ATLAS MAP SUPPLEMENT: SOUTHEAST ASIA

VOL. 119, NO. 5 MAY, 1961

NATIONAL GEOGRAPHIC

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

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COVER: *Balinese girls balance mounds of fruit and flowers for temple gods (page 603).*

Watches featured: Upper left, T-400, $95. Lower left, Sea-Lectric II, $100. Right, Boatswain II, $65. Hamilton Watch Co., Lancaster, Pa.
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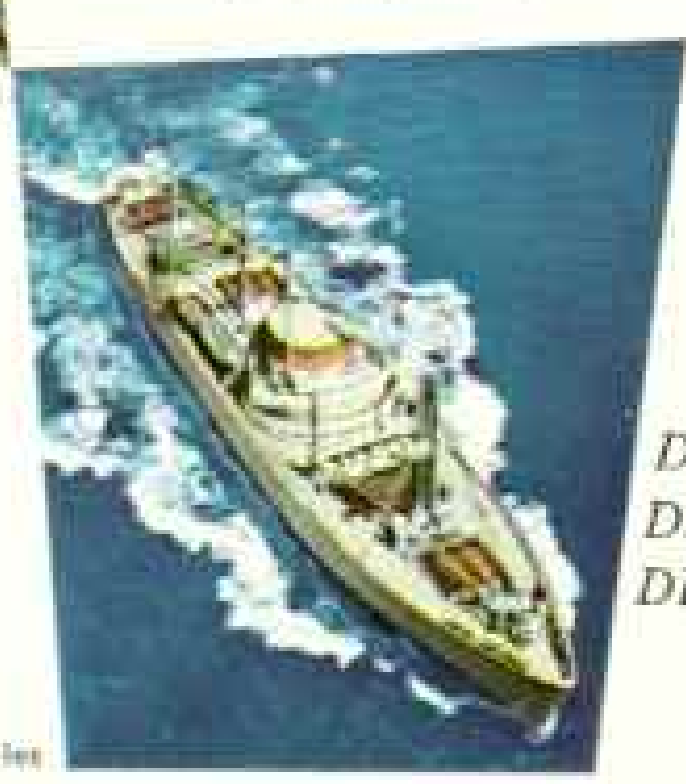

Route of the Liners

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THE GEOGRAPHIC MEETS A CHALLENGE IN MAPPING SPACE

Staff artist John Lothers pondered a problem: how to depict the paths of all 17 man-made satellites circling the earth as 1961 began.

Lothers (left) asked the Geographic's specialist on cartographic puzzlers, Wellman Chamberlin, for aid. Could he make a model showing the satellites in orbit?

Two days later, from his 18th-century home in the Virginia countryside, Chamberlin brought in this strangely festooned globe. Its intermeshing wire hoops, crisscrossing like balled twine, traced the tracks of all U. S. and Soviet satellites then in the skies. Using the model as his guide, artist Lothers set to work; he added orbits as both nations hurled new rockets into space. His remarkable painting on pages 716–17, up to date as of February 15, 1961, depicts eighteen American and five Russian vehicles, including four that now swing in orbit around the sun.

A brilliant cartographic engineer and one of the most inventive map makers of our time, Mr. Chamberlin has thrived on geographic posers for 26 years. The Chamberlin Trimetric Projection, a way to map whole continents with minimum distortion, has been used by cartographers the world over. His National Geographic Satellite Tracking Kit, developed for astrophysicists of the Smithsonian Institution, brings space problems down to earth with a combination of maps and transparent overlays.

Chamberlin carries our National Geographic aims—to simplify geography, to turn the well-worn, complicated formula into a new, uncomplicated tool. You and your friends may share in this exciting approach to the Space Age. Simply use the form below.

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And Torsion-Aire has the perfect partner in optional Constant Control Power Steering. It works full time so you scarcely work at all in parking, cornering, and cruising on the road.

And, of course, all these wagons have a wagonload of other family-pleasing features. See your dealer for the details.

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Rear-facing third seat, in 9-passenger models, keeps kids out of your hair.

One-piece tailgate. Easy to open; easy to load and easy to get into and out of.

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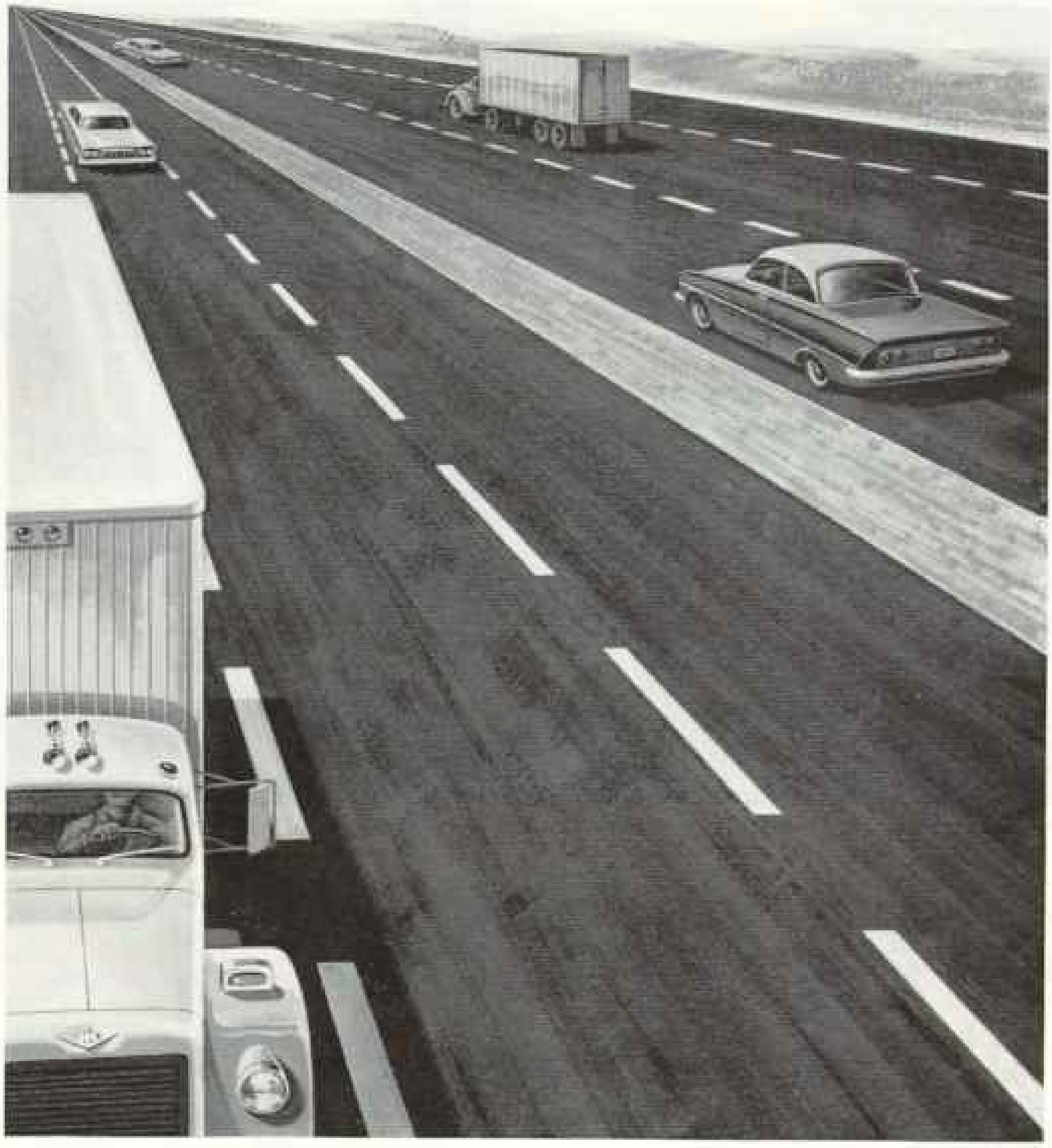

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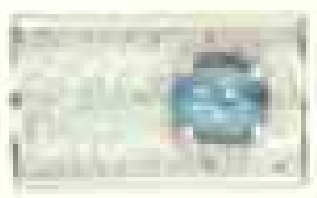

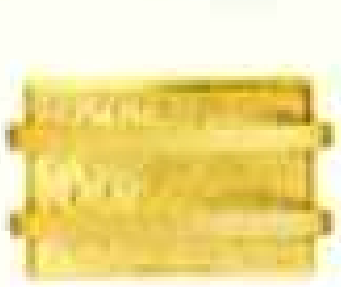

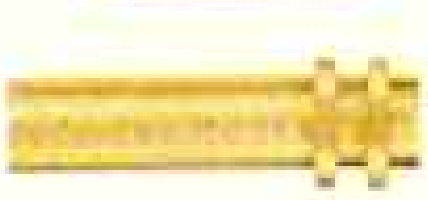

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Above right: Large cultured pearl. Earrings $15 Necklace $17.50 Dogwood motif. Earrings $12.50 Necklace $13.50 Circle Brooch $6.50 Double Circle Brooch $8.50

Below left: Heart Brooch $11.50 Center: Brooch $12.50 Right: Pink rose motif. Earrings $15 Brooch $12 (prices plus tax)

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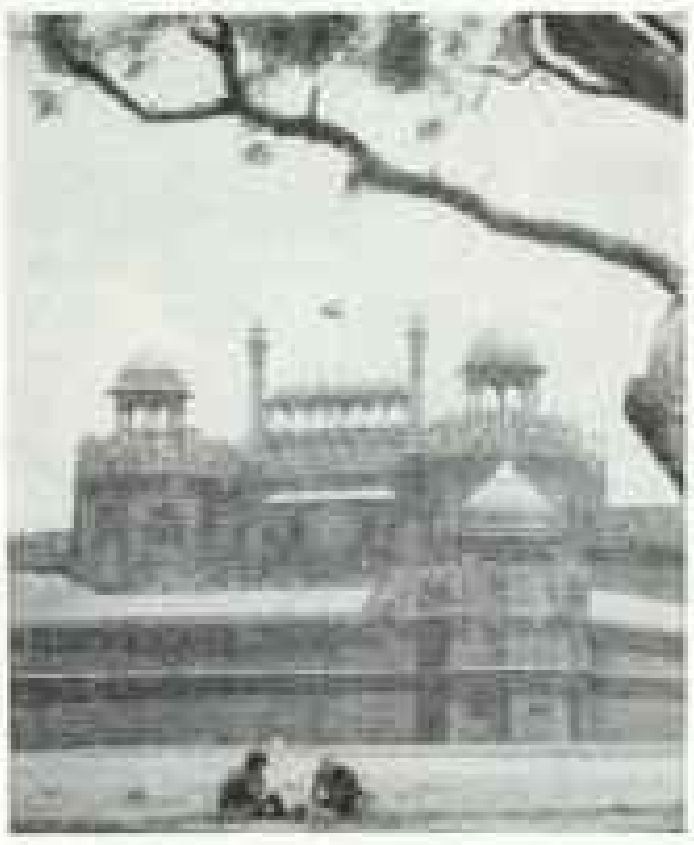

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Salvador Dali's Santiago El Grande, Beaverbrook Art Gallery in Fredericton, N. B., Canada. ▶

Why the Scallop Shells in Dali's famous painting?

Look closely at this monumental painting of St. James, at the Beaverbrook Gallery in Fredericton. On the chest of the Apostle's charger you see a scallop shell. In fact, the symbolic heavens surrounding the Saint are studded with shells.

In embellishing his painting with scallop shells, Salvador Dali let history and tradition guide his brush. For St. James is often depicted wearing the scallop shell. And this same emblem, the scallop, became the badge of pilgrims journeying to the Apostle's shrine in Compostela, Spain.

As a symbol of the pilgrimage or voyage or quest, the shell can be traced back to earliest times. It was identified with Venus, born of the sea. It was the badge of Crusaders to the Holy Land—symbol of their quest.

And today, as the name and trademark of the Shell Companies, the scallop shell remains a symbol of the quest.

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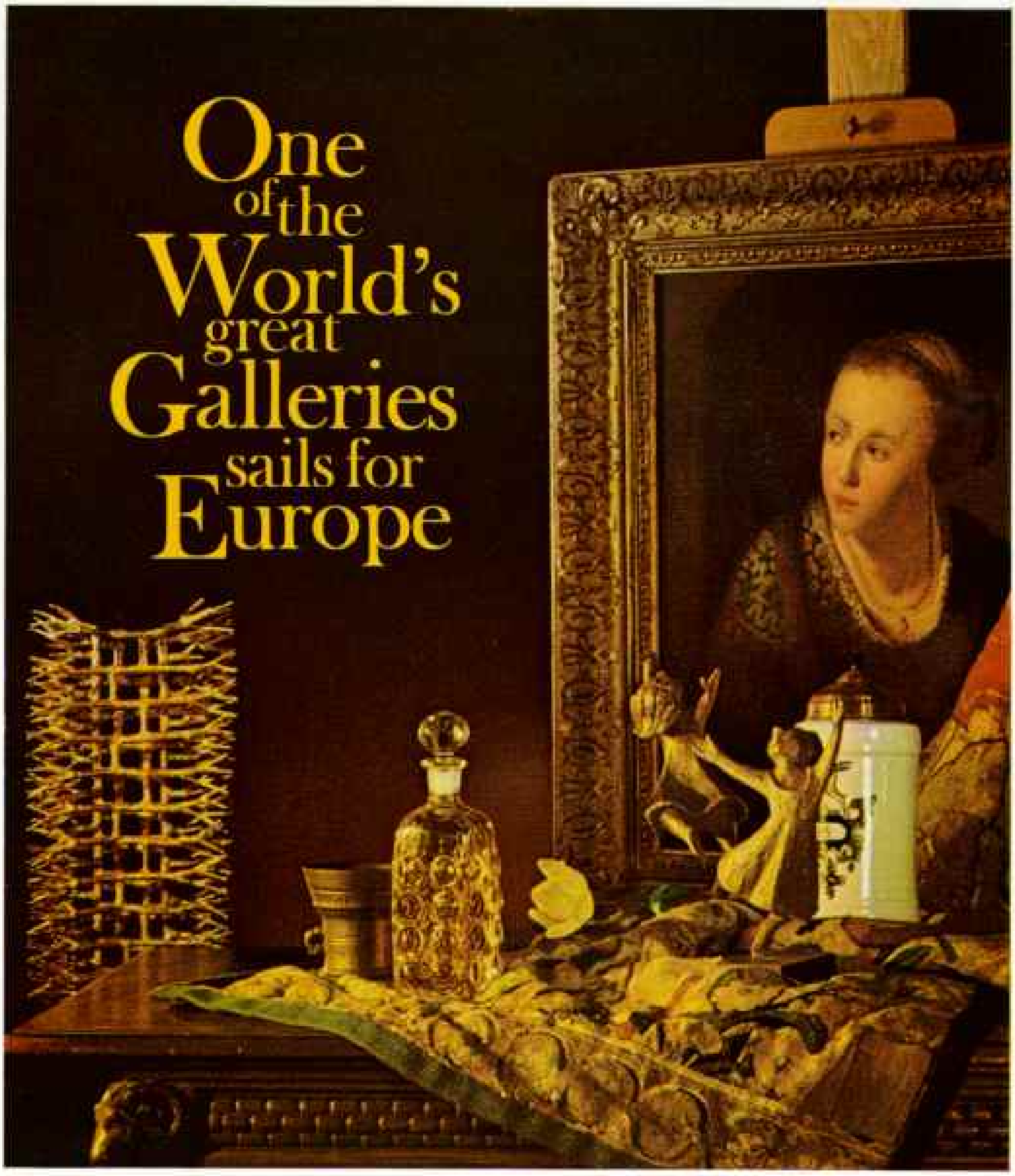

