was talking about.

"You saw the old lama," said His Highness. "He was murdered for his heavy turquoise earrings. This is a harmless ghost. There is another one that ticks like a clock. He is dangerous. The worst one manifests himself as a cemetery ghoul, with four skull-like heads, one on top of the other."

Perhaps I had been dreaming. But I do not want to sleep in that room again.

Prince Assumes Government Duties

The present Maharaja came to the throne when Sikkimese royalty, reduced to poverty, had been stripped of almost all authority by the British in India. Slowly, power was restored to him by the British, because of his benevolent ways.

Today, the Maharaja retires more and more to a world of meditation. He leaves government matters largely to his son, the Crown Prince, who early in life was declared to be a reincarnation of his uncle, a former maharaja and abbot of an important monastery. To Occidentals this may sound extraordinary. But to Mahayana Buddhists reincarnation is as natural as living.

The Crown Prince plays down the miraculous. When someone pursued the subject at a party, he said yes, of course, he is a Rimpoche, a reincarnated lama. But, he added, "Aren't we all reincarnations of a sort?"

Those who meet the Prince are impressed by his deep interest in many things, from orchids to atomic energy. In recognition of his knowledge of Buddhism, he has been elected president of the Maha Bodhi Society of India, and representative of Sikkim and India at several international conferences of Buddhists and Orientalists. He is the founder and president of the Namgyal Institute of Tibetology in Sikkim, which hopes to preserve the teachings of the Mahayana branch of Buddhism—a significant effort, now that the Chinese have overrun Tibet.

Hindus outnumber Buddhists in Sikkim, but Buddhism, the religion of the Lepchas, the Bhotias, and some Nepalese tribes, is the

state religion. The Sikkimese venerate the Dalai Lama, now a refugee in India, above all others, but they attach almost equal importance to the Gewa Karmapa Lama, another Tibetan refugee, now settled in his new monastery at Rumtek in Sikkim. He is the spiritual leader of the Red Hat order of Mahayana Buddhists, and all Sikkimese Buddhists belong to the Red Hat. He owns a miraculous hat which, it is said, will fly unless held in place. When he wears this headgear, he keeps a firm grip on it or has two attendants hold it.

When I was in Sikkim, preparing to join Sir Edmund Hillary on his scientific expedition to the Himalayas in 1960-61, an Indian friend suggested that I visit the young Gewa Karmapa Lama. It might be interesting, he said, to approach the trials of high-altitude acclimatization armed with the mystic Oriental view of such problems.

"Nothing is really impossible," the cheerful lama said, "if you know how to control the mind. In the cold you can remain warm, and in the heat stay cool. You can communicate over great distances, and I will teach you how not to feel tired when walking. Would you like to walk so fast that you almost fly?"

Mystic's Mind Prevails Over Mountain

Later, on the Hillary expedition, skeptical Western scientists were impressed when we saw a Nepalese mystic fight fatigue, hunger, and extreme Himalayan cold with thin cotton clothes, bare feet, and the extraordinary power of his mind.*

I watched His Holiness the Gewa Karmapa Lama, in meditation, in a relaxed and happy mood, in serious conversation, and in prayer. Usually he sat erect, hands folded upon his knees. He sleeps in this position and will

*See "Wintering on the Roof of the World," by Barry C. Bishop, NATIONAL GEOGRAPHIC, October, 1962.

eventually die in it. When he meditates, his eyelids quiver and his body seems almost to float, so obviously does every force in his ample body concentrate in his head.

He entreated me not to reveal his formula for battling fatigue and for "walking fast, like flying." It was a clever mental exercise. If I had the necessary powers of concentration it might work. But my Western mind is not conducive to mysticism. I will never fly.

Death: a Journey Over a Pass

Daily the sick and the dying are brought to Rumtek, because to be blessed by the Gewa Karmapa Lama is to escape many tedious reincarnations and so hasten to nirvana, the ultimate state of peace.

I expressed regret to a Tibetan that his old mother lay dying nearby.

"But she is happy," he said. "Death is like crossing a pass into another land. His Holi-

Ceremonial muzzle-loaders, gift of Queen Victoria, arm Lepcha guards drilling on the palace grounds. Cane hats bear the crescent moon clasping the royal arms. Forest-dwelling Lepchas, Sikkim's original inhabitants, live mainly on lands reserved for their exclusive use.

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Prayer Wheels Whirl, Rosaries Click

Waiting for the funeral pyre to flame, mourners pray in a sheet-metal shed. Weights on chains turn the prayer wheels. "May the departed soul go to heaven or to a higher life," mourners chant.

KODACHROMES BY WILLIAM ROBERT

Kanchenjunga, Sikkim's sacred mountain, grows beneath the Maharaja's brush. Largely retired from administrative duties, His Highness remains the spiritual head of his people. Symbols in the sky express his inward vision.

ness will make the journey safe and short. Can she desire more?"

She died one rainy night, and I, snug in my monastery room, heard drums and trumpets and the chanting of the lamas announce her passing. Over the pass, out of rain, into a new world of sunshine, propped up by prayer and rejuvenated by the great lama's blessing—could an old woman desire more?

India Watches Over Kingdom

Sikkim has shrunk considerably over the centuries. It once included the eastern tracts of Nepal known as Ilam, the Chumbi Valley in present-day Tibet, and the Ha Valley in Bhutan. Southward, Sikkim reached to the plains beyond Kalimpong and Darjeeling, until India took this region during British rule.

That the country survived at all testifies to the character and determination of its people and rulers. In 1947 India took over the responsibilities of the British in Sikkim, and in 1950 entered into a new treaty with the present Maharaja. Today Sikkim has an Indian Dewan, or Chief Minister.

With generous aid from India, Sikkim has made great strides. It offers free education and free medical treatment in rapidly multiplying schools and hospitals. Indian experts run demonstration farms and distribute hardy new varieties of grain, fruit, vegetables, and livestock. Jersey cattle from Australia have raised the milk yield; milk, rather than chang, can now be fed to children.

Burlap-and-canvas shack shelters a refugee family that fled the Red terror in Tibet. Sikkim cares for some six thousand refugees, predominantly men. Some came over the high northern passes, others by way of India. Bringing their wealth in the form of sheep and yaks, they found the animals worth little in the lower altitude of southern Sikkim, where they camp. Many Tibetans work on Sikkimese roads.

A woman doctor from India visits this family.

Refugee family heads north for labor on the roads. Women, who work with their husbands, take babies with them. Older children stay behind in school or camp. The Crown Prince took this picture and those on pages 424-25 and 427.

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Indian help includes construction of a new road into northern Sikkim. I accepted eagerly when the Indian political officer in Gangtok invited me to drive with him over this strategic route. "Be prepared to walk," he warned. "We might find the going impossible."

A mile beyond Gangtok a board nailed to a tree proclaimed, "No foreigners beyond this point without permission." Permission is seldom given. I would be the first visitor to travel the new road.

After three years under construction, this route is audacious and beautiful, but still hardly a road. We drove along it carefully, for in most places it was little more than a raw tear in great mountainsides.

Waterfalls crashed onto it and streams hurdled it with chattering abandon. In some places great trees leaned over it protectingly. At others it crept out across sheer rock faces hundreds of feet high.

At a terrifying spot the road cuts into vertical granite and a river thunders far below in a misty gorge. We left our jeep and walked—scrambled would be a more accurate word. Here we were introduced to Indian engineers and to cheery workers, often roped together like mountaineers.

By this spring the road will have reached the northern frontier with Tibet, linking the Lepcha centers of Lachen and Lachung with Gangtok. It will climb to 16,000 feet, and at the beautiful village of Lachen will be only 25 miles from towering Kanchenjunga and

Dazzling Kanchenjunga Floats Over Clouds; Sikkimese Revere It as the Abode of Gods

Astride the border of Sikkim and Nepal, Kanchenjunga lifts its snow-clad bulk from green valleys. Only Everest and K2 top it. At least eight

KODACHROME BY CROWN PRINCE PALDEN THONDUP NAMGYAL © NATIONAL GEOGRAPHIC SOCIETY

climbers have died on its slopes. British mountaineers in 1955 kept the 28,208-foot summit inviolate at the Maharaja's request, stopping five feet below their goal, the right end of the sawtooth ridge at left. Camera lens foreshortens the distant summit, making it appear lower.

KODACHROMES BY STEPHANIE DINNING (ABOVE) AND CROWN PRINC

15 from the sacred mountain of Siniolchu (maps, pages 406-7). One day, if defense considerations permit, it will be the greatest scenic drive a tourist can take.

I returned to Gangtok in time for two memorable events—the annual dance festival dedicated to the deities of Kanchenjunga, and the funeral of a widely revered lama.

Masked lamas representing legendary birds, beasts, and warriors began dancing in midmorning in the golden-roofed royal chapel. They pranced all day like stately mechanical toys to blasts of sound from monstrous trumpets, pipes, cymbals, and drums (pages 412-13).

All Gangtok, in its best robes and fur caps, giggled and squealed with delight. The women's jewelry tinkled like bells in the wind. The backdrop was a sawtoothed snowy mountain range: Siniolchu, like a gleaming spear holding up a dark canopy of cloud, and Kanchenjunga, an immaculate altar.

The Maharaja sat with his guests under a silk awning, dressed in brocade so heavy and unyielding that he seemed to be fashioned in gold. People prostrated themselves before him or bowed low, removing their hats. The old man seemed hardly to notice.

The Crown Prince, also in brocaded robes and cap, filmed the dances. Attached to him by a cord was a solemn servant carrying exposure meters and filters.

Rain threatened in the afternoon. "Don't worry," said an official, "His Highness has ordered prayers to be said. The right prayers, you know, prevent rain even as others en-

courage it. His Highness personally performed such prayers when the Dalai Lama passed through Sikkim in 1956."

"And when Mr. Nehru was on his way to Bhutan via Tibet?" I asked.

"Maybe."

I remembered that a strange coincidence surrounded the Indian Prime Minister with sunshine and clear skies while the rest of Sikkim was drenched with monsoon rain.

I had reached Natu Pass ahead of Mr. Nehru in heavy mist and freezing drizzle. When his caravan approached the pass, the clouds rolled away. For half an hour sunshine warmed us. Then the mists returned and rain fell relentlessly. But by that time Mr. Nehru was well on his way into Tibet, and the Maharaja was motoring back to Gangtok.

The funeral of the saintly lama impressed me deeply. He had died six months before, but Princess Kukula told me that his body was still pliant and fresh, though it had

Terraced Rice Fields Cover a Hillside in the Tista Valley

Industrious Nepalese immigrants have revolutionized agriculture in Sikkim. Now forming 75 percent of the population, they have discarded old slash-and-burn techniques for intensive wet farming of rice.

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Cardamom plants get a pruning from a Lepcha family. A natural forest undergrowth, the spice proves a prime source of income for the woods-loving Lepchas. Cardamom, whose seeds flavor cookies, bread, curry powder, and coffee, brings more export cash to Sikkim than any other crop.

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Primitive sawpit, one man on the planks, his partner in the pit, turns out timbers for new bridges. Thus a mule track in northern Sikkim becomes a jeepable road, opening the hidden land of the Lepchas. Woman gathers twigs for firewood.

Heading down into the fog of the Tista Valley, porters carry planks that will go into guesthouses for the Crown Prince's wedding, scheduled for March, 1963, at Gangtok. Porters' rain capes, made of bamboo matting and leaves, lie folded atop the lumber.

shrunk considerably. The evening he died, the skies over Gangtok had flamed as if rekindled by a second sunset.

"He had begun to levitate," the Princess explained, "so we knew he was leaving us."

Paying my respects to the dead lama, I lit a butter lamp before his jewel-encrusted casket in the royal chapel, where magenta-robed lamas kept vigil. Thousands more such lamps glowed hotly in the pungent gloom. Food, money, flowers, and ceremonial scarfs were heaped about, tokens of love and respect from the Sikkimese.

On a day declared auspicious by the lamas, the saint's remains were taken to a sacred hill for cremation. The procession was a blend of medieval pageantry and modern efficiency.

Jeeps bore the jeweled casket, the brocaded lamas, the banners, the ceremonial umbrellas, the many mourners in rainbow-colored clothes. One vehicle carried a traditional Sikkimese band dressed in wicker hats, peacock feather plumes, and homespun kilts.

Behind them a camera crew recorded the procession on film and tape for the government archives. The pomp and splendor of this Sikkimese ceremony, I noted with gratitude, will not be lost to future generations.

But what will be saved for coming generations? What is Sikkim's future? Certainly it is overshadowed by the Red China-India struggle; Mr. Nehru calls this "a drama of which only the beginnings have been seen, and no one knows what the end will be."

Sikkim's tranquillity could be swept away overnight. Just the same, we can venture to predict what will happen in Gangtok on the happy day of March 20, 1963.

Foreign diplomats will crowd the palace lawn for the wedding of the Crown Prince to Miss Hope Cooke. The American girl will wear traditional Lepcha dress for her wedding; Princess Kukula is seeing to that. During a three-hour ceremony in a beautifully frescoed chapel, the couple will be blessed by lamas and the families will exchange scarfs.

All Sikkim will be there to gape and cheer, even those who have opposed the unprecedented marriage of a Crown Prince to a foreigner. There will be a fresh mountain sun, willed to shine, and a breeze off the Natu Pass to keep the prayer flags stirring.

Bands will play and dancers will dance as they never danced before. And above the gaiety and color, Kanchenjunga, lord of all Sikkim, will soar serene. THE END

The Mighty *Enterprise*

Eight atomic furnaces power this incredible queen of ships, capable of roaming the seas for years without refueling

By NATHANIEL T. KENNEY

Photographs by

THOMAS J. ABERCROMBIE

Both National Geographic Staff

IN THE NORTH ATLANTIC Ocean the largest and most powerful ship ever built drove at high speed toward the coast of Portugal.

This would be the United States aircraft carrier *Enterprise*, 1,123 feet long, carrying 4,600 men to sail and fight her, shouldering aside more than 85,000 tons of salt water to make room for herself in the sea, powered throughout by atomic energy.

We were steaming to meet foreign ships of the North Atlantic Treaty Organization for maneuvers off the Iberian Peninsula. I had been below all day. Now I strolled to dinner through a maze of steel corridors.

The ship was steady as my house in Maryland—no vibration, no perceptible pitch or roll, the flames of tall Sunday-dinner candles on the wardroom tables unwavering. On board *Enterprise*, I was thinking, you could hardly tell whether you were at sea or tied to

World's largest ship and first nuclear carrier, the 85,350-ton *Enterprise* leaves tugs behind as she undergoes her shakedown cruise off Mayport, Florida. Bluejackets crowd catwalks and share the flight deck with tethered jets, many with wings folded. *Enterprise* inherits her name from seven naval predecessors.