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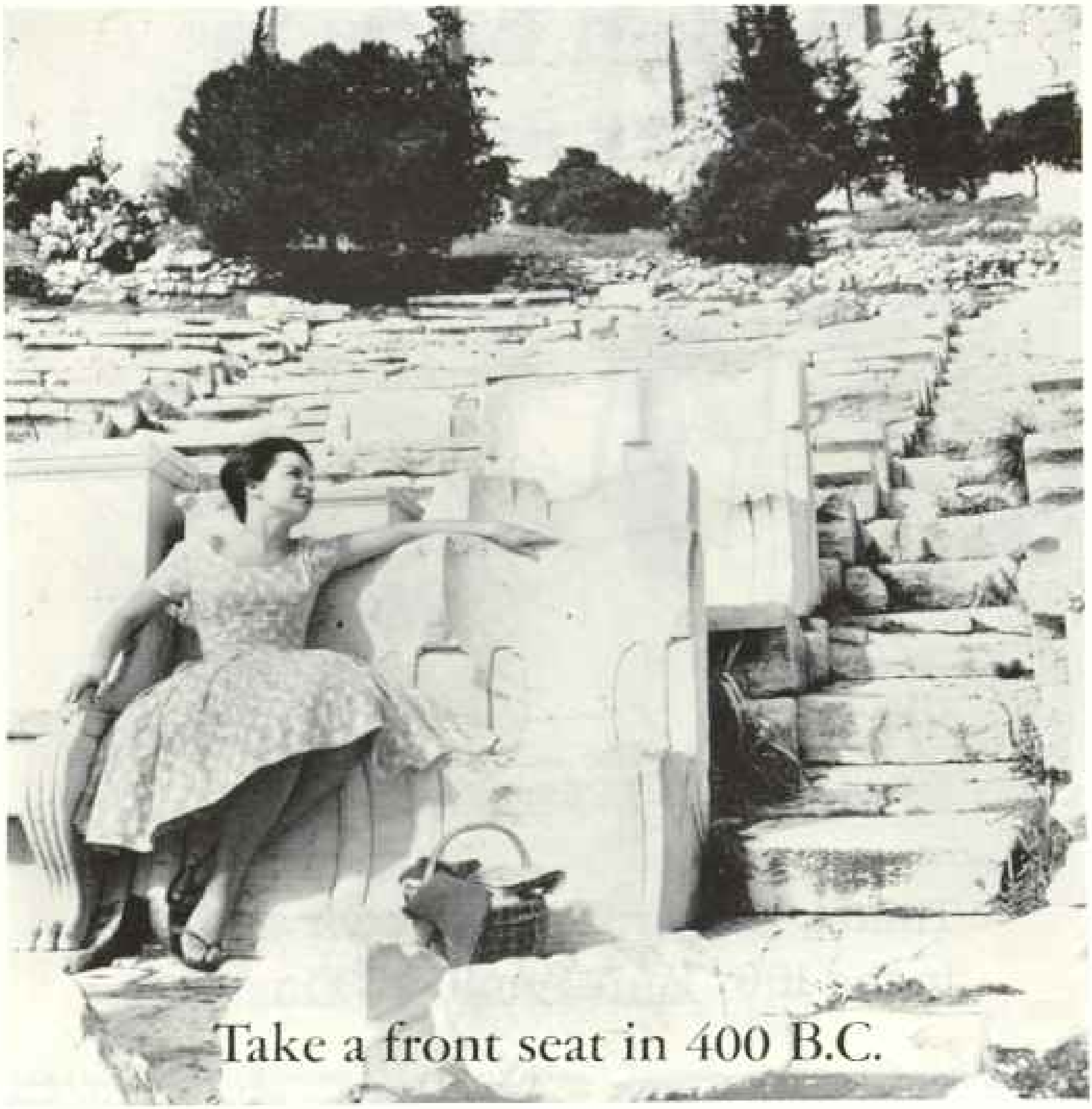

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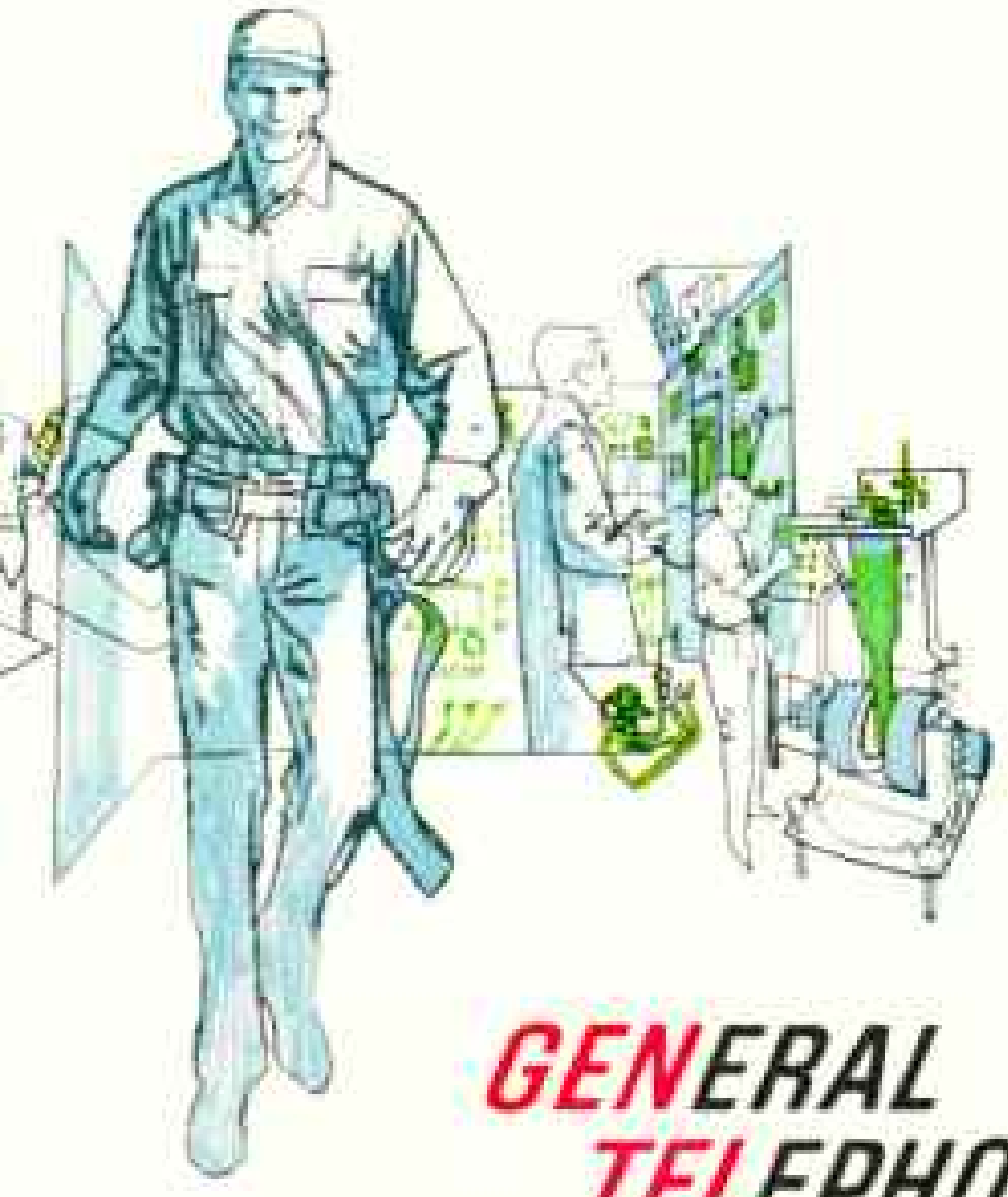

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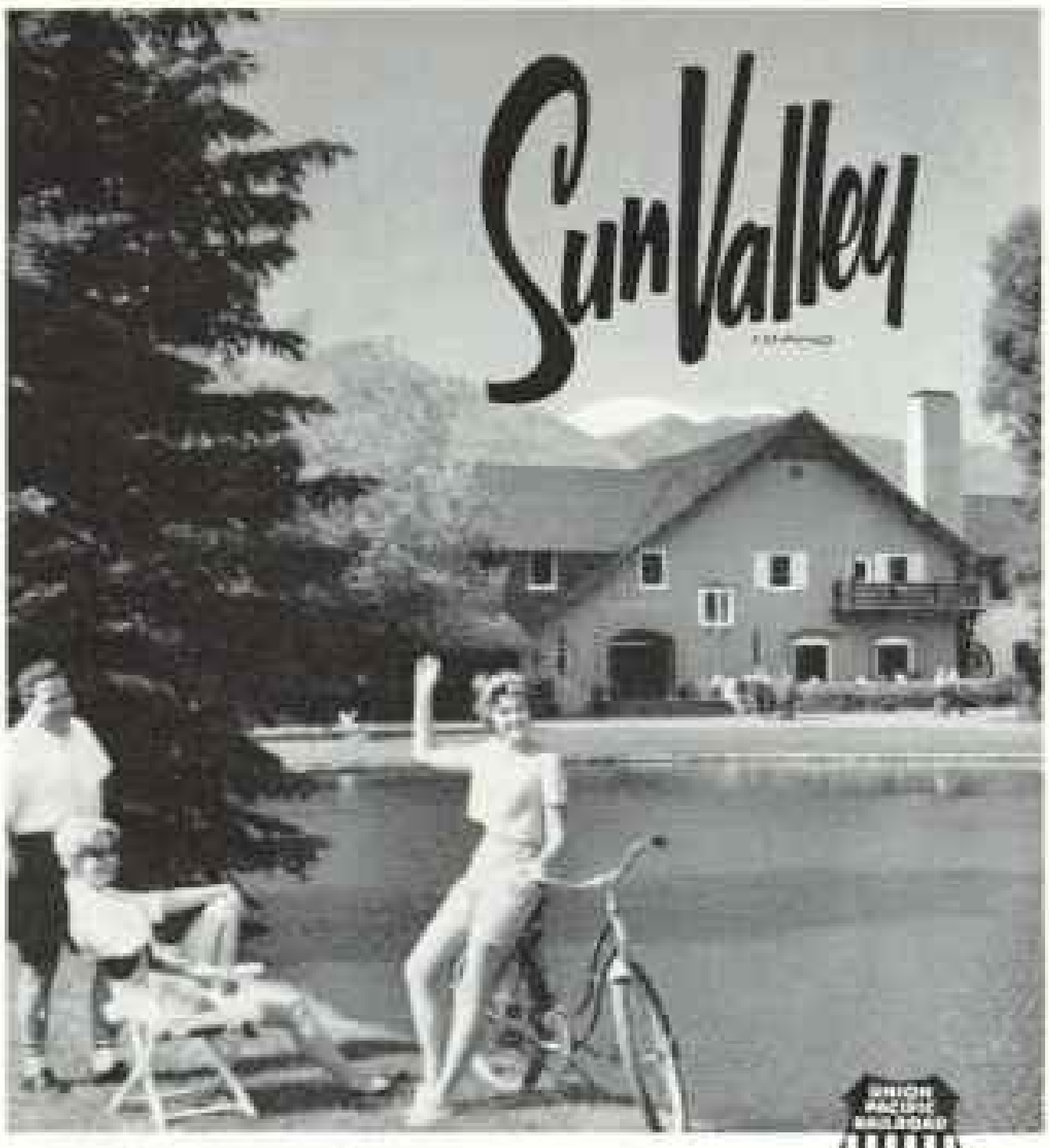

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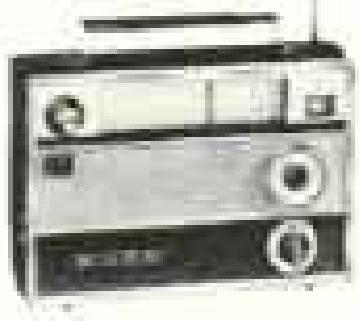

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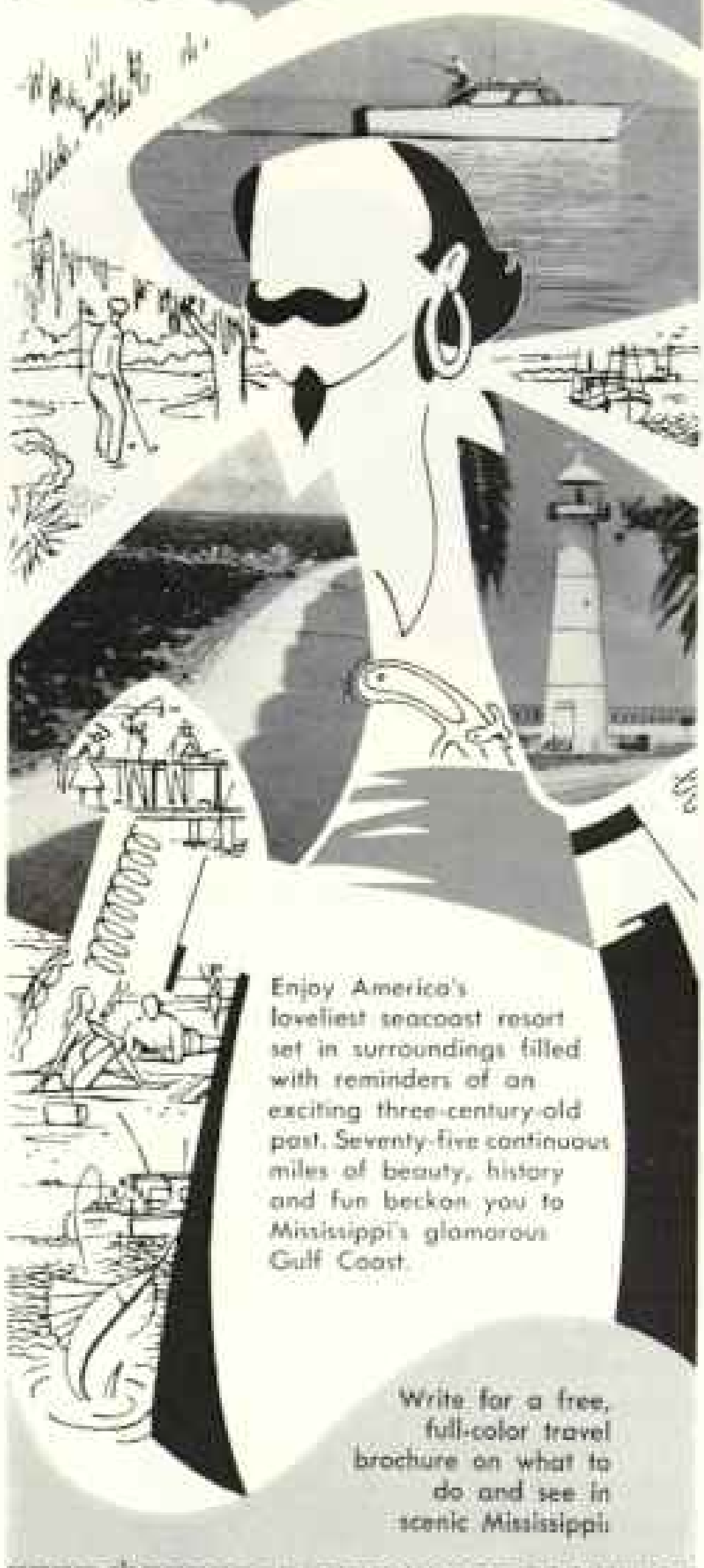

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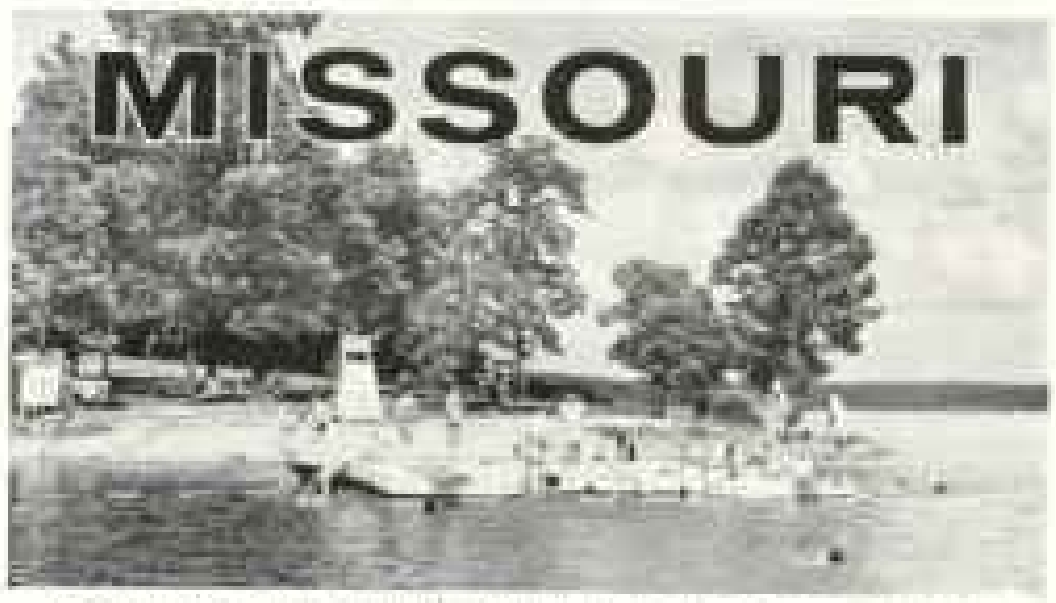

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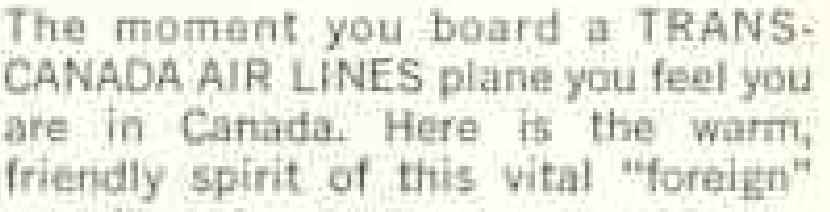