EKTACHROME © NATIONAL GEOGRAPHIC SOCIETY

the pier in Norfolk, unless you went topside.

Then the officer beside me casually told me that we were taking a whole northeast gale right in the teeth. This was so incredible that I had to go out and see for myself. I took an elevator to the flight deck.

What with the north wind plus the wind of our speed, it was more than a whole gale over the deck; it was wind to blow adrift any man standing in the open. Barely visible in the scud astern, two escorting destroyers reared and plunged, taking spray to their mastheads.

I looked toward the flight deck's edge and thought of the spuming seas 64 feet below. So I stayed in the lee of the mammoth control island, the only superstructure on *Enterprise*, and here a jet flyer joined me.

"Magnificent!" he exclaimed. "With a wind like this, I could take off without a catapult."

"You'd fly in such a gale?" I asked the young man, incredulous.

He nodded. "Night or day. Take off, do

Behind forbidden doors are the most powerful engines afloat. Eight reactors, using uranium instead of oil, develop more than 200,000 horsepower. Steam turbines drive four 21-foot propellers.

my job, and come back aboard the ship."

Then he fell silent, and I knew why. He was aware that he had just stated, in simplest form, the sober truth about *Enterprise*, the real reason our country was willing to spend, to create this ship, almost half a billion dollars, or enough to build 26,000 comfortable American homes or put about 68,000 young Americans through college.

The fact is that *Enterprise* is a dreadful retaliatory weapon of war which diminishes

Closing a Circle at Flank Speed, *Enterprise* Seems to Chase Her Tail

One of the world's swiftest ships, the nuclear-powered *Enterprise* has almost unlimited range. She can sail for years without refueling and race through the sea at a top speed announced only as "more than 25 knots." She heels so sharply on tight, fast turns that bullhorns warn the crew to hang on. Her four-and-a-half-acre angled flight deck permits her to launch and recover planes simultaneously.

the likelihood of war by its very existence.

While *Enterprise* ranges open seas, no nuclear attack could be made on the United States without the certainty of awful destruction in return. For all her bulk, this airbase afloat offers a relatively tiny darting target—here today, a thousand miles from here tomorrow—that can side-step a long-range missile in its flight.

Her astonishing maneuverability stems in part from her propulsion plant. Nuclear fission produces intense heat the moment you permit the neutron bombardment of the uranium fuel. Thus *Enterprise's* eight reactors make steam very quickly. Power in abundance is always there to unleash.

If need arose today, *Enterprise* could weave a missile-baffling course through the oceans of the world at more than 25 knots for years without refueling!

Carrier Harks Back to Days of Sail

It is a curious thing, but a Yankee whaleship often spent an equivalent time, several years, in distant oceans without coming home to New Bedford or Nantucket. Vice Adm. Hyman G. Rickover, chief of naval nuclear propulsion programs for both the Atomic Energy Commission and the Navy, saw the analogy. He once said that nuclear ships were throwbacks to the age of sail, when a captain need never seek the land for fuel.

Unlimited range, then, is the chief advantage of the nuclear ship, and there is a corollary one: You need no bunkers or tanks for fossil fuel, so you can carry something else in its place. At present *Enterprise* stocks fuel oil for her nonnuclear escorts. But if her escorts become nuclear powered, she will use the extra space for even more aviation fuel than she now carries in tanks kept as full as possible for complete combat readiness.

She is equipped to carry both nuclear and conventional weapons. Compared to the cataclysmic blast of all this carrier's nuclear capability, the combined explosion of every

White House and 275 feet of lawn could fit on *Enterprise's* flight deck.

World War II bomb would seem a feeble firecracker.

I know *Enterprise* quite well, having seen her commissioned in late 1961, made her shakedown cruise to Guantánamo, Cuba, and gone with her to the Mediterranean last summer on her first visits to foreign ports.

She nevertheless taxes my credulity, this colossus of a ship; my mind stumbles merely in the face of her random statistics.

Her machinery can distill enough fresh water from the sea to supply 1,400 homes. She bristles with 300 antennas for radar, radio, and television. She carries her own well-equipped weather bureau, garbage-disposal plant, post office, and brig.

Enterprise has only five hull portholes, sentimental relics taken from the World War II *Enterprise*. This is disconcerting to men who work in the bowels of the ship: You can cross the ocean on her and never see the water, and I know more than one of her crewmen who have done just that.

Thus, without portholes, and needing no engine air intakes or smokestacks—absolute necessities for oil burners—she can be tightly buttoned up against nuclear blast and radioactive fallout. Again a corollary advantage: She trails no smoke and soot, something much appreciated by pilots coming up astern for their tricky landings.

I wish I could describe all of *Enterprise's* modern marvels, but since it took 2,400 miles of 30-inch-wide blueprints to build her, I must obviously leave something out.

But her greatest wonders lie in shielded compartments below decks: The atomic furnaces that can drive her incredible distances at top speed, producing fantastic power from minute quantities of fuel.

Alarm Sounds Under Bunk

I confess at the outset that I know little of these wondrous engines, and this is as it should be. Security regulations bar most of her own crew from *Enterprise's* reactor areas. The Navy politely declined even my serious request to be led through a reactor compartment blindfolded, so that I might write at least that I'd been there.

Nor, of course, was I permitted to enter the magazines reserved for her nuclear weapons. (Although once, not knowing what it was, I brushed against a practice bomb being loaded—to the consternation of the Marine guard.)

Of *Enterprise's* nuclear mysteries I can say only that I slept over a reactor, separated

KODACHROMES BY THOMAS J. ABERCROMBIE © NATIONAL GEOGRAPHIC SOCIETY

Skipper of the carrier, Capt. Vincent Paul de Poix, works in his in-port cabin. At sea, he uses a small cabin near the bridge. In World War II he flew fighters from the old *Enterprise,* one of the Navy's famous fighting ladies. The earlier "Big E" earned an enviable battle record in the South Pacific. Communications console above desk lets captain talk to key personnel and interrupt radio and TV programs for announcements.

Triple-deck bunks replace traditional Navy hammocks. Each man has his own locker, air-conditioning outlet, and reading light, enabling him to read or write letters without disturbing his shipmates' sleep. To serve its crew of 4,600, *Enterprise* offers the facilities of a small city: laundry, bakery, butcher shop, pharmacy, soda fountain, several ice-cream bars, 7,000-volume library, waterworks, and even a blacksmith shop.

from it by insulating layers of undisclosed material of classified thickness.

I know this because one night a loud alarm rang, seemingly under my bunk. In the morning I asked Comdr. Dan Brooks, the ship's Reactor Officer, about it. He said it was one of hundreds of safety devices, warning of a minor maladjustment in a reactor.

The atomic furnace under my bunk, and seven more like it, generate high-pressure steam. Four conventional turbines develop more than 200,000 horsepower to drive 21-foot-high propellers that weigh 64,500 pounds.

A ship the size of *Enterprise* would, admittedly, be difficult to conceal. Under wartime conditions the Navy would hope to keep her out of sight as long as possible, aided by

(Continued on page 441)

Catapults Hurl Jets Into Flight for a Sweep Over the Mediterranean

Enterprise's powerful steam-driven slingshots accelerate planes to 160 miles an hour within 250 feet. Catapult launches prove less hazardous and take less space than unassisted take-offs. The hot blast from a jet is deflected by the retractable blast shield behind the catapult; water cools the shield's center section. Hinged radio antennas at right swing outboard like fishing rods when the *Enterprise's* planes take to the air.