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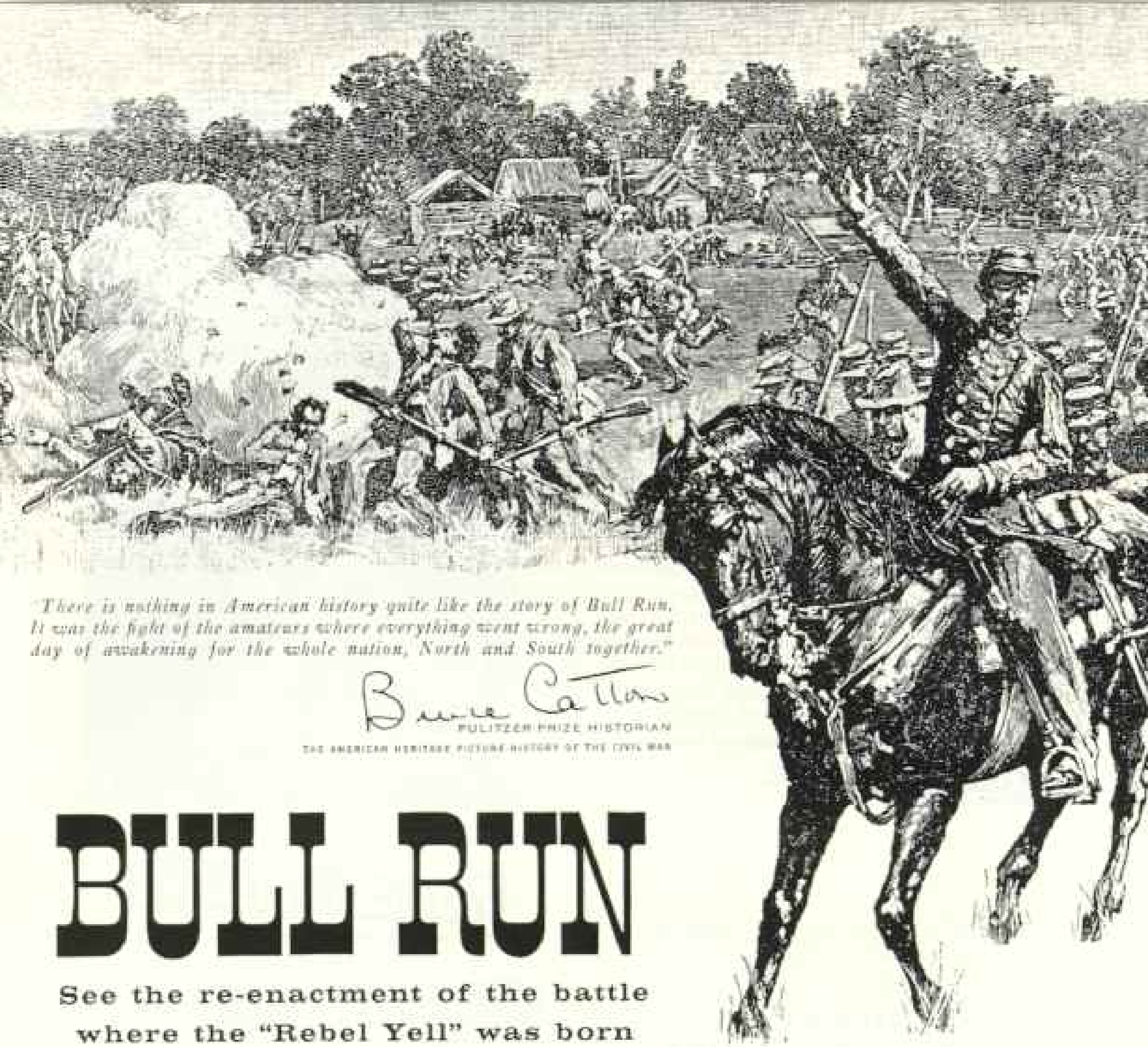

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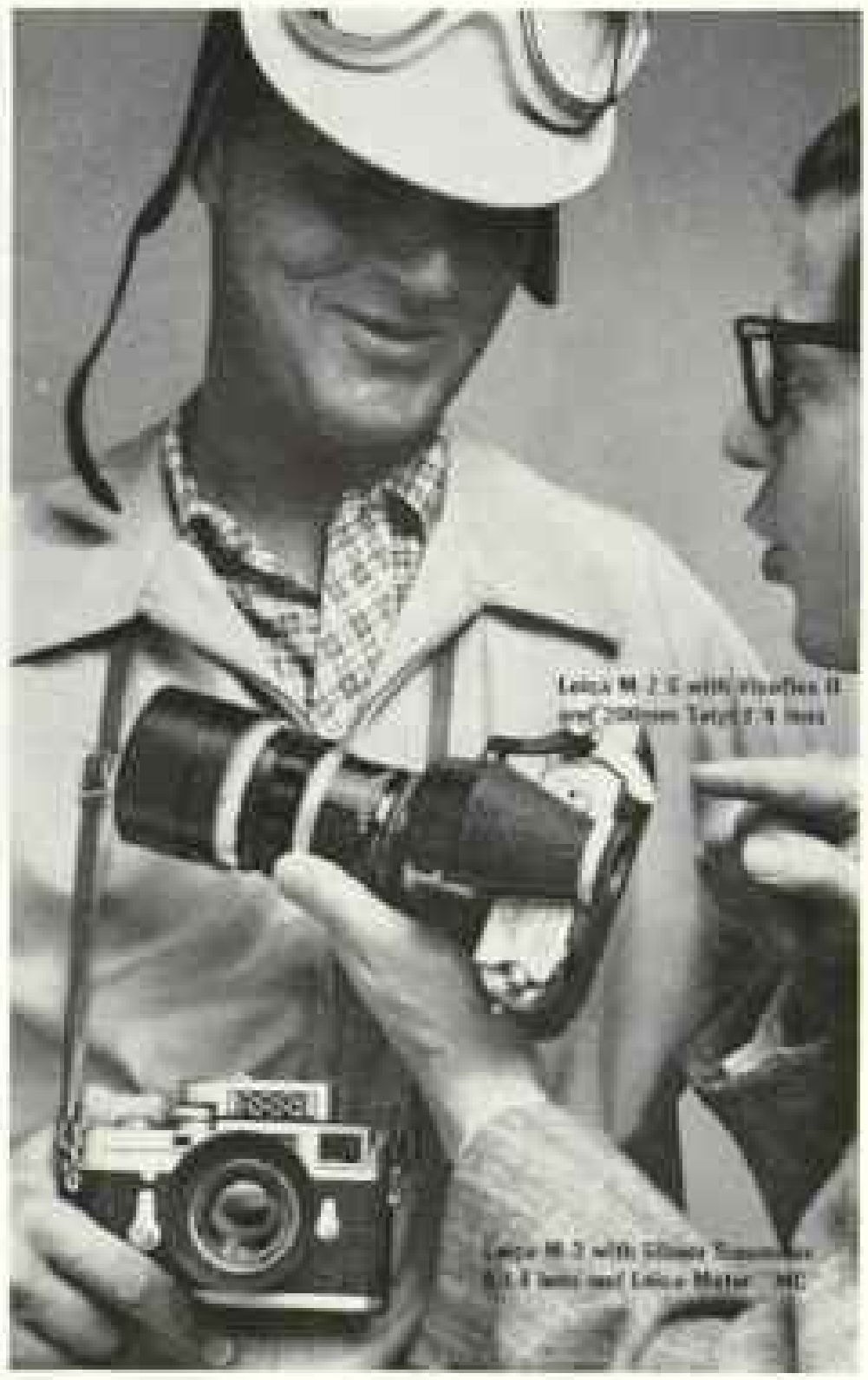

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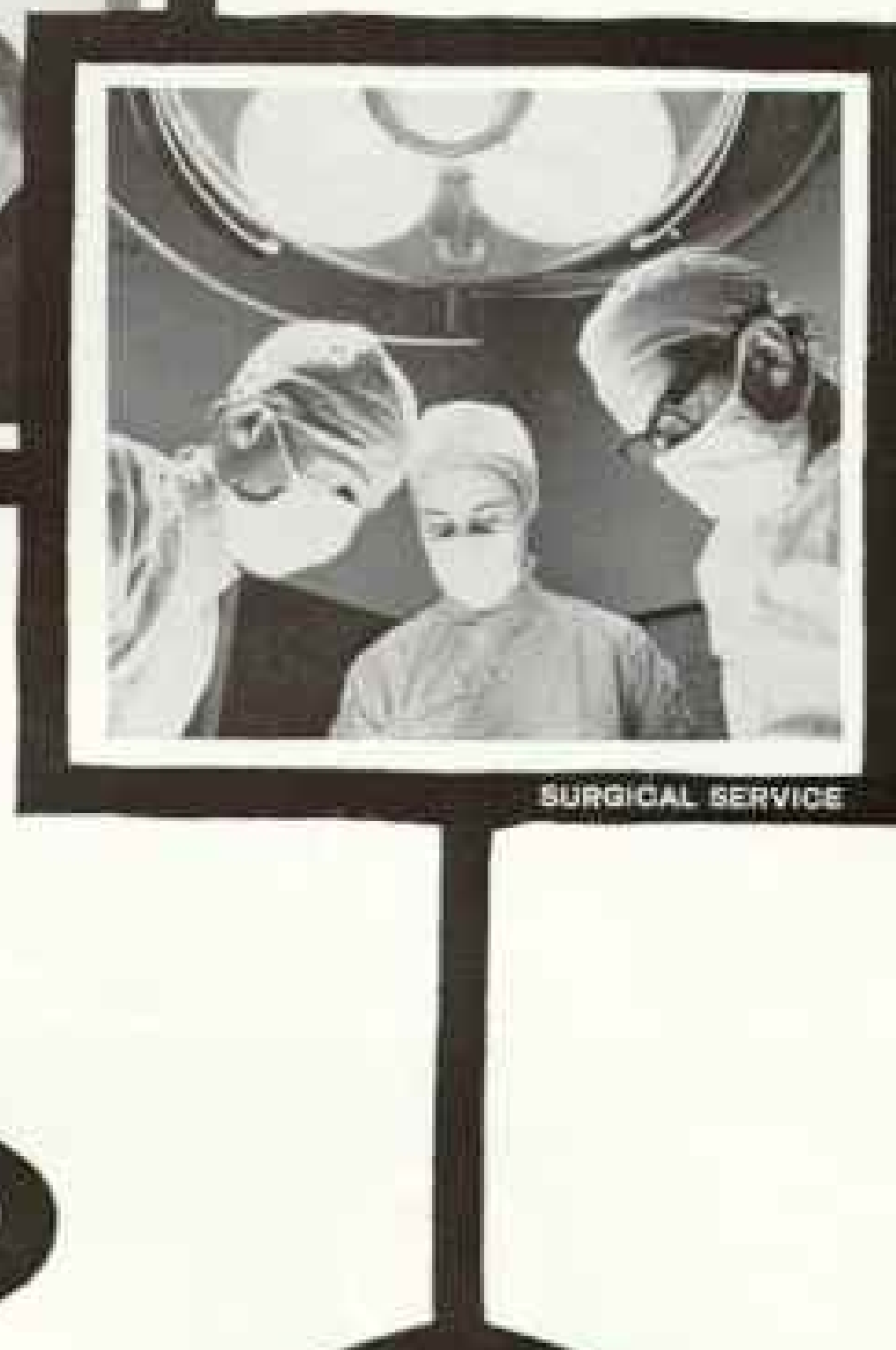

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THE NATIONAL GEOGRAPHIC MAGAZINE

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VOL. 119, NO. 5 MAY, 1961

Indonesia

THE YOUNG AND TROUBLED ISLAND NATION

East Indies republic of temples and 200 tongues achieves a victory in merely surviving its tumultuous infant years

ARTICLE AND PHOTOGRAPHS BY HELEN AND FRANK SCHREIDER

DJAKARTA'S TRAFFIC swarmed around us; I made my turn with more than usual caution.

Crack! A rifle flashed close by, and a cordon of soldiers materialized. In minutes we stood in the office of an army commandant.

"But all I did was make a wrong turn," I protested. "Your sentry could have blown his whistle—he didn't have to shoot!"

The commandant smiled in apology.

"Forgive us," he said, "but Indonesia is in a state of emergency. Even here in the capital, one sometimes shoots first and asks later."

He offered us chairs. "I'm glad you're all right, and your car, too." He hesitated. "It *is* a car, isn't it?"

Helen, my wife, laughed. "Half of it is, anyway. It's an amphibious Jeep. We call it *Tortuga*—Spanish for 'turtle'—because it's at home either on land or in the water.

"We wore out *Tortuga I* driving from the Arctic to South America. This is *Tortuga II*."

The commandant nodded. "I hope you and your turtle will enjoy our islands, and I'm sorry we gave you such a rough welcome. But perhaps it is better that you learn at once: Indonesia is a troubled country."

As we drove off past Djakarta's Freedom Square, I pondered the commandant's words. His is a troubled country indeed. But then it is lucky to be a country at all.

Indonesia's modern history begins with the close of World War II and the end of Japanese occupation. Determined to be free of foreign influence, the former Dutch colony—today comprising more than 3,000 islands and 92,000,000 people—proclaimed itself a republic on August 17, 1945, and resisted reoccupation by the Netherlands.

Four years of bitter negotiation and bloody warfare followed. No one knows what it cost in lives, but Indonesian estimates run to hundreds of thousands. At last, in December of 1949, the Netherlands relinquished all claims to the islands except for half of New Guinea.

Under President Soekarno, a veteran of the

The Authors: Helen and Frank Schreider were introduced to NATIONAL GEOGRAPHIC readers in an October, 1960, article on the Ganges River, "From the Hair of Siva." Vehicle for the young Americans' Indian odyssey was the same amphibious Jeep that now carries them across the stepping-stone islands of the Republic of Indonesia.

Joyful Indonesians on Mohammed's birthday bear symbolic rice mountains toward

KLEIN AND HUBA SCHNEIDER © NATIONAL GEOGRAPHIC SOCIETY

a mosque in the Javanese city of Jogjakarta. Paraders believe offerings bring luck

revolution (next page), the new nation took its first halting free steps. They were almost its last. Divisions and jealousies among the major islands fostered civil war. Local militias and armies of bandits kept government troops constantly busy.*

The new government settled the major rebellions, but strife persists. In more than a year of travel through Indonesia, we found few islands that did not have underground groups or antigovernment forces.

President-Prime Minister Soekarno himself recently told the national legislature:

"The greatest achievement of the Republic of Indonesia is that we have survived."

World Watches Rich and Vital Land

Helen and I had many questions about our tour. How would *Tortuga II* fare, for example, island-hopping an archipelago spread over an area half the size of the United States? How well would our study of the new national language, Bahasa Indonesia, serve us when the islanders speak 200 dialects?

Yet we were eager to start—to put *Tortuga* and our tongues to the test. For many reasons Indonesia is of vital interest to the world today: because of its bountiful natural resources, because strategically it links Asia and Australia, and because politically it has a strong voice in the Afro-Asian bloc.

But it was going to be difficult to cover Indonesia's best-known islands, Java, Sumatra, and Bali, for NATIONAL GEOGRAPHIC. Guerrilla warfare and banditry were reported almost daily. For a beginning, we turned to the Indonesian Government in Djakarta.

Despite a boom in construction, the capital has a housing shortage. From a tiny 17th-century Dutch East India Company trading post called Batavia, the city has grown to a metropolis of nearly 3,000,000 people. It is a kaleidoscopic mixture of squatters' shacks, housing developments, and soaring new office buildings. Rush-hour traffic is all but paralyzed; bicycles, automobiles, and *betjaks*, the three-wheeled pedicabs, jam streets.

Hotels, of course, were jammed beyond hope. Helen and I gratefully accepted the hospitality of Mr. Mohasson of the Ministry of Information.

Mr. Mohasson—like many Javanese he used only one name—lived in the former Dutch residential district.

"I hope you won't mind sharing a room with our two children," he apologized. "We're a bit crowded, but we're lucky to have a house at all."

The room was tightly shuttered because night air is considered unhealthy. The beds were bright with embroidered sheets and draped with mosquito netting.

After a refreshing *mandi*—an Indonesian-style bath of lukewarm water sloshed over the body—we were called to supper by Mrs. Mohasson, a petite woman with that delicate Javanese charm we came to know so well.

Indonesian Sauce—Red Hot!

"We want you to try Indonesian food," she said, heaping our plates with steaming *saté*, a miniature kebab; flaky chips of *kroepoek*, ground shrimp; *gado-gado*, a vegetable dish with peanut sauce, and mounds of boiled white rice.

"The food is not spicy enough," she advised us. "You must add your own *sambal*, our Indonesian pepper sauce."

Both Helen and I like hot food, and I used the sambal liberally. The result was as explosive as the eruption of Krakatau, Indonesia's famous volcano. Blinded by tears, I groped for the tea in a frantic effort to put out the fire.

(Continued on page 585)

*For accounts of Indonesia in this trying period, see, in the NATIONAL GEOGRAPHIC: "This Young Giant, Indonesia," by Beverley M. Bowie, September, 1955; and "Republican Indonesia Tries Its Wings," by W. Robert Moore, January, 1951.

Umbrella Hat Shades a Rice Harvester Against Java's Tropic Sun

Successor to the Netherlands Indies, the Republic of Indonesia ranks as Southeast Asia's biggest, most populous nation. Its 92 million people, representing a dozen ethnic groups, spread across some 3,000 equatorial islands. Two-thirds squeeze into Java, making it one of the world's most densely populated areas.

Though a field worker, this woman of the Puntjak area wears jewelry, lace blouse, and wide bamboo *chapil*. When she cuts the grain, she conceals a knife in the palm of her hand to avoid offending the rice goddess. Her caution stems from an old belief that rice possesses a soul, without which it lacks power to germinate.

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

From teeming Djakarta, Indonesia's capital, the authors began their tour. *Tortuga II*, their amphibious Jeep, parks by a downtown canal, where modern billboards and motor traffic meet Djakartans using the sluggish waters in traditional way as bath and laundry.

President Soekarno addresses an opening session of Parliament. Eaglelike *garuda*, the republic's coat of arms, spreads its wings above the rostrum.

Black cap worn by Soekarno in public appearances symbolizes Indonesian nationalism.

AN EASTMAN KODAK © NATIONAL GEOGRAPHIC SOCIETY

"It adds a little something, doesn't it?" asked Mrs. Mohasson modestly.

Later, sitting in rattan chairs in the comfortable living room, surrounded by planters of orchids and wall hangings of hand-woven cloth from various islands, we discussed our travel plans. In his gentle way, Mr. Mohasson warned us that, despite endless preparations and two years of correspondence with the government, we might be delayed in leaving Djakarta.

Barriers Melt at Social Gatherings

He was right. In the weeks that followed we saw every corner of the city, from the teeming Chinese Glodok section to the new Kebajoran residential area, where many American State Department families live. It was August, the month of Indonesia's Independence Day celebration, and our application for travel and photographic permits made little progress. But as the banners and streamers came down, we resumed our peregrinations through government offices.

Finally we discussed the matter with a friend, Col. Ray Cole, U. S. Army attaché. His reply was casual:

"Let's see what we can do at a party or two." Thus, "business" hours abruptly changed from

Good triumphs over evil in the *wayang kulit*, an Indonesian shadow play (below). The *dalang*, or puppeteer, intones the story while manipulating stick-mounted figures cut from buffalo hide. His flickering oil lamp casts lacelike shadows on the screen at bottom. Almond eyes and pointed noses distinguish beneficent puppets; bulging eyes and bulbous noses identify evil ones. This performance in Jogjakarta began after dark and lasted all night.

Epic heroes pose in the *wayang wong* —human puppets—a form of entertainment derived from the shadow plays. Actors simulate movements of the shadow figures, relying on stylized gestures to show emotion. They speak their lines with singsong monotony.

Photographed in Surakarta, this scene shows an episode from the Mahabharata, a Hindu epic poem. Performers with hornlike headdresses represent the Pandavas, divine brothers who warred with the jealous sons of Dhritarashtra. Glittering costumes reflect the court dress of early Java.

"Members of the audience seemed to know all the roles by heart," the authors say. "Though they were constantly moving around, eating, sleeping, and talking, they never lost the thread of the story. But we found it impossible to keep track of the characters, battles, and intrigues, though we remained glued to our seats."

AS SKETCHED BY HELEN AND FRANK SCHREIDER © NATIONAL GEOGRAPHIC SOCIETY

daytime to night as we accompanied Colonel Cole on a round of official receptions. Each night we met a different dignitary; soon we had all our permits, plus a dozen introductory letters. As we picked up the last one, a smiling Indonesian official said:

"What a pity we didn't meet five weeks ago. For friends, one does everything."

Tortuga Begins Her Wanderings

At last we were off. A few miles from Djakarta we pulled over to the roadside. For the first time we were away from the capital, and we needed a moment to grasp the change. Gone were the strident cries of the *tukangs*, the vendors who bring to your door everything from tropical fish to rare old Chinese porcelain. Gone the persistent clamor of betjak bells, the piercing police siren, the mysterious rifle shot in the night.

Instead of the mustiness of masonry, there was the fragrance of a frangipani; the southeast monsoon, that heavy breeze that brings little rain, rustled through groves of coconut palms that hid villages from the fierce sun. Instead of sluggish canals bearing sewage, we found streams flashing with bright sarongs and the golden skin of women bathing.

Gaily I shifted *Tortuga* into gear. Our pockets were full of permits: from the army—*Tortuga* would travel by land; from the navy—*Tortuga* would cross hundreds of miles of sea; from the air force—no, *Tortuga* couldn't fly, but her compass had been calibrated at the airport. Even Dinah, our German shepherd, had a travel permit! We were eager to be under way. In Java alone, larger than Pennsylvania, thousands of miles of road lay waiting (map, page 591).

As we neared the mountains, part of the chain of more than 400 volcanoes that reaches the length of the archipelago, another change became apparent. At Bogor, only 30 miles from Djakarta and less than a thousand feet higher, the temperature had dropped considerably. Beyond, the road climbed steeply toward 4,800-foot Puntjak Pass, leading to a weekend refuge for tired Djakartans.

Motorized traffic was light as we drove on, but hundreds of bicycles thronged the road.

BUDIACHARMAN AND HIS DETACHMENT (LOWER RIGHT) © NATIONAL GEOGRAPHIC SOCIETY

Women with baskets of produce on their heads cycled leisurely; soldiers, Sten guns slung from their shoulders, rolled in squads; children pedaled furiously to school.

The sight of the young scholars reminded us that since the war, Indonesia has nearly doubled its number of schools and quadrupled the number of teachers and students. The literacy rate has climbed from 7 percent to more than 50.

Fields Display Life Cycle of Rice

Flooded rice lands lay everywhere—in the valleys a patchwork of jeweled green, on the hillsides in stairstep terraces that glowed in the afternoon sun like panes of scarlet glass. In our drive we saw the whole cycle: heaving buffaloes plowing hock-deep in mud; women field workers, their immense hats floating like lily pads against the brown water; and the emerald crop itself.

Farther along, the ripened fields lay golden and heavy with bursting kernels and sprinkled with the bright confetti of harvesters' costumes. Deftly the women palmed their *ani-ani*, the small crescent-shaped rice knives, concealing them in order not to offend the rice goddess (page 582).

Always they laughed, for rice is life to Java, and harvest is a happy time.

For thousands of years the Javanese have depended on irrigated rice, but now the

Wheel to wheel, cyclists cruise the streets of Bandung. Bicycles abound in Indonesia; only the most fortunate ride motorbikes. Hotel Savoy-Homann rises in layered floors beside a busy intersection. In 1955 twenty-nine Afro-Asian nations met in Bandung to discuss world problems.

Future engineers survey the campus of the Institute of Technology in Bandung. President Soekarno earned a civil-engineering degree here.

Bandung youngsters study Bahasa Indonesia, Malay-based official language. To combat illiteracy, older students often teach younger ones.

island's food needs far exceed production. Imagine Pennsylvania with 60 million people! In some areas, Java's population exceeds 1,000 per square mile. Each year the island imports hundreds of thousands of tons of rice, using precious foreign exchange.

Irrigation Could End Food Deficit

As a remedy, the government is opening new land in Sumatra and Borneo, and starting large irrigation schemes. The most important of these is Djatiluhur Dam in West Java. We toured the construction site with Mr. Soerodjo, an assistant to the director of the project, though only in his twenties.

"When Djatiluhur is completed," Mr. Soerodjo said, "we can irrigate 600,000 acres and harvest two rice crops a year. With other projects, we hope to make Indonesia self-sufficient in food.

"In addition, Djatiluhur will provide power, a fresh-water fishery, flood control, sanitation for Djakarta, and a recreation area."

Mr. Soerodjo pointed to a modern building that housed project offices.

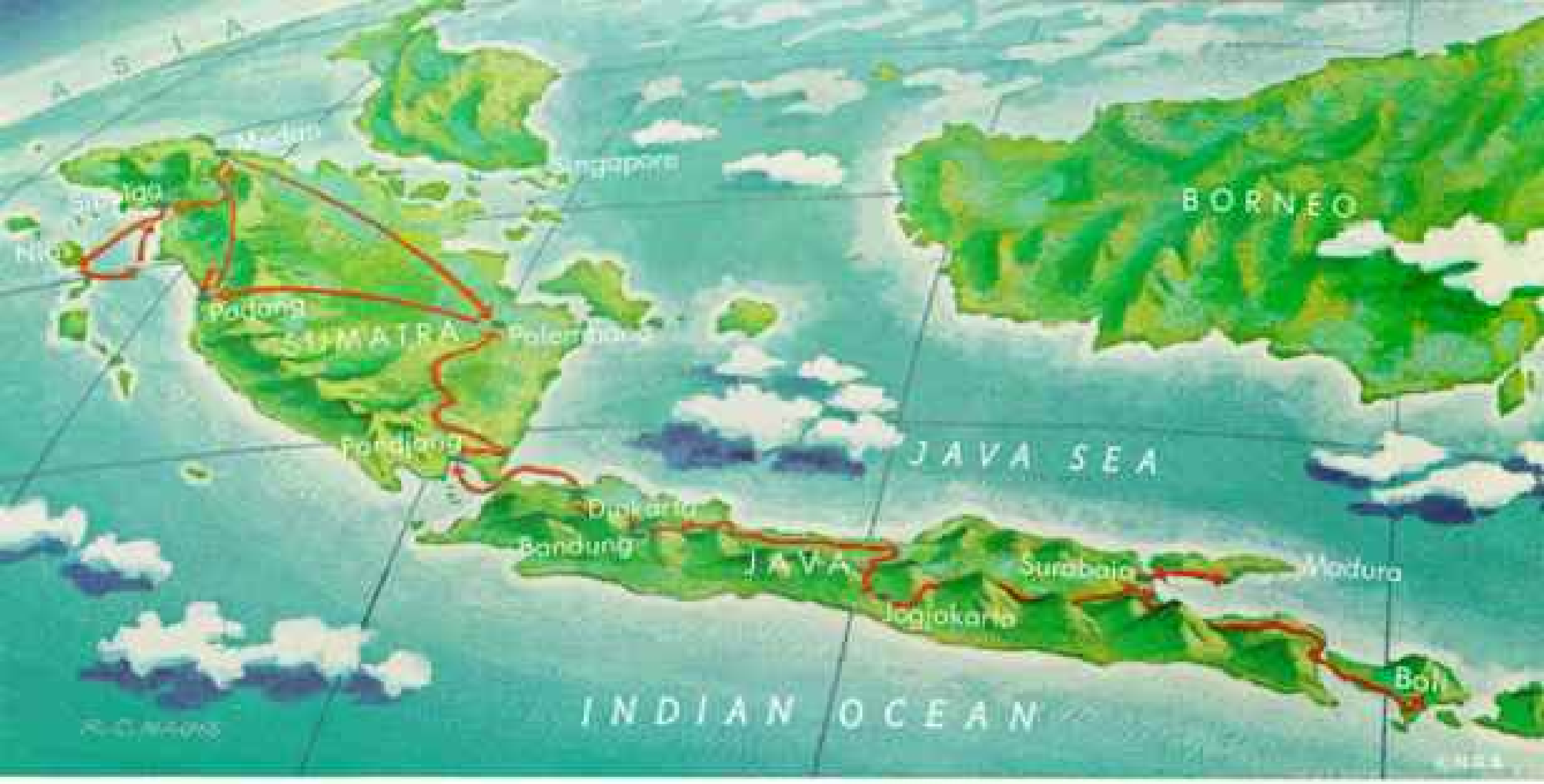
"That will be our yacht club, as soon as the dam builds our lake for us," he said.

Impressed by the earnestness of this young Indonesian, I asked his background.

"One of Indonesia's greatest needs," he answered gravely, "is experienced engineers. I graduated from the Institute of Technology in Bandung only three years ago."

Bandung's Institute, founded in 1920, was Indonesia's first engineering college (page 589). President Soekarno, a civil engineer, was among its early graduates. On the staff now are many Americans, on loan from the University of Kentucky.

One of the professors, Milo Wolff, told us: "Adoption of English as Indonesia's second language puts a strain on the universities.



Authors' 4,000-mile tour covers five islands; map supplement details places they visited

ILLUSTRATIONS © NATIONAL GEOGRAPHIC SOCIETY

Amphibious Jeep, steamer, airplane, and military convoy carried the Schreiders across Sumatra, Java, Bali, Nias, and Madura. Southeast Asia Atlas sheet charts all the islands of Indonesia. A subsequent article by the Schreiders will cover the Lesser Sunda Islands that stretch to the east.

Tea Pickers of Subang Gather Tender Leaves

Dutch colonists in Java first tried growing tea from Japan and China in the early 1800's, but without much financial success. Not until the turn of the century, with tea from Assam in India, did the industry flourish.

Tea demands tropical heat and heavy rainfall. Paradoxically, the finest varieties thrive on mountain slopes, where cooler air slows growth and increases flavor.

Constant pruning keeps the plants short and bushy. Harvesters take only young leaves and buds. A plucker can pick as much as 50 pounds daily, enough to make almost 10 pounds of dried tea.

These pickers work on an estate in West Java.

Brooding Borobudur, viewed from the air, suggests a filigreed brooch pinned to the heart of the jungle. A monument to Buddhism, its nine tiers of carved stone dominate a mound in Central Java. In size the edifice dwarfs the cathedrals of Europe. Indian colonizers built Borobu-

Stories in stone depict scenes from the life of Buddha. If placed end to end, Borobudur's reliefs would reach almost three miles. Painstaking sculptors, now forgotten, gave attention to the smallest details.

Dinah, the Schreiders' German shepherd, rests while Frank catches up.

PHOTOGRAPHS BY NATIONAL GEOGRAPHIC PHOTOGRAPHERS J. BAYLOR ROBERTS (ABOVE) AND HELEN AND FRANK SCHREIDER © N.G.S.

dur in the eighth century, but later abandoned it to the jungle. Sir Stamford Raffles, a British governor of the Netherlands Indies and founder of Singapore, rescued the shrine from oblivion. He began excavating the ruins about 150 years ago; the Dutch finished the project in this century.

Pinnacled stupas occupy Borobudur's upper terraces. Stone latticework forms each bell-shaped shrine and encloses an image of the Buddha. Visitors try to touch the statues by reaching through openings, hoping their wishes will come true. Helen Schreider and Dinah explore a lower tier.

New textbooks are needed. Whole courses and even methods of teaching are being revised."

Bandung lies in the heart of Java's most troubled area. The dissident Darul Islam group, which wants an Islamic state, was raiding the very outskirts of the city, so we detoured north toward the Java Sea.

At Subang, we visited an estate operated by one of Java's largest tea and rubber producers, P & T Lands. The British-owned company cultivates some 55,000 acres (page 590).

Dr. John G. Churchward, an agricultural adviser, invited us to spend the night. In the morning, a servant knocked on our door.

"Would you like morning tea or coffee?" he asked.

"Coffee, please," I murmured sleepily.

At breakfast I realized my error. Dr. Churchward held up a steaming teapot.

"You can't leave Subang without trying our tea," he grinned. "We're quite proud of it, you know."

Because of varying elevations of P & T's Indonesian plantations, Dr. Churchward explained, the firm produces tea, rubber, sisal, tapioca, kapok, cinchona, rice, teak, cocoa, pepper—and of course coffee. "Our exports bring in more than eleven million dollars a year in foreign exchange," he said.

As I looked at the list of products, I was reminded of the old Spanish proverb: "He who would bring home the wealth of the Indies, must carry the wealth of the Indies with him."

Though the spices of Indonesia brought the first Europeans, it was the newcomers themselves who imported the estate crops that today bring the country wealth: tea from Assam, rubber from Brazil, cinchona from Bolivia, coffee from the Congo.

Emperor Orders a Rhinoceros

We headed for Jogjakarta, metropolis of Central Java, and as the miles rolled leisurely by, we tried to piece together what we had learned of Indonesia's complex past.

Little is known of the centuries before the Christian Era, when migrants from central Asia brought the secrets of bronze and irrigated rice culture, domestication of the ox and buffalo, and the cult of animism. Chinese mariners sailed to the islands 2,000 years ago, an ancient text records, in quest of pearls and other precious gems. In the first century A.D., an emperor dispatched a delegation to Sumatra to obtain a rhinoceros for the imperial zoo.

Only with the fifth century does Indonesia's written history begin: the early chapters of Hindu, Buddhist, and Islamic kingdoms; the sequels of Portuguese, Spanish, British, and Dutch colonization; and finally Japanese occupation and the postwar revolution.