Banking away at left goes a Crusader, now designated the F-8E, but formerly known as the F8U; all military aircraft were renumbered in September, 1962. An A-4C (formerly the A4D) Skyhawk climbs at right. Other Skyhawks with bomblike fuel tanks await their turns. An F-4B (F4H) Phantom II, the Navy's 1,600-mile-an-hour interceptor, noses into view at lower left.

KODACHROMES BY THOMAS [illegible] © NATIONAL GEOGRAPHIC SOCIETY

Twin jets howling, A-5A Vigilante (formerly the A3J) touches down on *Enterprise's* deck. An arresting cable snags on a hook under the tail and halts the plane.

Ready, set, go! Flight Deck Director demonstrates take-off signals in a double exposure. Twirling a green wand in his right hand tells the pilot to gun his engine; red light in left hand says, "Brakes on." Plane leaps forward when the signaler cuts the red light and sweeps the green wand toward the ship's bow.

Mickey Mouse helmet takes its name from earlike pods crammed with radio equipment. It protects the eyes and ears of Lt. H. J. Bouchard, who serves as traffic director and parking-lot attendant for taxiing aircraft, and enables him to talk to "Primary Fly," the carrier's flight-control tower.

A Vigilante pilot approaches the carrier at 125 knots, while maintaining power to zoom to safety in case of a miscalculation. He chops the throttles only after the tail hook engages. "When I watched my first jet land," photographer Abercrombie recalls, "I dived for cover, thinking it was crashing." Newest of the Navy's attack bombers, the needle-nosed Vigilante carries a crew of two and flies at twice the speed of sound.

Tail-loading fuel tanks slide into a Vigilante's unusual linear bomb bay, a tunnel through the fuselage. Bombs are ejected from the rear like torpedoes from a tube.

512
TRACTOR
F 62

her speed and the latest marvel of sea warfare, the electronic brain known as the Naval Tactical Data System. Information of every sort feeds into this brain—position, altitude, course, and speed of attacking enemies. In millionths of a second, the machine can recommend orders for her captain to issue.

The Navy has equipped other warships with NTDS. The computers intercommunicate, so that the Officer in Tactical Command may maneuver a task force as readily as he would a single ship.

For further defense *Enterprise* has a screen of escort ships, including ones especially built to combat submarines. Their primary job is to protect her against enemy vessels and aircraft. Spread out in formations sometimes as large as the State of New York, these ships would intercept an attack coming from above, under, or on the seas.

Russian Trawler Follows Fleet Maneuvers

During the NATO maneuvers I was struck by the wide dispersion of a modern naval force. Although 38 ships took part in the exercise, no more than a dozen ships were ever in sight at one time (pages 444-45).

To fight off enemy aircraft, *Enterprise* looks to an umbrella of friendly planes, including a deadly force of her own. She carries missile-firing Phantom II's, manufactured by McDonnell Aircraft. This fighter holds the world jet-plane speed record of 1,606 miles an hour.

To deliver bombs—nuclear or conventional—we had on our flight deck and in our cavernous hangar some 75 planes of several types. The most impressive is North American Aviation's Vigilante, a needle-nosed terror that goes twice the speed of sound and climbs 17 miles high, with payload (pages 438-39).

The other side has seen us launch our Vigilantes, and we were quite willing that they should, for we can be a deterrent to war only if our capabilities be known. During our trials off Guantánamo, they watched us from Russian ships and Cuban hills. They photographed us and surely made tape recordings of our noises for the benefit of their sonar-equipped submarines.

A Russian trawler showed up for the NATO maneuvers. During the time I watched him, I never caught him dragging or drifting a net, or lowering a dory. I admired his courage in mixing in such swift, deadly, and unfriendly company.

"If I were skipper," said one *Enterprise* officer as we watched

(Continued on page 446)

Color-coded Costumes Reveal at a Glance the Tasks of Flyers and Crewmen

White-aproned cooks and pilots with flight helmets and orange flight suits flank a landing signal officer in yellow-paneled coveralls. Silvery asbestos suits encase two "hot papas," who rescue airmen if a plane catches fire. To the left stand two orange-garbed helicopter pilots and a radiation-safety technician with mask and hood. Men in red handle fuel or explosives. Blue-jerseyed sailors jockey aircraft around the deck. Plane captains wear brown. Red crosses identify flight-deck medics; hospital corpsmen who serve below decks wear pale green. Yellow diesel mule in background tows a propeller-driven A-1H (AD-6) Skyraider tailfirst.

Brains of the ship lie in the dimly lit and closely guarded Combat Information Center, where secret electronic systems evaluate enemy threats and instantaneously recommend countermoves. *Enterprise's* improved radar uses billboardlike antennas mounted on the superstructure instead of the usual rotating dish. Her electronic eyes detect, identify, and track attackers and feed data to computers that require

but millionths of a second to reach a conclusion. Consoles (above and below) display positions of ships and planes within range of the carrier's far-seeing radar. Such scopes are supplemented by the manual plotting of positions on transparent map overlays, but the scopes cut error and delay. Other battle information appears on fluorescent maps above. Status boards show disposition of friendly forces.

KODACHROME (ABOVE) BY JOHN E. WILLIAMS, U.S.N., AND HS EKTACHROME BY THOMAS J. ABERCROMBIE © N.G.S.

SHIPS OF THREE NATIONS—*the United States, France, and Great Britain—steam through the Atlantic on Riptide III, a North Atlantic Treaty Organization exercise. Destroyers lead the way, followed by* **Enterprise** *(top), the U. S. cruiser* **Newport News** *(center), and the British carrier* **Hermes** *(bottom). French carrier* **Clemenceau** *brings up the rear.*

BATHED IN A FIERY GLOW, *crewmen of the* **Enterprise** *attach the catapult bridle to a Phantom II. Man at left beckons the plane forward. Red lights preserve night vision and reduce the carrier's vulnerability to enemy detection.*

When armed with atomic weapons, **Enterprise's** *planes pack far more punch than all the carrier-based strikes of World War II.*

the trawler yawing wildly in our wake, "I think I'd invite old Ivan aboard and put him out on the flight deck during a night operation. It would scare him so badly he would turn in his Russian Navy commission and never go to sea again."

I had such an experience myself, and it terrified me. The whole thing was accidental. On a soft night of stars and warm wind I had been sitting on one of the flight-deck catwalks, watching the phosphorescent sea below. I started across the deck for the control island, picking my way through parked planes in the dim red glow of battle lights.

All of a sudden the bullhorns roared a command. Then the plane engines started—the screaming, thundering jets and the huge gasoline engines of the Skyraiders, which still use propellers. You cannot describe the noises of *Enterprise*'s flight deck during business hours. It is an end-of-the-world noise, so overwhelming and even so dangerous to human eardrums that men who work there must have protective flaps on their strange-looking communications headgear.

I can describe the obvious dangers; in fact, I thought of every one of them in the brief minute I squatted in the midst of bedlam, holding one of the tie-down rings set in the *Enterprise*'s deck, wondering why I ever chose a reporter's life.

You can walk into a propeller or a helicopter rotor blade. A flight elevator can drop out from under your foot at lightning speed,

a bit of catapult gear or arresting cable can snag you, you can be run down by one of the little diesel trucks they use for towing planes and starting their engines.

Worst of all, the tail end of a jet plane can burn you to a cinder, and the front end can suck you into the engine. Lt. H. J. Bouchard, Assistant Flight Deck Officer (page 438), knows all about the latter: He is one of the few men to be sucked into a jet and live.