First Suspicion, Then a Cup of Tea

Once in Central Java, we looked for places to camp: a teak forest; a clump of palms; or, higher in the mountains, a grove of casuarinas overhung with tree moss.

A site chosen, we would select tinned food from the cabinets, uncover the sink and stove built into the dash, and extend the bunks behind the seats. At about that time, Dinah would growl and a child would scamper to his village crying, "*Orang putih, kapal dharat*"—"white people, land ship." Then elders would come to investigate.

Speaking through the school children—the elders knew little Bahasa Indonesia—we would explain: "Yes, our kapal dharat goes on the sea and the land."

Astounded, they would walk around *Tortuga*; the smiles would come, and then the welcome: "*Bagus, tuan*—please come to our village." And that, we found, meant tea.

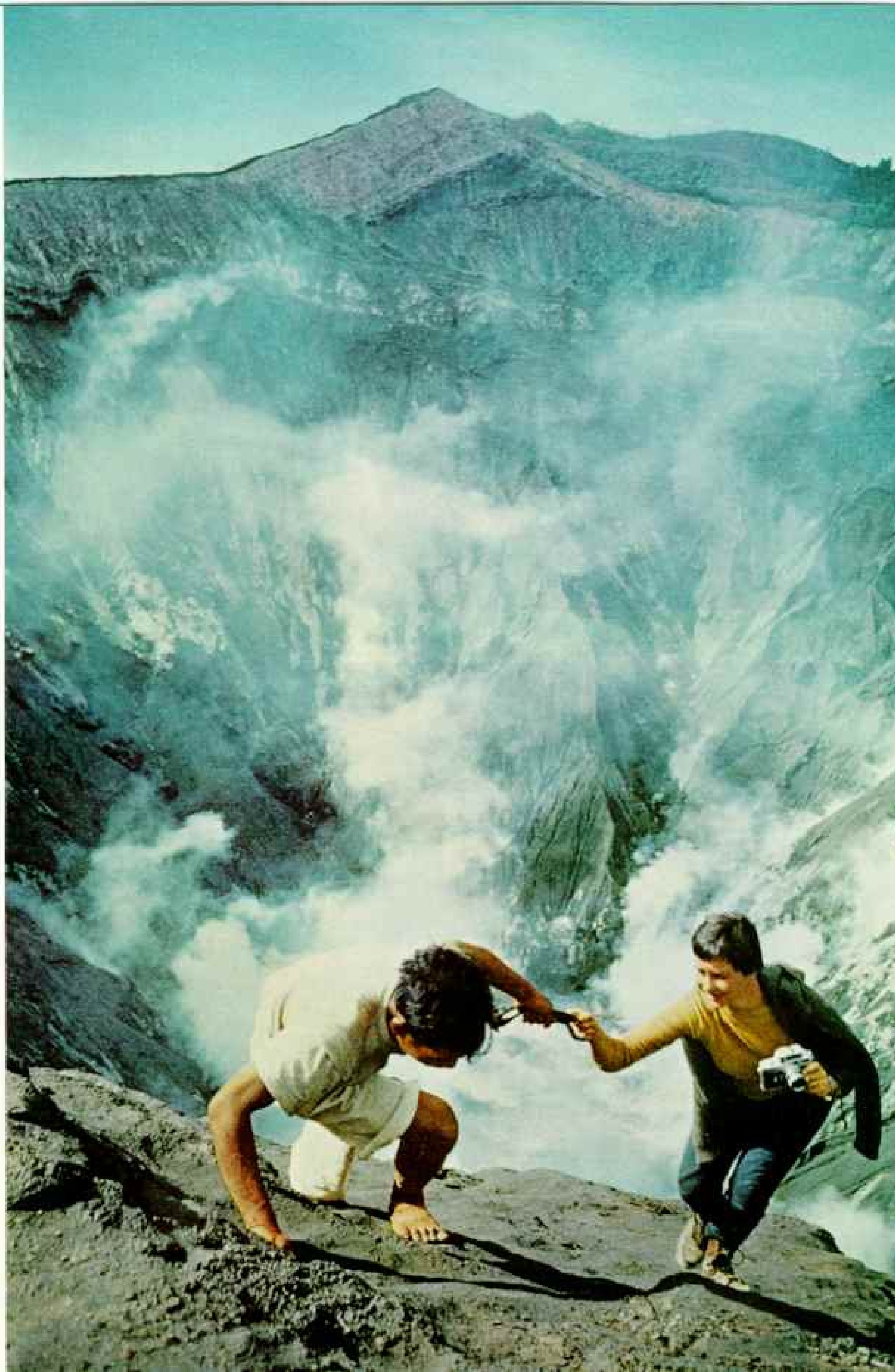
Once, strolling the narrow dikes between flooded rice fields, we came to a palm-hidden village of split-bamboo and woven-fiber huts. The village chief, a little old man whose bones jutted beneath parchment skin, waved us into chairs in his front room. His wife, equally ancient but arrow-straight from a lifetime of carrying loads on her head, brought the tea, in glasses capped with embossed aluminum covers.

Our eyes wandered from the inevitable portrait of President Soekarno on the wall

When Bromo Rumbles, Mountain Folk Say, the God of Fire Is Hungry

Java's Mount Bromo last erupted in 1930. To reach its 8,000-foot crest, the authors struggled up a grueling 12-mile trail by night (page 607). Here, with the help of a guide, Helen explores the rim of the caldera where once a year the volcano's neighbors toss in chickens to appease the spirits; they used to sacrifice human beings.

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY



KODACHROME (ABOVE) AND ECTACHROME BY HELEN AND FRANK SCHREIDER © NATIONAL GEOGRAPHIC SOCIETY

to the rolled sleeping mats in the corner, the string of chili peppers hung from the rafters, the charcoal brazier glowing red through the door to the cooking room. There the No. 2 wife, a smear of green paste on her forehead to cure headache, prepared supper of sago, rice, fried bananas, and dried fish.

Doors and windows were dark with children, happily dressed in nothing and fascinated by the strangers. Beyond them, an old man fondled his fighting rooster, probably ruminating on its many conquests. Cockfighting and its accompanying gambling have been banned on Java and are permitted only on holidays on neighboring Bali.

The old chief invited us to drink—and as soon as we drained our glasses they were refilled. We ate the rice cakes he offered and finished our tea again. Over our protests, the glasses were filled anew. I read distress in Helen's eyes: "I just can't drink anymore." It was months and gallons of tea later that we learned a sip and a nibble are all that etiquette requires.

Jazz, Doughnuts, and a Palace

On the outskirts of Jogjakarta—Jogja for short—bullock-drawn carts moved quietly along the roads, the hoofs of the animals muffled with shoes fashioned from pieces of automobile tires. But the city's main street was a bedlam. Jazz blared from radio shops, bicycle bells jangled in discord, and from the main square came the sound

Bull racing, sport of Madura island, pits brawny teams on a grassy straightaway. Derby Day in October matches 24 pairs, winners of regional finals, in the championship runoff at Pamekasan, Madura's capital. Before the races, owners deck the animals with elaborate harnesses and headdresses and ply them with raw eggs and rum. A serenade by a gamelan, an orchestra of drums, gongs, and xylophones, puts the beasts in a running mood.

Two teams before the soccer goal posts (above) await the starter's flag. Muscles strain as they charge toward the finish, at left. Jockeys on plow-like sledges prod the bulls furiously with pointed sticks.

Crossing Bali Strait in *Tortuga*, Frank Schreider battles rough seas and a seven-knot current. Seconds later a wave swept into the hatch. In this stout craft the authors toured Indonesia's roads and seas for 13 months.

Inquisitive Javanese, many of whom had waited all night, watch *Tortuga's* launching into the strait. Through this channel, Allied ships fled to safety in 1942 after defeat by the Japanese in the Battle of the Java Sea.

Taking a turn at the wheel, Helen scans the water for treacherous reefs. Shallow-draft proas filled with Balinese fishermen skim past *Tortuga's* stern.

SUKARNO AND HIS SATACHRIME (OPPOSITE, ABOVE) © NATIONAL GEOGRAPHIC SOCIETY

of a merry-go-round, the shouts of a doughnut merchant, and the shrill cries of other vendors.

Jogja is famed for its hand-tooled silver products and its batiks, patterned cotton cloth dyed by an intricate process using protective layers of wax. More important, Jogja is the headquarters of the Special District of Jogjakarta, the only active sultanate in Indonesia.

With a young man called Pek, from the Ministry of Information, we maneuvered *Tortuga* through the crowded streets to the *kraton*, or Sultan's palace.

"In the early days," Pek told us, "certain batik designs were reserved for the court. No one else would think of wearing them."

As we approached the palace, we heard the gamelan, the Indonesian orchestra of gongs, xylophones, and drums, echoing somberly through pavilions near the mosque.

"When Islamic traders came to Java," Pek explained, "they found well-established Hindu kingdoms. They converted the rulers, who placed their royal gamelans in the new mosques. Even as today"—he indicated the crowds entranced by the music—"people came to listen and stayed to be converted."

Beyond the high wall of the kraton, the first pavilion was filled with chairs.

"Why, this looks almost like a school," Helen remarked.

"It is," replied Pek. "The Sultan gave over a section of his palace to Gadjah Mada, the first university founded since Indonesia proclaimed its independence."

Sultan Helps Promote Tourism

Later we saw Gadjah Mada's new building, a nearly completed structure on the outskirts of Jogja, where more than 10,000 students in 13 departments study subjects ranging from engineering to philosophy.

"During the fight for independence," Pek continued, "Jogja was Indonesia's capital. In appreciation of the Sultan's help, Jogjakarta was made a special province of the new republic. The Sultan is very progressive. He drives his own automobile and dresses casually. He's in Djakarta now. He's our chairman of tourism."

At the entrance to the kraton proper, we

Eyes Flash, Arms Twist, Fingers Quiver as Balinese Girls Dance the *Legong*

Swathed in cocoons of gold-painted fabric, the performers enact the drama of a princess kidnaped by a despised suitor. Crowns of gilded

feather laced with frangipani blossoms cap the young dancers, who sway to the music of a gamelan before a temple in Saba.

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

were met by the chief guard, who holds a hereditary post of great dignity. The old man wore traditional court costume: royal indigo-and-brown batik, close-fitting, high-necked jacket, and neat Javanese turban with a bun on the back. In his sash he carried a long kris, the wavy-bladed dagger credited with magic powers.

Born in the tradition of the Sultan's divinity—the royal bath water, fingernails, and hair trimmings were once saved for medicinal use—the old man watched us suspiciously. We passed the sacred weapons room, bridal chamber, throne platform, and the Golden Pavilion with its high, gold-embossed ceilings, all without getting a single picture.

We met a procession of women crossing the palace courtyard. Servants of the Sultan's wives, they wore colorful wrap-around skirts, or *kains*, their shoulders bare and their breasts bound with yellow bands. One carried a teapot shaded by the royal umbrella. I raised my camera. The guard leaped forward—no photographs!

I groaned, "If only that progressive Sultan were here."

Taboos Still Plague Cameraman

The next morning was the feast of Sekaten, a celebration involving animism, Hinduism, and Islam, and we arrived at the palace early to watch the procession.

It was still dark within the walls, but the rice mountains, huge beehive-shaped bamboo frames covered with paper packets of rice, were already in place on the pavilion. Later they would be carried to the mosque, where people would scramble for the packets, believed to bring good luck.

Seeking a camera platform, I climbed to a vantage point on an abandoned portico atop the courtyard wall.

At eight o'clock, the gates opened and the female kraton guards emerged. Bulky women with formidable krises in their sashes, they made last-minute adjustments on the rice mountains. Vendors sold sweets, balloons, and pinwheels to the spectators. Several policemen strolled by and grinned up at me.

Another hour passed, then another. The gates opened again and the kraton officials, wearing the white turbans and flowing white robes reserved for hadjis—those who have made the pilgrimage to Mecca—marched out and settled comfortably on thick cushions.

About that time a policeman approached me. "Come down," he ordered.

The gamelan struck up and the procession

KODACHROMES BY HELEN AND FRANK SCHREIDER © NATIONAL GEOGRAPHIC SOCIETY

Threshing rice in hollow tree trunks, Balinese pound the grain with pestles. These women in a remote mountain village ignore a government decree in favor of blouses.

Skyscraper offerings of fruit and flowers ride the heads of straight-backed Balinese girls striding past the tiered temples of Mangwi. After priests bless the gifts and present symbolic portions to the deities, villagers will receive the remainder.

was starting. "But why?" I asked. "I'm not in anyone's way."

He merely shrugged. "Come down."

In desperation I showed him my press card. In fact, I showed him all my permits, but to no avail.

A young lady in the crowd explained. "I'm a teacher in the kraton school," she said. "I'm sorry, but you really must come down. You're sitting higher than the Sultan's head."

"But the Sultan isn't here," I pleaded.

"I know, but you're sitting higher than his representatives. It is considered impolite."

Defeated, I jumped down. The gamelan was ready, and the men carrying the rice mountains were in position. I couldn't help regretting my lost picture.

But the teacher caught my sleeve. "Quick, over there," she ordered, pointing to a sheer 15-foot wall. "It's far enough away, and I've sent for a ladder."

The ladder arrived, I dashed up, and snapped the procession just in time (page 580). Royal education, I thought later, is in able hands!

One evening we watched a *wayang kulit*, or shadow play, with a medical student, Mr. Humardani, whose hobby was the study of Javanese dance and drama. While the gamelan throbbed, an oil lamp flickered, throwing the puppets' shadows on a white screen. Under the skillful hands of the *dalang*, or puppeteer, the heroes of the Hindu epics of war and adventure—the Mahabharata and the

Ramayana—fought and loved with great realism (page 586).

"In ancient times," Mr. Humardani explained, "it was believed that shadows were the souls of the dead and that the dalang was the medium between them and the living. He was considered holy, and even today, incense burning and prayers mark an important performance.

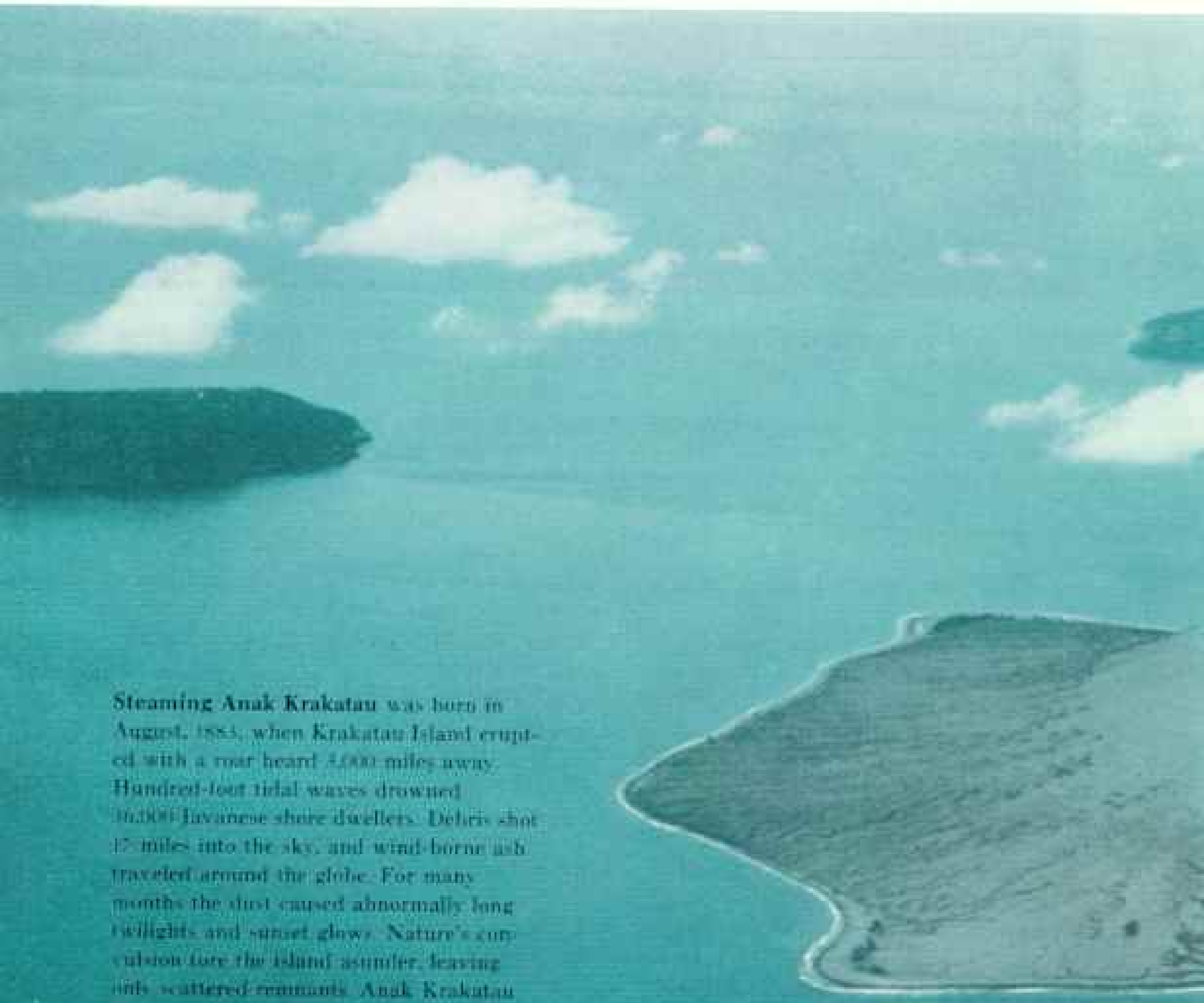
Show Rivals One-man Band

"His words carry great weight," Mr. Humardani added. "As he travels from village to village, he gives the news of the day, and his political comments are often heeded."

For a while we sat on the screen's shadow side, once reserved for women only. Later, we moved to the side where the dalang sat, adroitly handling the buffalo-skin puppets, speaking the parts, making sound effects, and dispensing philosophy. One-man bands, we decided, have nothing on dalangs.

The road east from Jogjakarta toward Surabaja ran through rich sugar country. Dozens of mills lay in ruins along the way, still unrepaired after destruction in the revolution. Much of the land had been converted to rice; sugar exports, meanwhile, have fallen below 5 percent of prewar levels. The Communists have capitalized on this blow to the country's economy; the city of Madiun, for example, was the scene of some of Indonesia's bloodiest riots since the revolution.

Surabaja, Indonesia's chief seaport, was a change of pace after Jogja's quiet formality. At the modern docks lay freighters, tank-



Steaming Anak Krakatau was born in August, 1883, when Krakatau Island erupted with a roar heard 4,000 miles away. Hundred-foot tidal waves drowned 36,380 Javanese shore dwellers. Debris shot 17 miles into the sky, and wind-borne ash traveled around the globe. For many months the dust caused abnormally long twilights and sunset glows. Nature's convulsion tore the island asunder, leaving only scattered remnants. Anak Krakatau erupts briefly from time to time.

ers, warships, and a naval training vessel. The Kali Mas, the main canal, was bright with sailing proas, vital links in the country's inter-island shipping system (page 598).

From Plowing to Bull Racing

Across the narrow channel from Surabaja lies the island of Madura.

"You must see Madura's bull races. You'll never forget them," a Madurese in Djakarta had urged.

It was bull-race season when we went to Madura, but Mr. Soenarto, chief administrative officer, told us that the races had been canceled because of unsettled conditions resulting from a currency devaluation.

"However," he added, seeing our disappointment, "I'll see what I can do."

The next morning we awoke to a piercing medley of flutes, drums, and gongs, coming from the stadium. Overnight, Mr. Soenarto had collected seven teams of champion bulls, complete with bells and gilded ornaments, ceremonial parasols, and accompanying gamelans. Behind each team stood the jockey, balancing on an enameled skid that looked like a bladeless plow.

"The faster a bull can run, the faster he can plow," Mr. Soenarto explained. "The bull races originated generations ago, out of the need to plow fields quickly. One of the results is improved cattle strains."

It was obvious that the bulls, magnificent animals with coats like burnished copper, received good care.

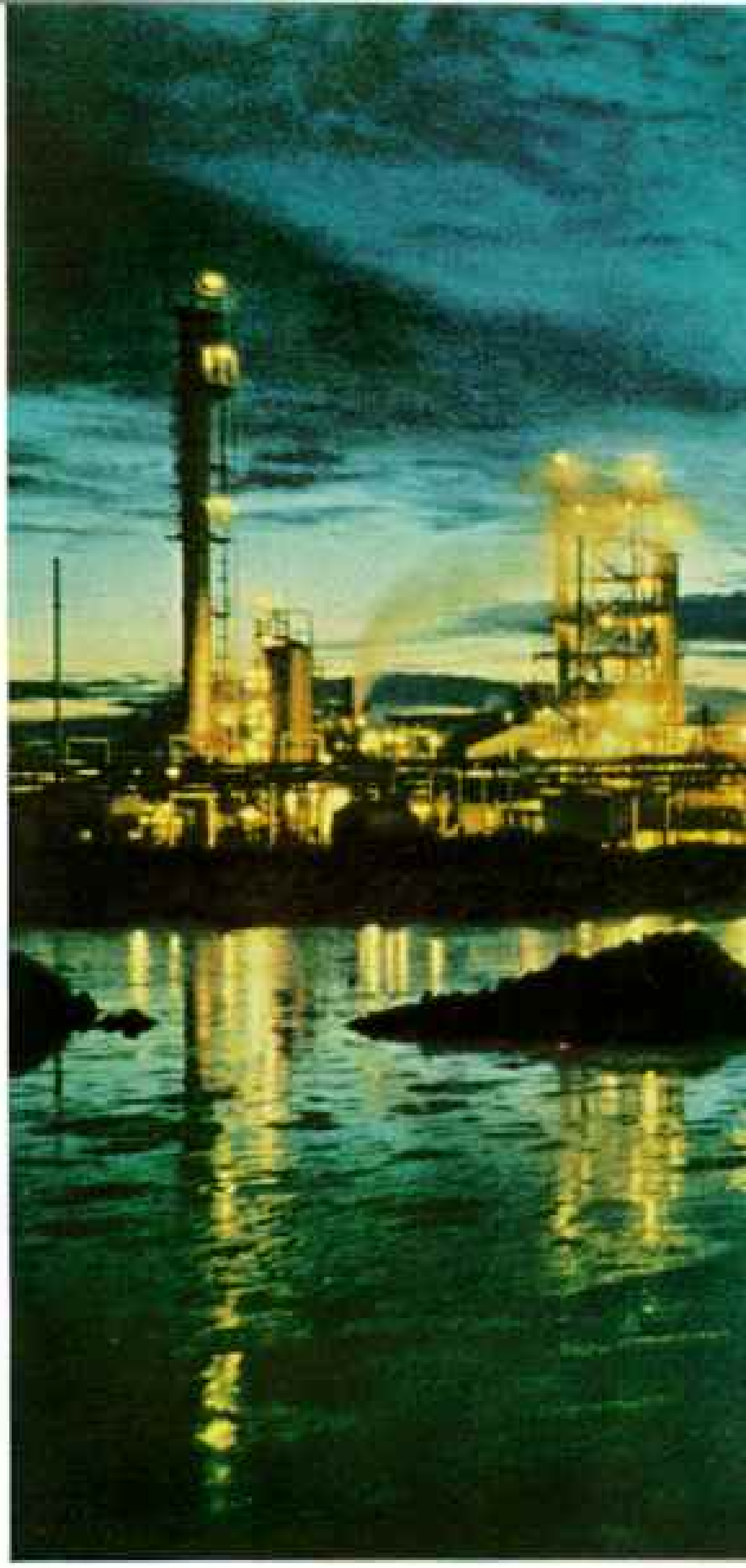
"They are fed raw eggs, as many as fifty a

PHOTOGRAPH BY B. W. BEEBE © NATIONAL GEOGRAPHIC SOCIETY

Sumatran Refinery, Cathedral of Industry, Processes Crude Oil Around the Clock

Indonesia holds the largest oil reserves in the Far East. Two American-owned companies produce two-thirds of the nation's petroleum. To tap the oil, crews pushed rigs into tiger-infested rain forests.

Glowing towers of Standard-Vacuum Oil Company's refinery near Palembang cast mirror images upon an inky swamp from which the refinery grew.



Derrick man tightens the hook of a drill rig in southern Sumatra's Pendopo. Until foreign companies can negotiate new leases with the Indonesian Government, drilling is confined to proven fields; wildcatting has all but ended.

day," said Mr. Soenarto. "But listen, the gamelan is playing stirring music to excite the bulls. After the race, they will be rubbed down to quiet, soothing music."

Before the race, each bull received the final stimulus, a bamboo tubeful of rum. Then the starter dropped his flag, and with a blur of speed, the teams charged (page 596). After sweeping across the finish line, the victorious team paraded triumphantly around the stadium.

"Our bulls are a bit out of practice today," Mr. Soenarto said. "Normally they do 100 meters in nine seconds, faster than the men's world track record."

We returned to Java and the city of Sura-

III EASTERNMOST (MIDDLE) AND SUBSIDIARIES © NATIONAL GEOGRAPHIC SOCIETY

baja, the center of the Madjapahit realm until the 15th century. Greatest of Java's Hindu kingdoms, Madjapahit once repelled the forces of Kublai Khan. High in the Tengger Mountains of East Java live the descendants of the Hindu priests whose duty it was to appease the god of fire residing in the volcano of Bromo.

"Nice Walk" Becomes a Trek

Late one afternoon Helen and I arrived at Tosari, in the heart of the Tengger country. The air was chill, and the fading sun gilded the zinc roofs and dark walls of the sturdy houses that terraced the hillsides. At the flower-bordered government resthouse, we asked the mustachioed caretaker how we could reach the crest of Bromo.

"*Ja*, tuan," he said, "I'll have horses here at 3 a.m. You must start then to reach the peak at sunrise."

The only way from Tosari to Mount Bromo, he said, was by a 12-mile horseback trip.

We awoke in the moonless night and mounted small Javanese horses. With a flaming torch, a guide preceded us along the narrow trail through silent villages and over dark drainage ditches. Wind soon chilled us, and I could hardly believe we were only a few degrees from the Equator.

For several hours we climbed, crawling at times while the guides led the horses.

Helen kept grumbling, "I can't understand it. They told me it was just a nice walk from where you could leave your car." We reached the ridge, almost 8,000 feet above sea level, as the sun rose.

Dismayed, Helen pointed to a narrow line descending the opposite slope.

"Why yes, tuan," the guide said casually, "that's a road. You could have driven all the way here from Probolinggo. But from Tosari, as the caretaker said, the horse trip is the only way."

Tortuga Makes a Briny Debut

We traveled eastward to Bali Strait and found it chopped to a froth by competing tides and monsoon winds. While I inspected *Tortuga*, Helen charted our maiden voyage in Indonesia.

Across the mile-wide strait, the green peaks of Bali beckoned. Our course plotted and Dinah dripping from an unauthorized swim, we slid down the gravel shore (page 599). Ahead, a broad band of whitecaps marked the 7-knot tidal current that funnels through the narrows.

To avoid the worst of the current, we detoured north toward the Java Sea, then swung east toward a point 14 miles away on Bali's north coast. The waves seemed to run in all directions: from the stern, they humped *Tortuga*; on her beam, they rolled her; and onto her bow they poured foaming cascades. *Tortuga* took them all without faltering.

Once across the strait and into the lee of Bali, we hit calm water. We steered a zigzag course through brown reefs bright with tiger fish, sea urchins, and red branches of coral. Our map showed a trail touching the coast, but all we could see was a jagged line of cliffs. Toward midafternoon the cliffs opened, and we took a chance on a gently sloping beach. Bumping ashore, we cut through a coconut grove, hit the trail, and barged into a procession of Balinese goddesses.

I'm not sure who was more startled, the goddesses at seeing *Tortuga* rising from the sea, or we at finding ourselves among a score of regal girls, each with golden flowers in her hair, and each balancing a yard-high temple offering of sculptured fruit.

But then Bali, after all, is full of surprises. To begin with, in a nation that is 90 percent Moslem, Bali remains an outpost of modified Hinduism, the legacy of a 15th-century prince

Barefoot Moslems in Sumptuous Robes Are Wed at Palembang, Sumatra

Bride and bridegroom wear costumes patterned after the royal court of the Srivijaya empire in the Middle Ages. Bride's *kain*, a family heirloom, shimmers with gold thread. Flap on the husband's golden headdress is intended to prevent his looking at his mate when they sit in state at the wedding feast. Should the girl smile or glance at him, a female relative would admonish her with a pinch. Older woman at right instructs the bride on her duties.

Custom prescribes that participants and guests leave their shoes on the doorstep.

who refused to submit to Islam. With his priests, artisans, musicians, and dancers, he fled to Bali and set a pattern of idyllic life that remains to this day.

Ducks March in Formation

There is a magic to the prince's island. Even the animals seemed to us to be enchanted: The golden cows with large ears and white ovals on their rumps looked like deer; the elongated, saggy-bellied pigs resembled oversized dachshunds; and in the rice fields, quacking ducks marched in formation like squads of penguins, upright behind the signaling flags of their herders.

In every village there were temples; near each house was an altar for offerings to the multitudes of lower and higher spirits. Everywhere we saw processions, for this was the beginning of Galungan, the festival celebrating the first day of Bali's seven-month year.

One morning at dawn, Njoman Oka, efficient head of Balitour, pounded on our hotel door.

"Wake up, Mr. Frank, there's a cremation," he shouted.

"It's too early for jokes," I yawned. "You said there would be no cremations during the festival."

Njoman insisted, "But this one is different. Hurry up."

We tumbled out of bed, knowing that the Balinese cremations, far from being somber affairs, are joyous times when families release

NG PHOTOGRAPHER © NATIONAL GEOGRAPHIC SOCIETY

the souls of relatives to the pleasures of heaven, which, to Balinese, is merely Bali with fewer troubles.

When we arrived at the village, the ceremony was in full swing. The cremation tower, garlanded with gold paper and glass chips, was already being carried on the villagers' shoulders; the wooden coffin, shaped like a black cow, was in place; and a buffalo had been duly sacrificed.

Amid shouts to frighten evil spirits, the tower holding the corpse was carried to the cremation ground. Someone struck a light and the flames licked upward. The tower crashed, the coffin crumbled, and the elder son raked the coals to ensure that all was consumed. Joyful hands carried the ashes to the sea and sprinkled them on the waters. The soul was free at last.

I was still wondering why a cremation should have been scheduled to compete with a festival celebrating Bali's New Year. I asked Njoman for an explanation.

"It's simple," he said. "This man was of high caste. Custom says that until he's cremated, the village is impure. Therefore, no festival. So they had a hurry-up cremation; now the celebration can continue."

With Njoman Oka and art connoisseur Jim Pandy as our guides, we attended many festivals. In the village of Paksabali, we witnessed the War of the Gods. The gods, it seems, had emerged from the temples and were so delighted with the dances, sweets, and rice offered by the people that they had refused to return. A great night battle, resembling a tug of war, ensued as Balinese youths in a trancelike state attempted to force the palanquin of the invisible gods back into the temples.

"But why," Helen asked, "don't the gods want to return to heaven?"

"Because they're having such a good time here," Njoman answered.

"Then why can't they stay?"

"It's too expensive to entertain them."

Dance Provides Tense Moments

One night Njoman took us to a *djoged* dance, village style. Here were no shy glances, no demure gestures such as one sees in the *legong*, the stylized dance done by very young Balinese girls (page 600).

This time, a golden-crowned girl in her late teens danced artfully among admiring males, moving her brocade-swathed hips to the provocative beat of drums and gongs. She approached a youth in the audience. He

Solitary Moslem Reads the Koran in Medan's Lofty Mosque

Nine-tenths of Indonesia's people hold to Islam, but the rituals of animism, Hinduism, and Buddhism survive. Many mosques lack minarets.

In the villages, drums beat out the hours of prayer because dense foliage muffles the cries of muezzins.

Tiara-crowned dancer, whose heavy gold jewelry complements a velvet-and-brocade gown, led an interpretive group that took a prize in a recent nationwide competition. Imaginative carvings dress exterior walls of a house in Sumatra's Padang Highlands. "This beautiful architecture, like most things traditional in progress-hungry Indonesia, is fast disappearing," the authors report.

PHOTOGRAPHS (ABOVE) AND [illegible] © N. G. S.

Rice terraces shingle the slopes of Central Sumatra. In this seemingly

KODACHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER J. BAYLOR ROBERTS © N.G.S.

peaceful valley, rifle fire rakes the hills during sporadic outbursts of guerrilla warfare

Ignoring passers-by, a weaver looms silver cloth in her home near Lake Manindjau, Sumatra. Restrictions on the import of silver thread have almost wiped out her time-honored craft. Fabric draping the wall took four months to finish. Soldiers escorted the authors to the village, lest rebel bands intercept them.

feigned shyness. She charmed him, and he became aggressive. She then discarded him and chose another.

From my place in front I could see Helen across the circle among the women, standing on a pile of bricks. All at once, the dancer slyly advanced toward me. The gamelan picked up the tempo of the music, and the girl began to gesture.

There was a rumble of masonry, and Helen's pile of bricks collapsed. The girl reached past me, and I breathed with relief—or disappointment—as she selected a young Balinese behind me.

Guerrillas Roam Sumatra Highlands

A few days later we bade Bali farewell and headed east for a thousand miles of island-hopping through the Lesser Sundas.* Twice we were reported lost at sea.

When we returned once again to Djakarta, we decided with great reluctance that *Tortuga*'s amphibious days in Indonesia were over. Cruelly battered by boulder-strewn trails and pounded by choppy seas, she was in no condition to cross on her own to Sumatra, the next island on our itinerary. We loaded her aboard a freighter at Tandjungpriok, Djakarta's port.