He rescued me that night on the flight deck and led me to the safety of the island. There he recalled his mishap years ago on another carrier.

"I was sucked in crosswise, and I stuck before I reached the machinery," he said. "They should have given me a medal for that. A man in the machinery, even a cap or a jacket, can knock out an expensive plane."

Needless to say, the lieutenant spent quite a while in a Navy hospital.

Despite the constant dangers, the accident rate is low because the crew is so highly trained and the equipment well-maintained. Officers sternly enforce safety rules.

After my experience on the deck, I watched flight operations, night or day, from the safety of the ship's high bridges. Never did the noise and violent action fail to thrill me.

The men below look like beings from another world in outlandish costumes, some with antennas for their walkie-talkie radios sticking out of their helmets like the feelers of giant bugs. They wear bright colors—

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

Surgery at Sea Poses No Novel Risks Aboard the *Enterprise*

An 86-bed sick bay rivals the facilities of many a metropolitan hospital. Six doctors and some fifty corpsmen staff the central sick bay and seven scattered battle dressing stations. Specialists frequently examine the ears of every man on board to check for hearing damage caused by jets.

Ship's newscaster, Chief Journalist Robert Wells, reports the news over closed-circuit television. Some 80 sets bought by the crew receive the picture in lounges and living quarters. At sea WENT-TV carries news, filmed telecasts, and live variety shows featuring members of the crew. In port the station tunes in on local channels.

Telescoping vista down a port passageway on the gallery deck emphasizes the $444,000,000 vessel's length and attests her compartmented construction. Red lights glow after taps.

If gas or atomic attack threatens, *Enterprise* can be made airtight by dogging down outside doors. Air-conditioning units purify and recirculate air trapped inside. Exterior nozzles wash the ship with sea water if she receives radioactive fallout.

green, red, yellow, blue—so that everyone knows at a glance to what jobs the others are assigned (page 440).

The tiny yellow trucks tow and butt the planes into position over the catapults hidden below decks. Fearless men dive beneath to hook the planes to the catapult shuttles ensconced in their steel tracks (page 444).

The men roll to safety, the bullhorns roar commands and exhortations from the lofty "greenhouse" where the Air Officer rules, and Bouchard, beside a poised Vigilante, makes twirling motions.

The twin jets bellow like a thousand bulls, spitting flame against water-cooled blast shields that swing up from the deck when there is need of them. Bouchard gestures "Launch!" straining forward as if he also were to be slung into the void.

The Vigilante shoots away like a Fourth of July rocket. Already, through a cloud of spent catapult steam, another plane is moving up to take its place (pages 436-37).

"Angels" Hover Alongside for Rescue

To me, landing seems more tense than launching. The great planes come roaring in from astern, pilots watching the "meatball," the panel of electronically controlled lights on the carrier that tells them when course and altitude are correct. Also in sight is the "wave-off" light; it signals incoming aircraft that have strayed from the proper landing pattern.

Planes hit deck with a thump at approximately 125 knots (page 438). The pilot does not cut his throttle until he is certain the tail hook has caught an arresting cable, for if he misses, he must have flying speed to go around and try again.

The plane catches one of the four cables with its tail hook and jerks to an eye-popping halt. Like all modern carriers, *Enterprise* has a landing deck built at an angle to the center line of the ship. Thus she can recover planes while simultaneously launching others over the bow, without danger of collisions (pages 430-31).

Always, during daytime launches and recoveries, two rescue helicopters fly alongside the vessel. The jet pilots call them "angels." They would fish pilots out of the water in case of mishap. During night operations, when helicopters are grounded, trailing "plane-guard" destroyers perform the same function.

Enterprise's pilots had but one emergency landing in their first 1,000. A jet approached with only one landing wheel down. The landing officer waved the pilot off, and he circled above while the crew on deck swiftly erected a tall barrier of strong nylon webbing.

Then the pilot came in and flew into the net like a child running to the arms of its mother, and all was well except that the smothering net damaged the plane's wingtips. Everything went calmly; no one showed any undue excitement.

Once I asked *Enterprise's* skipper, Capt. Vincent Paul de Poix (page 435), how he was able to stand the feeling that he was solely responsible for such a tremendous ship and so many lives.

He seemed genuinely surprised at such a question. He said he had spent a lifetime training for the job, that he just did the best he could and didn't worry about it. He also said that he had a great many people to help him, and noted that many of his crew had spent months in the Idaho desert operating a prototype of *Enterprise's* engineering plant, including reactors.

Old Tradition Clings in Nuclear Navy

When I left *Enterprise* in southern Europe, I thought I had seen all her marvels, or at least all I was going to be permitted to see. I knew every corner of a flight deck big enough to hold our new ten-story, half-block-long National Geographic headquarters building in Washington, D. C.—and three football fields as well.

I had closely examined a rather large radio tube, one of a million or so electronic spare parts the ship carries—but this tube cost $25,000.

I had ridden flight elevators that would hold a house, including the lot and an automobile.

I hadn't seen everything. Waiting for a boat to take me ashore, I ran out of cigarettes and asked a sailor for one.

"Sure," he said, and took the pack out of his socks. On *Enterprise*, as on John Paul Jones's *Ranger*, sailors' trousers still have no pockets.

THE END

For other articles on nuclear-powered vessels, see, in the NATIONAL GEOGRAPHIC: "Submarine Through the North Pole" (*Nautilus*), by Lt. William G. Lalor, Jr., January, 1959; "Up Through the Ice of the North Pole" (*Skate*), by Comdr. James F. Calvert, July, 1959; "*Triton* Follows Magellan's Wake," by Capt. Edward L. Beach, November, 1960; and "*Savannah*, World's First Nuclear Merchant Ship," by Alan Villiers, August, 1962.

Our Nuclear Navy

By ADM. GEORGE W. ANDERSON, JR., USN

Chief of Naval Operations

JANUARY 17, 1955, marked the opening of a new frontier for the U. S. Navy, for on that memorable day Comdr. Eugene P. Wilkinson, Commanding Officer of U.S.S. *Nautilus* (SSN-571), flashed his brief but historic message to President Eisenhower, "Underway on nuclear power." Since that day, achievements in adapting nuclear propulsion, first to submarines and then to surface ships, have been little short of miraculous.

Navy Cruises Under Polar Ice

Vivid are the memories of *Nautilus's* first and second voyages under the North Pole and those of *Skate*, *Sargo*, and *Seadragon* to and through the Arctic Basin. Equally dramatic was the submerged circumnavigation of the world by *Triton*, an 84-day voyage which approximated the historic route of Ferdinand Magellan more than 400 years ago.

Of tremendous importance to the security of our country was yet another long submerged patrol—that of our first Polaris submarine, *George Washington*. Her 67-day cruise beneath the surface successfully concluded our efforts to marry the missile with nuclear power. The *George Washington's* launching tubes carried 16 missiles as an eloquent example of our deterrent and retaliatory force. Many of these feats by submarines have been dramatically documented in this publication.

Within this past year, two nuclear-powered surface ships joined the fleet. The first of these was the cruiser *Long Beach*, our first cruiser to be built since World War II. Shortly thereafter she was joined by the mighty *Enterprise*, whose engines generated more shaft horsepower during her early sea trials than any other ship ever to sail the seven seas. Late in 1962 the frigate *Bainbridge* was placed

The author, Adm. George W. Anderson, Jr., Chief of Naval Operations, examines the models of two nuclear warships. Sleek *Lafayette* (left), launched in 1962 as the Navy's 32d nuclear submarine, carries Polaris missiles and can cruise for weeks underwater. Work began in February on the *Bainbridge*-class frigate at right. Admiral Anderson, a 1927 Naval Academy graduate and an aviator, has decorations from the United States, Great Britain, Nationalist China, Portugal, Greece, Brazil, France, and Chile.

KODACHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER ROBERT F. SISSON © N.G.S.

in commission and ultimately will become a part of our first nuclear task force.

To those who have made possible this new means of propelling ships through and under the water, everlasting credit shall be due. *Nautilus's* first successful voyage opened new horizons for those who take ships to sea, just as Astronaut John Glenn's three orbits of the earth opened new horizons in space.

Those of us responsible for developing the finest Navy possible are convinced that the future with regard to adaptation of nuclear power to our ships is virtually unlimited.

However, we find ourselves now in much the same position as so many others who have pioneered the fields of science and industry. We foresee the tremendous potential of nuclear power, just as others before us understood the future possibilities of their own projects. Yet even though we have successfully adapted nuclear power to ships of a certain size and type, we recognize that many problems must be solved before we can have a fleet that is predominantly nuclear powered.

In fact, the over-all impact upon our Navy of the atom and its attendant problems perhaps can be compared to an iceberg, which hides $^{7}/_{8}$ of its mass beneath the waves. Although there is remarkable tangible evidence of the success of our nuclear program, the difficulties we face in our efforts to further this program are not nearly so obvious.

Costs Limit Number of Nuclear Ships

The first and greatest problem is cost, a factor to be considered in these days when there are so many demands upon our country's economy. Were it possible simply to substitute a nuclear power plant for a steam or diesel plant at equal cost, there would be many more nuclear ships in the Navy today.

To build a nuclear ship and to operate it for its estimated 20-year life span presently costs $1\frac{1}{4}$ to $1\frac{1}{2}$ times as much as for a conventionally propelled ship. Taken by itself, this factor may seem relatively insignificant. But when we talk in terms of large numbers of ships, it becomes highly important.

A second problem to which we are devoting much time and effort is that of reducing the size and weight of nuclear reactors, while at the same time increasing their unit power. Great strides have been made in lengthening the life of the cores of our power plants, but we do not yet have in operation a plant which is adaptable to a ship the size of a destroyer escort or to others of our smaller but still vitally needed ships. This is much the same problem faced by those who ultimately arrived at an efficient adaptation of gasoline and diesel engines to automobiles and trucks; for them, too, it was a long, slow process.

Highly Trained Crews Required

Still a third and equally important problem we must solve is that of the educational and training requirements of those who must operate and maintain a nuclear power plant. Whereas one year of training may be required to prepare an officer or an enlisted man to operate a steam-powered plant, more than twice that amount of training is required to prepare one to perform comparable duties in a nuclear-propelled ship.

In addition, not all or even a greater portion of those who wear Navy blue possess, when they enter the Navy, the educational qualifications and scientific interest required for a nuclear-ship sailor. We will face severe limitations in this area, and we will not always find it easy to procure and train crews for our nuclear ships. Better education and improved training, therefore, become of greater importance than ever before.

For these reasons we must proceed with great care in the development of a nuclear Navy. I personally have no doubt that progress in this field within the immediate future will be even greater and more exciting than it has been during this past decade.

The unquestioned advantages of nuclear power are manifold, and certainly will be adapted for many other purposes than for propelling the ships of our Navy. Yet, although the future definitely is most promising, we sincerely believe that it is in the best interests of our country and the Navy to move ahead in this area with *deliberate* speed.

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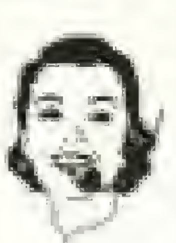

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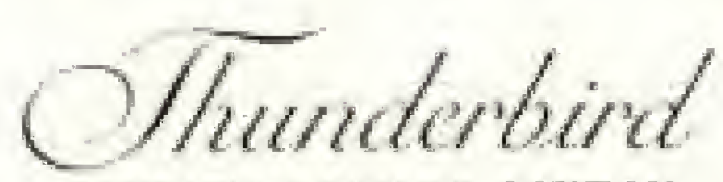

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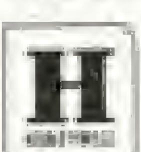

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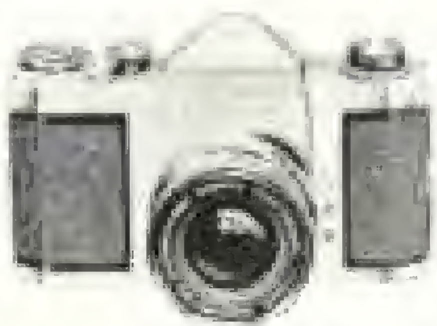

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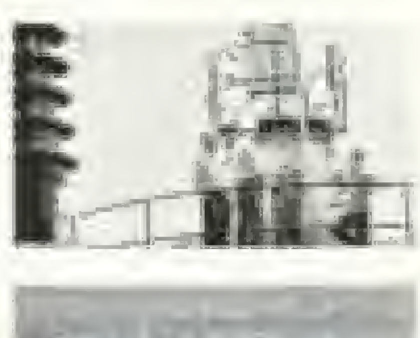

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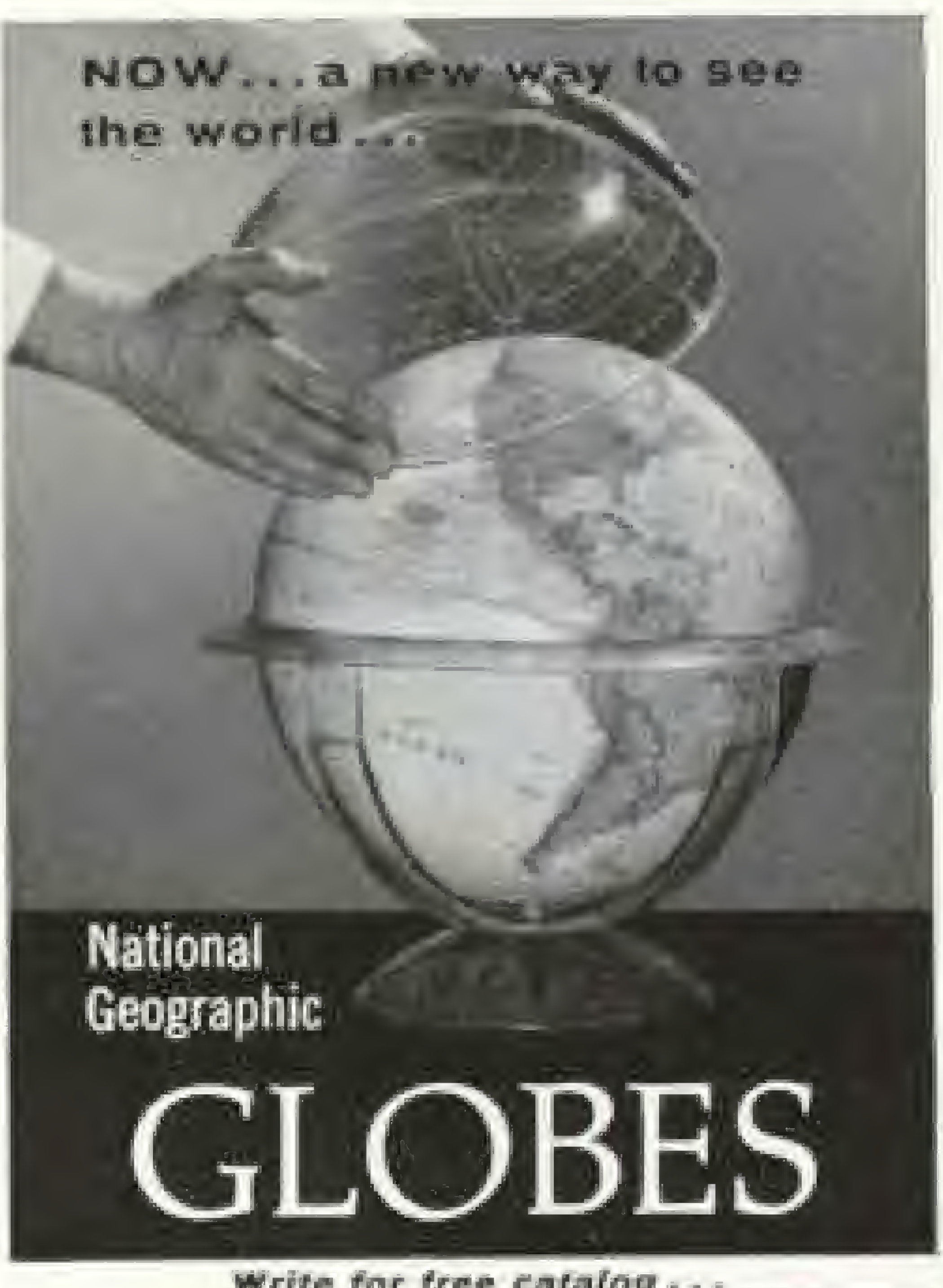