The morning of departure was filled with uncertainty. Djakarta was still in a state of emergency, and armed patrols prowled the docks. *Tortuga*, with her tanklike lines, drew many suspicious glances from the soldiers. But she was going to have to get used to it, for we were headed for Indonesia's most troubled isle.

Sumatra's woes date back to 1956, when a group of Sumatran officers revolted. "With our petroleum, rubber, palm oil, spices, and tobacco," they announced, "Sumatra contributes almost 50 percent of Indonesia's foreign income. Java spends most of it. We want a fair share."

The revolt was crushed, but Sumatra still suffers from guerrilla warfare. At the time of our trip, much of the island's rugged mountain spine was in the hands of rebels. South Sumatra and most of the island's towns, how-

*The Schreiders will describe their voyage through the Lesser Sunda Islands in a forthcoming NATIONAL GEOGRAPHIC article.

ever, were under government control. By joining army convoys in the unsettled areas, we hoped to see much of the land.

As we sailed toward Sumatra, the captain called to us from the bridge. He pointed to a tiny blue-white puff of smoke on the horizon. "There," he said, "Krakatau."

Through our binoculars we strained to see the remains of this famous volcanic island, whose explosion in 1883 sent ash around the world and raised tidal waves that killed more than 36,000 people (page 604).

We landed at Pandjang and headed for the heart of South Sumatra's Lampung district. The narrow road was lined with pepper groves, each vine forming a green sleeve around the special shade tree it thrives on. Centuries ago, the Lampung was a prime source of pepper, a spice so valued that Alaric the Visigoth demanded—and got—3,000 pounds of it as tribute from Rome.

Our first stop was the village of Maringgai. I hailed an old farmer leading a team of oxen.

"How far to Maringgai, father?" I asked in the Indonesian way.

"Two cigarettes, tuan," he replied.

Obligingly, I handed him two cigarettes. With pleasure and surprise, he put them in his hat.

"Thank you, tuan," he said and padded off after his oxen.

"Hey," I called, "how far to Maringgai?"

"Why, tuan," he grinned, "I just told you—the time it takes to smoke two cigarettes."

Tiger Whisker Bestows Strength

Maringgai had reported a marauding tiger, but we found no tiger there. We had hoped to see other wildlife, since Sumatra is rife with it. Maringgai had seen no elephants, however, and the last rhinoceros sighting had been months before.

But we learned to address a crocodile as "grandmother" in order to ford a river, and to call a tiger "grandfather" so that he would not molest us in the jungle. A tiger's claw, we

Cheeselike lumps of coagulated latex await processing at Goodyear's rubber plantation at Dolok Merangir, Sumatra. Creping mills at left squeeze out excess moisture and compress the clumps into sheets for shipment to the United States. As a producer of natural rubber, Indonesia ranks second only to Malaya.

HS EKTACHROME BY HELEN AND FRANK SCHREIDER © NATIONAL GEOGRAPHIC SOCIETY

REPRODUCIBLE © NATIONAL GEOGRAPHIC SOCIETY

were told, makes a powerful good-luck charm, and a tiger's whisker, when grated in alcohol and drunk, will make a man strong. Powdered rhinoceros horn—valued today at $1,000 a pound on the Singapore market—makes an irresistible love potion. By the time we reached Palembang, we had learned much lore but had seen no animals.

Palembang, once center of the Srivijaya kingdom and now South Sumatra's principal port, was born of pepper, raised on tin, and has grown rich on oil. From the fields of Standard-Vacuum Oil Company, Shell, and Caltex comes almost 2 percent of the world's supply of petroleum (pages 606-7).

We toured Standard-Vacuum Oil Company's refinery with Stanvac engineer James C. Burrill. "Besides contributing much foreign exchange," Jim said, "the oil industry provides employment for thousands. At Stanvac alone we have 9,000 employees; 95 percent are Indonesians, and our training programs and university scholarships are preparing many more for administrative and supervisory positions. We provide schools, housing, clubs, swimming pools, and commissaries. Our medical facilities care for 55,000 people."

In a speedboat we skimmed along the broad Musi River that bisects Palembang. As we darted among sailing proas, sampans, and tankers from

Glittering pendants festoon the treelike crown of a South Sumatran dancer. Lavish ornamentation of her dress reflects an era when the pepper trade enriched the region.

Twin peaks of a Minangkabau headdress commemorate the legendary Battle of the Buffaloes (page 619). Gold flowers spangle the finery of this Central Sumatran villager.

Silver earring strains the lobe of a Batak woman of North Sumatra. She props the 2½-pound heirloom on a shoulder. Fringed hat suggests a Victorian sofa pillow.

Spear-carrying Dancers of Nias Meet Imaginary Enemies in Mock War

Head-hunters and slave traders once scourged the island of Nias. These homes in Hilisimaetano reflect the islanders' defenses. Bars guard windows, and trap doors pierce roofs. Interior doors allow residents to go from one end of town to the other without stepping outside.

"At first the village seemed empty of women," the authors recall. "But soon we saw them peering through the window bars."

In battle regalia, the warriors demonstrate how their ancestors fought.

Horned helmet, metal tusks, and barbed spear are worn to instill fear in an enemy. This Hilisimaetano warrior guards the throne of a dead chief. European armor may have inspired his shoulder plates. Gold necklace calls to mind the days when a man could wear the "ring of bravery" only after taking an enemy's head.

ports all over Asia. Jim, a student of Palembang history, pointed out the former Sultan's fort and the spot where a chain across the Musi once controlled river traffic.

Avoiding Central Sumatra's guerrilla territory, we left *Tortuga* and Dinah with Jim and took to the air at Palembang. As we flew north, the low swampy terrain drifted beneath us like a deep-pile carpet of green.

Near the Barisan Mountains, mainly controlled by rebel forces, we climbed through a layer of cotton clouds obscuring the peaks, some of which towered more than 10,000 feet.

KODACHROMES © NATIONAL GEOGRAPHIC SOCIETY

The territory below belonged to the Moslem Minangkabau, among the most enterprising people of Indonesia. The Minangkabau have contributed many of the country's greatest statesmen, including former Vice-President Mohammed Hatta and the late Hadji Agus Salim, both revered workers for independence. But this independent spirit has become a problem for the government, and the area is one of the most rebellious in Sumatra.

Land of a Calf With Iron Horns

We landed at Padang, a coffee-and-copra port on the west coast, and, convoyed by armed soldiers, toured the Padang Highlands. Here we saw the unique buildings of the Minangkabau. This beautiful architecture—like most traditional things in progress-hungry Indonesia—is fast disappearing from the countryside.

"The high peaked roofs," explained our army escort, "commemorate the great Battle of the Buffaloes. For centuries Java and Sumatra were at odds, and, according to legend, a Javanese king once challenged the Minangkabau to pit their best buffalo against his champion animal.

"The Sumatrans had no buffalo strong enough, so they starved a calf, tied iron horns to its head, and entered it in the contest. In its eagerness to nurse, it gored the Javanese buffalo to death. Ever since, the Minangka-

bau have built their roofs in the shape of buffalo horns. Even the name, Minangkabau, stems from the battle; it means 'Victorious Buffalo.'"

At Medan, a neat, bustling city that lies 350 air miles to the north, the army assigned Lt. Ibrahim Nachi to accompany us as official escort. The young officer turned out to be quite an acquisition.

Lieutenant Nachi — with typical Indonesian informality he soon became Ibrahim — was a thoroughly likable young Minangkabau. He had spent two years in the United States, and spoke English well. He also had a sense of humor.

We were driving into the popular mountain resort country near Medan, in the territory of the Karo Bataks. These people, together with their cousins, the Toba Bataks to the south, make up the dominant racial group of North Sumatra.

We had been invited to attend a celebration at a remote upland village, and as we approached our destination, Ibrahim feigned concern. The Bataks, he explained, once had a taste for human flesh. Now thoroughly Christian, their preference runs to dogs.

Fortunately the menu of beef curry gave us no problem that day.

Celebration Costs Buffalo Its Head

There was much dancing and singing, but after a while I asked about the buffalo sacrifice. I knew that Bataks, like many other groups in Indonesia, traditionally beheaded a buffalo on any great celebration, be it

KODACHROME (ABOVE) AND VC EKTACHROME © NATIONAL GEOGRAPHIC SOCIETY

Gleaming Jawbones of Sacrificial Pigs Decorate the House of a Nias Chief

Isolated from the main stream of Indonesian life, Nias developed a megalithic culture. Lutheran missionaries introduced Christianity in the 20th century. Today Nias men sing hymns instead of hunting heads, their children go to school, and the old ways die out.

When the Schreiders visited Bawomataluo, the village chief offered them lodging in his great house. Neither nails nor pegs went into its construction; slaves carved the timbers to fit.

Human heads may once have hung from the pegged rafters. Barred window overlooks the street.

Warriors in ancestral battle dress pose for Helen's sketch pad. Carving overhead depicts a Nias attack on a European ship.

the opening of a new home, cement plant, oil refinery, or bank.

The village chief was shocked. "Why," he exclaimed, "we never do that anymore!"

An hour later, as we drove off, we noticed a still-dripping buffalo head on a post near the square. So much for abandoned customs!

Later that week, Ibrahim arranged our trip to Nias, a seldom-visited island of megalithic culture, off Sumatra's west coast.

From Medan, we drove in an efficiently organized army convoy across Sumatra to the port of Sibolga, where we met *Tortuga*'s stand-in for the voyage. *Utama* was a 70-foot wooden

craft of dubious vintage. She carried a deck-load of passengers, goats, and baskets of an evil-smelling fruit called durian.

It is said that the Dyaks of Borneo will kill for a mere taste of durian. Before we landed on Nias, I was ready to do the same to get rid of it.

There were no cabins aboard *Utama*, and stacked timber and corrugated iron didn't make the most comfortable resting place. But, we thought, if the other passengers could stand it for the twelve-hour trip, so could we. Had we known that those twelve hours would stretch to four days before we reached the island, our thoughts might have been far different.

We sailed at sunset, and about midnight, the ship began to groan. Everyone was sea-sick. Accustomed to *Tortuga*'s frightful pitch, we were unaffected—until the wind shifted and added the stench of durian. Water began to pour over *Utama*'s bow, and the whole ship shuddered and groaned ominously. With reluctance, the captain decided to turn back, and we returned to Sibolga.

It was two days before he tried again, but this time he made it, and soon we were anchored in the palm-ringed bay of Telukdalem in south Nias.

Warrior Sells His Weapons

Ibrahim and I checked in with the police. While we were talking, I heard a commotion from the village's one street, where Helen was waiting. We rushed outside to find a Nias warrior brandishing sword, shield, and spear in a jerky dance around her. Cautiously, I intervened.

"*Minta maaf, njonja,* I'm sorry," said the swordsman. "You like to buy my weapons? I don't need them now—I'm a Christian."

Persuaded by his fervor and novel approach, we made a purchase.

A 25-year effort by Catholic and Protestant missions has mellowed the people of Nias. Instead of hunting heads, the people sing hymns; instead of waging war and keeping slaves, they barter copra and pigs for bicycles and gold teeth.

In south Nias's only Jeep, we bounced along a slide-scarred trail with Dr. Gottfried Hartmann, a German physician who was working for the government. As we crossed a swamp-bordered river, Dr. Hartmann said, "A girl was killed by a crocodile here this week."

"And now it will rain for nine days," added a Nias youth riding behind us.

"This is the dry season," I reminded him. The sky held not a single cloud. But crocodile magic is strong. Soon after, the clouds gathered, the sky darkened, and the rains came down.

Fortunately Dr. Hartmann had a spare bedroom, where we waited for the showers to end.

Head-hunters Turn to High Jumping

On the first clear day, we set off afoot, climbing steep stone stairways to near-by villages that seemed to balance atop the hills. The locations alone seemed impregnable; yet defense went even further: Each house had barred windows and a pyramidal roof with a trap door (page 619).

At the first village, the grizzled chief met us at the top of the steps. In front of his house stood a score of large stones, blocks carved like treasure chests with designs of pistols and keys, and thronelike chairs surmounted by serpents. Each stone had been hauled laboriously from riverbeds miles away, so that some chief might attain a higher station in this life or the next. For all except the newest carvings, heads had been required to complete the stone-moving ceremony.

"In the old days," said the chief, explaining the fortifications, "wars were an everyday thing. Before a man was permitted to marry, he had to take at least one head, and boys were trained from childhood in the art of making war."

He gave an order to a group of boys standing near by. In turn each youth made a running leap from a raised take-off step and cleared a six-foot stone barrier (opposite).

"Today, this is a sport," the chief explained. "But when I was young, I could clear that wall with a burning torch in one hand, draw my battle sword in mid-air, set the village on

Leaping Nias Youth Soars Effortlessly Over a Six-foot Pillar of Stone

Once a test of manhood, high jumping survives as a sport. Warriors of an earlier era vaulted barriers with a torch in one hand and a sword in the other. Springing from a raised stone behind this column, Hilisimaetano boys performed for the authors.

PHOTOGRAPH © NATIONAL GEOGRAPHIC SOCIETY

fire, and get away before the alarm could be given."

Later, the old men of the village performed their traditional war dances. In armor of metal or leather reminiscent of medieval knights, they clattered and clanked into battle formation, grunting with each short, choppy step (page 618).

The dancers worked themselves to a high pitch, and then, with a banana trunk as a victim, they made the attack. One sword swipe sufficed for the symbolic head taking; then came retreat and a stand to repel would-be avengers.

When the dance was over, one man approached me with drawn sword. Its hilt was carved in the shape of the hornbill, symbolic bird of death. The scabbard was studded with crocodile teeth for supernatural power. The blade? Proudly the owner told me it had taken 34 heads.

That night Helen and I were alone in the large main chamber of the chief's house, built 150 years before by slave labor. Clean embroidered sheets had been spread for us on the warrior's sleeping bench. Overhead hung a life-sized crocodile carved in dark wood. The mammoth fireplace was cold and soot-blackened, but light among the rafters gleamed from the hook-toothed jawbones of hundreds of sacrificial pigs (page 620). A rusty chain hung in loops, a reminder that an early European ship had been captured by the fierce Nias people.

But Nias's glory is no more: The wall niches that once housed statues of ancestors were empty. The mammoth ceremonial war drum in the corner was broken.

Back in Nias's port of Telukdalem, we waited anxiously for the return of *Utama*. Five days overdue, she arrived at last, and, with a dozen Nias boys bound for mission school in Sumatra, we sailed for Sibolga.

Our old enemy the wind caught us again that night and tossed us like a button in a washing machine. By morning we were 80 miles south of Sibolga, paralleling the rebel-held part of the Sumatran coast.

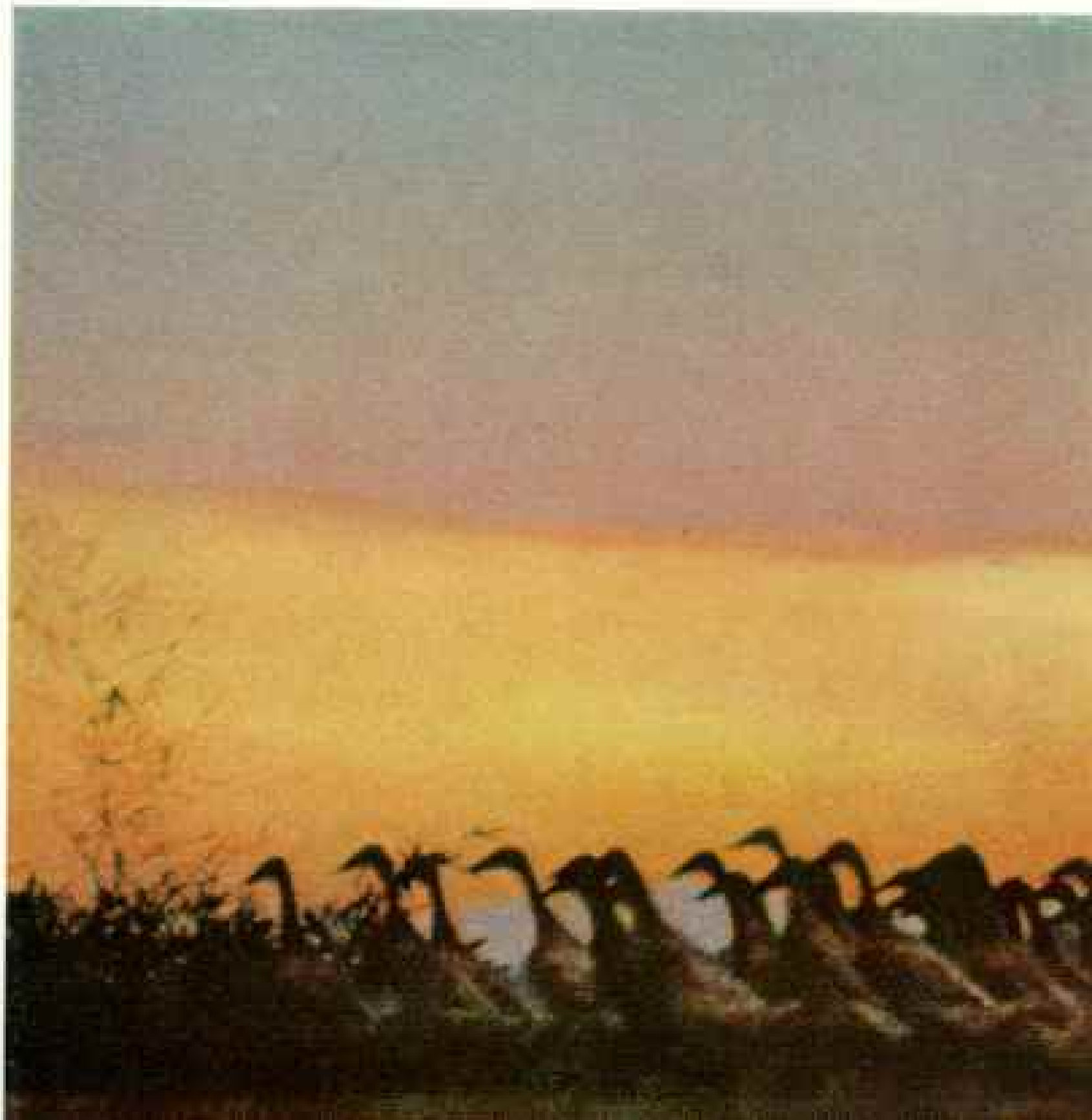
Ibrahim brought a message from the captain: "The ship can't take these waves, and the blow may last two days. We must make for port. But we're not sure which ports are in government hands. Possibly Airbangis, halfway to Padang, is all right, but we aren't even sure there is enough fuel to carry us that far."