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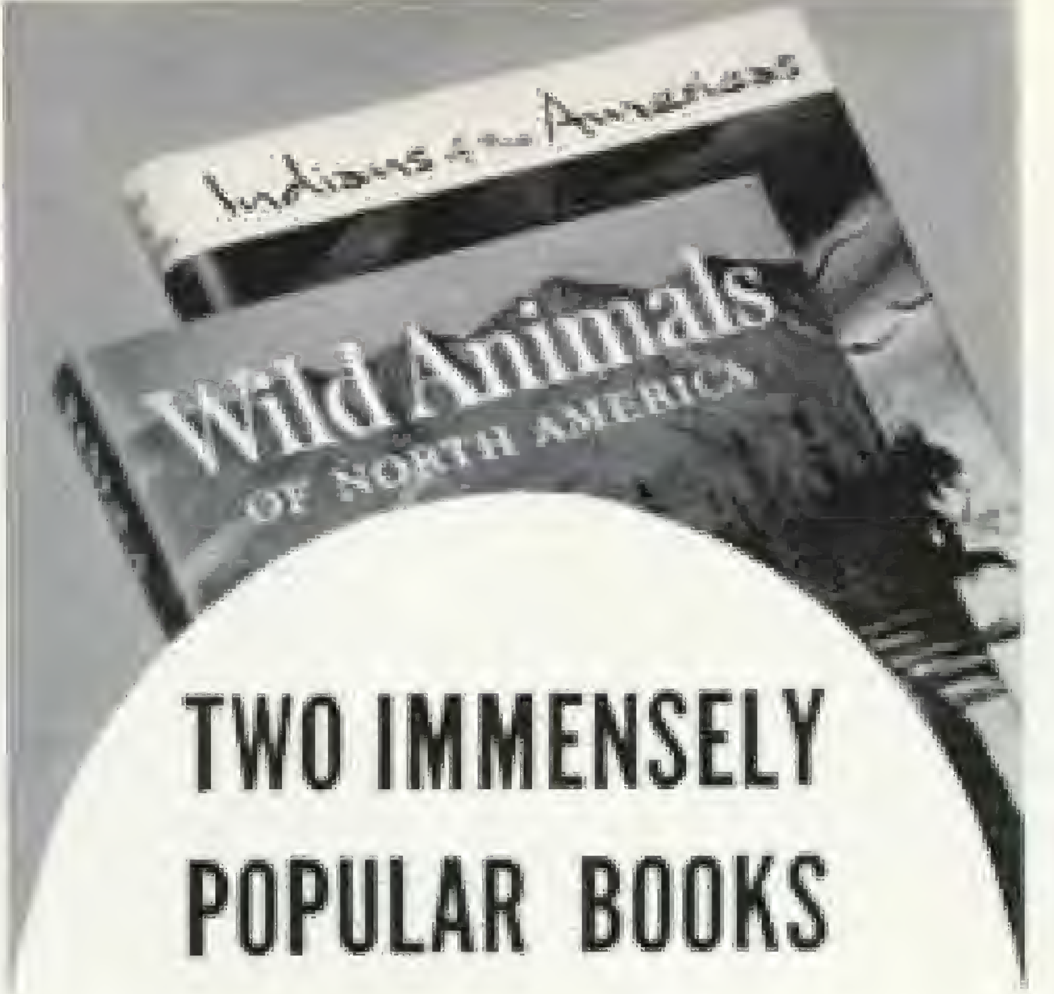

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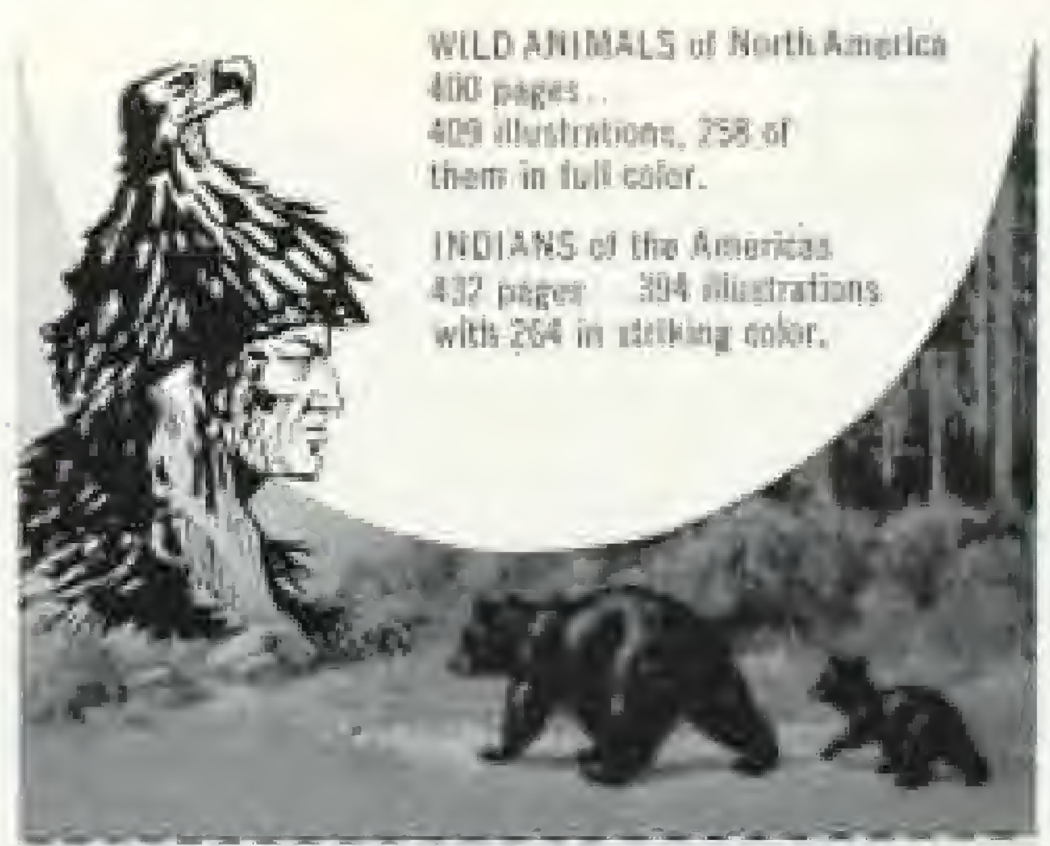

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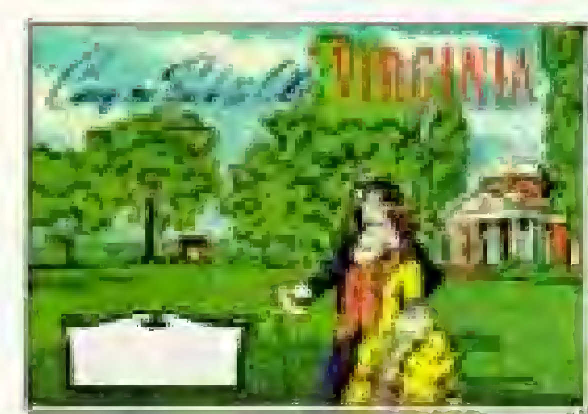

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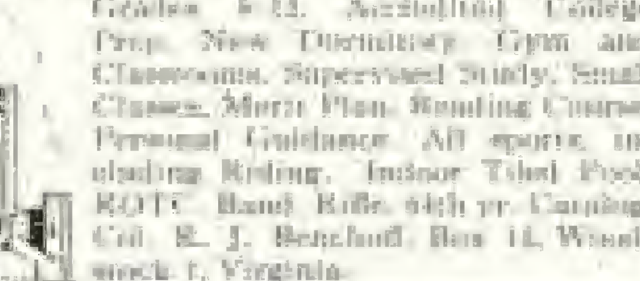

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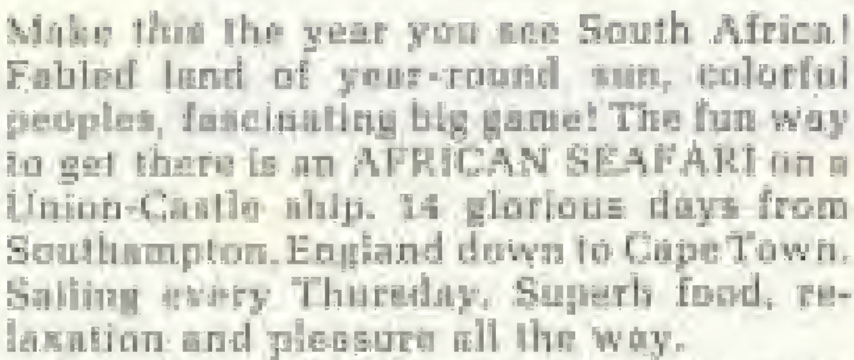

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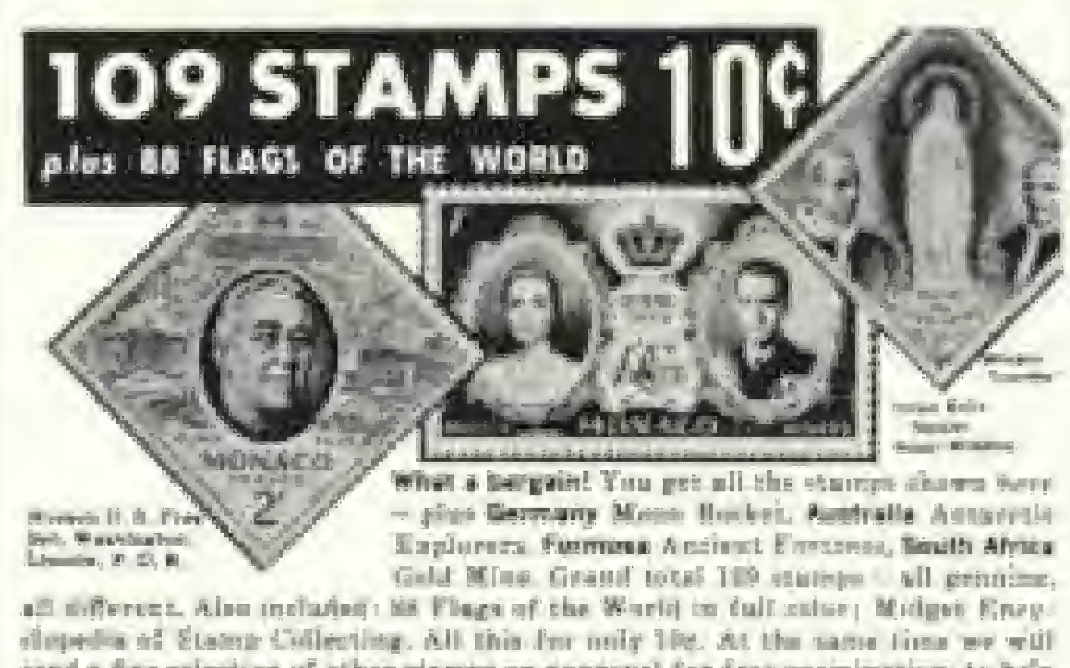

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THE Bell System is cables and radio relay and laboratories and manufacturing plants and local operating companies and millions of telephones in every part of the country.

The Bell System is people . . . hundreds of thousands of employees and more than two million men and women who have invested their savings in the business.

It is more than that.

The Bell System is an idea.

It is an idea that starts with the policy of providing you with the best possible communications services at the lowest possible price. But desire is not enough. Bright dreams and high hopes need to be brought to earth and made to work.

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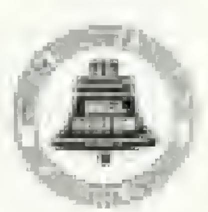
You could have all the separate parts of the Bell System and not have the benefits of all those parts fitted together in a nationwide whole.

It's the time-proved combination of research, manufacturing and operations in one organization—with close teamwork between all three—that results in good service, low cost, and constant improvements in the scope and usefulness of your telephone.

No matter whether it is one of the many tasks of everyday operation—or the special skills needed to invent the transistor, the solar battery, or, with Telstar, to pioneer space communication—the Bell System has the will and the way to get it done.

And a spirit of courtesy and service which has come to be a most important part of the Bell System idea.

BELL TELEPHONE SYSTEM 

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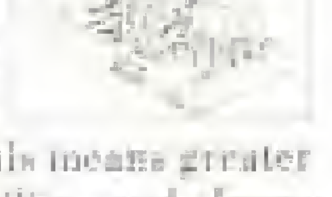
Zenith Color TV is Handcrafted. (TV servicemen know this is *truly* a major advantage in color television!)

Every chassis connection in a Zenith is hand wired and hand soldered. There are no printed circuits . . . no production shortcuts. This means greater operating dependability and fewer service problems.



For longer TV life and superior picture reception—even in weak signal and fringe areas—every Zenith Color TV has the exclusive Gold Video Guard Tuner. It has 104 16 carat gold-filled (*not* gold-plated) contact points. They will not oxidize or wear out for the lifetime of the set!

For the finest color reception, Zenith's Electronic Color Brain gives you beautifully clear, true-to-life colors. For black-and-white telecasts, Zenith has developed a special Color Cut-off. It automatically locks out *all* the color to give you brilliant black-and-white reception.

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ZENITH

The quality goes in before the name goes on

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