"Speedboat" Raises Fear of Attack

For the rest of the day, *Utama* cruised at a fuel-saving four knots. Tension mounted. We kept watching the shore, and when the captain reported a speedboat coming to intercept us, the crew fell deathly silent. Ibrahim and the one soldier aboard took stations in the bow. The distance narrowed, and all eyes were fixed anxiously on the speedboat.

Finally, Ibrahim shouted from the bow, and the captain grinned sheepishly—our speedboat was a drifting log.

Homeward-bound ducks, driven by a Javanese farmer,



At dusk we anchored behind an island opposite Airbangis. A fisherman assured us the port was secure, and the next morning we docked.

One of the northernmost of Minangkabau towns, Airbangis had only recently been retaken, and during the day it took *Utama* to refuel, a meeting of the women had been called. An army officer in combat fatigues spoke in Minangkabau dialect. Ibrahim translated for us:

"Women of Airbangis," he pleaded, "call back your men from the mountains. Beg them to rejoin the republic."

Ibrahim was silent. Normally cheerful, he seemed depressed. We learned the reason later, when he suddenly blurted out: "We have so much to build. Why must we fight one another?"

We cleared Airbangis and finally made port at Sibolga. The army met us once more, and escorts convoyed us back across Sumatra toward Medan. We retraced the mountainous route that we had traveled weeks before. Trucks bristling with heavily armed soldiers always led the way.

It was dark when we reached the last mountain pass and heard ominous news that a truck had been burned less than half a mile from one of the army's picket posts.

We were still 90 miles from Medan, where a plane waited to return us to Palembang and to *Tortuga* and Dinah. Ibrahim left the decision to us:

"If you're willing to risk it, the army will drive you on to Medan as planned."

It proved to be a long, black night. At each rocky overhang, searchlights probed the shadows for possible ambush. It was dawn when we reached Medan and safety.

Indonesia's Strength: a Ready Smile

Ibrahim saw us to the airport and watched us take off. We had met many like him in Indonesia, a young nation run by young men who are gaining experience the hard way.

Having met Ibrahim and his countrymen, we think we understand now why Indonesia has survived her first decade and a half. It was Ibrahim's grin and final wave that reminded us: With all her troubles and heartache, Indonesia remembers how to smile.

march like a company of soldiers. Sunset silhouettes Mount Semeru

HIS FATHER-HOME BY HELEN AND FRANK SCHREIDER © NATIONAL GEOGRAPHIC SOCIETY

Beneath their flag, South Vietnamese wave hats to hail a visit by President Ngo-dinh Diem

Southeast Asia: Arena of Challenge

FEW AREAS of the world are more consistently and ominously in the news than that shown in the Society's newest map, **Southeast Asia,** distributed to members with this issue.*

Here, under the shadow of Red China, lie crucial outposts of freedom: strife-torn Laos and troubled Viet Nam, half Communist and half free. Here, too, the tiny Portuguese colony of Macao and British Hong Kong stand precariously as the Free World's only windows on the Chinese mainland.

Drawn across the narrow waist of Viet Nam near the 17th parallel is the cease-fire line that slices the country in two. In Laos, Viet Nam's western neighbor, lie towns with odd names that appear frequently in the news: Phong Saly, Sam Neua, and Xieng Khouang. From these centers Communist guerrillas, with support from North Viet Nam, have launched attacks threatening the Laos royal and political capitals, Luang Prabang and Vientiane.

To the south sprawls the vast land-and-water world of Indonesia. Authors Helen and Frank Schreider, whose adventures appear elsewhere in this issue (page 579), needed military escort to visit many parts of the strife-wracked republic.

Cartographers Map Island Maze

To map accurately this island-studded region (the Philippines alone number more than 7,000 islands, Indonesia some 3,000) proved one of the most difficult tasks the Society's cartographers ever faced. Much land remains wilderness—rugged mountains and jungles where tigers and orangutans roam.

In contrast, the settled regions of the map

hold some of the world's densest populations —Java averages more than 1,000 people per square mile—with a bewildering variety of languages, religions, and political beliefs. And these areas are changing as never before.

Perhaps this change—with forces causing it—is best seen in Cambodia, a pawn in world politics since it became independent in 1955. The map shows the country's only modern seaport, Sihanoukville, just one year old. The French-financed city bears the name of Cambodia's Chief of State, Prince Norodom Sihanouk.

A red line connecting Sihanoukville with the capital, Phnom Penh, traces a modern 133-mile highway—complete with elephant crossings and dirt lanes on either side for ox-drawn traffic—constructed with U. S. aid. In the capital itself, Russia has built a large hospital, and Red China backs factory construction.

Thailand—the only Southeast Asian country that escaped colonial rule (*Thai* means free)—utilized United States assistance to build a "Friendship Highway" between Bangkok and Korat. A vast new power and irrigation project, Bhumiphol Dam, named for Thailand's king, is under construction on the Ping River. Another huge dam was completed at Chainat several years ago. Its extensive canal system, when finished, will irrigate more than two million acres.

Just off eastern Cebu in the Philippines, the 8,500-foot main runway of one of the largest jet airports in the Far East stretches across tiny Mactan Island, a base for both military and commercial planes. Magellan was slain here just 440 years ago, the victim of unfriendly natives.

The whole region recalls romance and adventure. Off western New Guinea lie the Moluccas—the Spice Islands that lured countless mariners with promise of rapid enrichment. South lies Timor, the island to which doughty Captain Bligh sailed in an open boat after the famous mutiny of H.M.S. *Bounty* in 1789.

Modern Explosions Turn Political

Between Java and Sumatra rise the remains of the volcanic island of Krakatau, which blew up in 1883 with a roar heard thousands of miles.

Today's explosions from this area are of a different kind, but they, too, echo around the world. Your up-to-date map will make them more meaningful when they appear in tomorrow's headlines.

*Southeast Asia, twenty-fourth in the series of uniform-sized maps issued as magazine supplements in the past three years, becomes Plate 49 in the Society's Atlas Series.

More than 330,000 members have ordered the convenient Atlas Folio, at $4.65, to bind their maps. Single maps at 50 cents each, or a packet of the 21 maps issued 1958-60 at $8.25, may be ordered from the National Geographic Society, Dept. 68, Washington 6, D. C. The folio plus all 21 maps folded flat is available at $12.50.

Low-rent apartments hearten Hong Kong's homeless, many of whom still live on sampans 627

PHOTOGRAPHS BY MELVILLE BELL GROSVENOR (BELOW) AND HOWARD SOCHUREK © NATIONAL GEOGRAPHIC SOCIETY

Enchantress!

QUEEN OF AN INDIAN PALACE, A RARE WHITE TIGRESS COMES TO WASHINGTON

By THEODORE H. REED, D.V.M.
Director, National Zoological Park, Smithsonian Institution

Photographs by THOMAS J. ABERCROMBIE
National Geographic Staff

"THE HAREM COURTYARD lies beyond this door," said His Highness, the Maharaja of Rewa, as he handed a servant a big brass key. "In my grandfather's day you would have been in trouble just for standing here—fanatic retainers, razor-sharp swords, and all the traditional amenities."

The door creaked open—revealing a gorgeous creature with inquisitive gaze focused on us. She stared with calm curiosity, then walked slowly toward us with the dignity of one to the palace born.

As she came closer, I was astonished by her perfect development. Her ice-blue eyes were peculiarly aloof, yet inquisitive. I extended my clenched hand in the experienced animal handler's form of greeting. Daintily, she licked my knuckles. Fortunately, bars separated us—her fangs were three inches long.

Here at last was one of the rare white tigers for which I had come halfway around the world. Her stripes were black, shading into brown, but her main coat was eggshell white instead of the normal rufous orange. Exotic coloring and magnificent physique

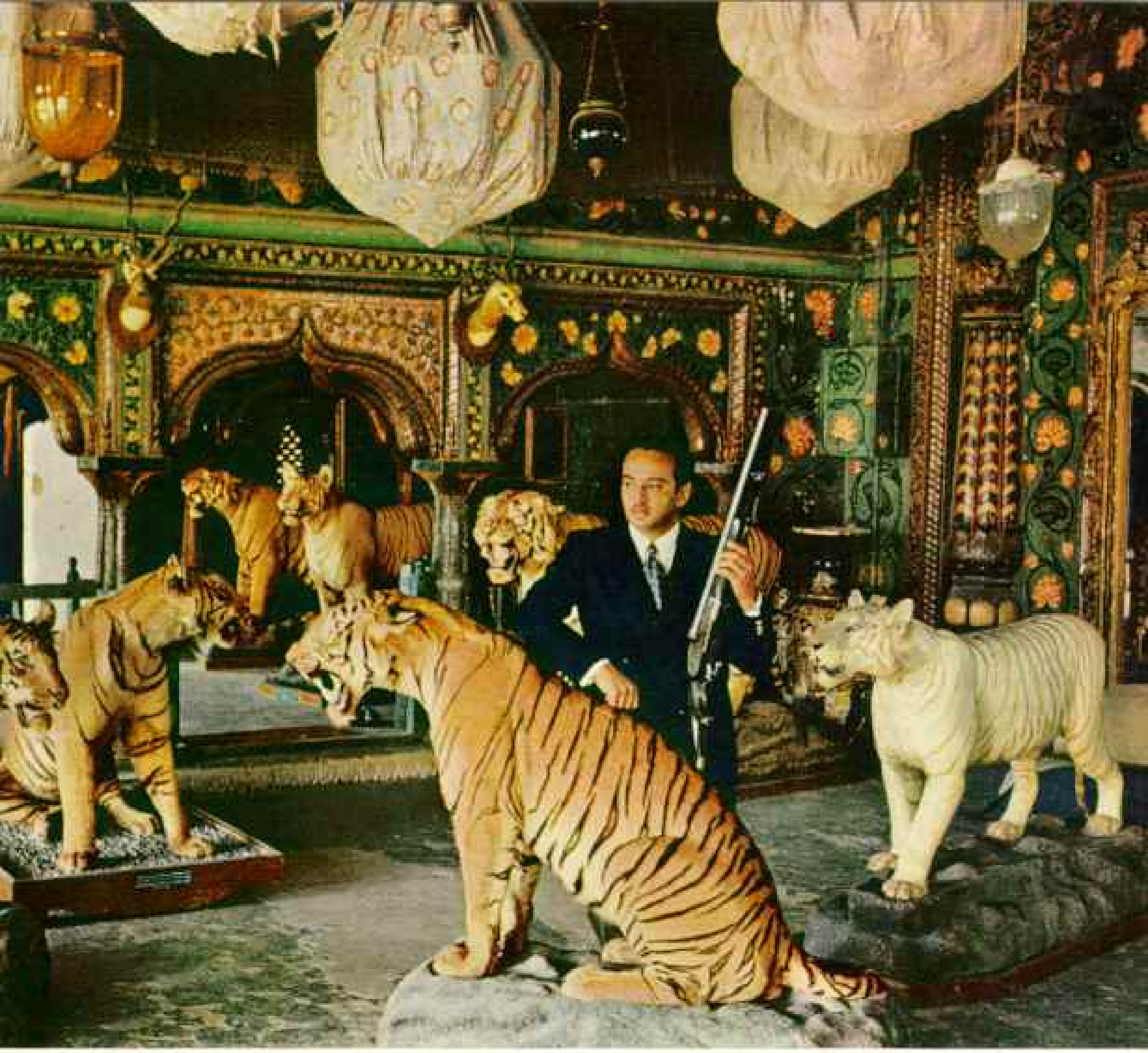
★ COLOR PICTURE BY NATIONAL GEOGRAPHIC PHOTOGRAPHERS
THOMAS ABERCROMBIE AND JOHN E. FLETCHER © N.G.S.

Wide forests of Rewa serve as a breeding ground for one of the rarest of all cats, the white tiger. Captive beasts live in a palace at Govindgarh. The town of Rewa served as capital of a onetime princely realm that now owes allegiance to the Republic of India.

Snarls frozen, eyes glazed, mounted tigers adorn the throne room of the Maharaja of Rewa. One at right is white.

Legacy of grandeur, a state coach parades before Rewa's pink palace. The Maharaja (left) and author Reed ride thronelike seats in a custom-made Daimler with a Rolls-Royce-type grill; photographer Abercrombie drives. Metal serpent on the fender houses the car's horn.

Dr. Reed, a veterinarian by profession, became interested in zoo animals after being named to the Mayor's Zoo Commission in Portland, Oregon, in 1951. The interest led him four years later to the National Zoological Park in Washington, D. C., where he served as zoo veterinarian. In 1958 he became director.



KODACHROMES BY NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS J. ABERCROMBIE (ABOVE) AND BERT BARKER © N.G.S.

made her a tiger without peer. For a two-year-old kitten, she had tremendous growth—almost 190 pounds, three feet tall at the shoulders, and eight feet from nose to tail. Her three rowdy siblings bounded up to the door. The largest had heavier jowls and chunkier face, marking him as the male.

As I studied the tigers studying us, I was glad that financial details had been completed before I came to India. How could I have made a canny bargain after seeing these magnificent cats?

I noted the possessive smile of my traveling companion, Bert Barker, senior keeper of cats at the Smithsonian Institution's National Zoological Park in Washington, D. C. One of these rare animals was to be "his." A camera hid the face of Tom Abercrombie, NATIONAL GEOGRAPHIC photographer. I doubt if the tiger ever saw his face—she thinks he has a telephoto nose and range-finder eyes.

After a while the Maharaja suggested tea. Even though these were the only white tigers in captivity, they had become commonplace to him. As we reluctantly left the tigers, His Highness was explaining that, since Indian independence, he had been unable to maintain two palaces. He resided in the town of Rewa, 12 miles away, and the 120-room Govindgarh palace housed the white tigers, the shikaris—hunters for the Maharaja—and a few pensioners (page 636).

On the delicate stone-and-marble pavilion overlooking Govindgarh's lake, five liveried servants waited on the four of us. The smiling butler never permitted our fine bone-china cups to be less than half full.

As my gaze drifted out over the lake, I recalled how, more than a year and a half previously, I had first heard of the white tigers

Orange Tigress Mothers White Cubs

Rare white tigers stalk the forests of Rewa like ghosts; hunters' diaries have recorded sightings of only nine in the past fifty years.

A decade ago the Maharaja of Rewa captured a white male and mated him with a normal female. All the cubs were born orange.

The male then was bred to one of his daughters, the big cat at right. One of their white offspring is Mohini, or Enchantress, now a resident of the National Zoological Park in Washington, D. C.

Here, in the "tiger palace" at Govindgarh (page 636), the mother guards three cubs of her second litter. Two are white, one orange.

Cubs at play by the drinking pool suggest Hilaire Belloc's lines:

The Tiger . . . is kittenish and mild, he makes a pretty playfellow for any little child. . . .

HI EKTACHROME (BELOW) AND KODACHROMES © NATIONAL GEOGRAPHIC SOCIETY

Crated for her journey to the United States, Enchantress bids farewell

of Rewa. Ralph S. Scott, a Washington realtor and attorney, had seen them on a hunting trip to central India. He thought that one should be exhibited at the National Zoological Park. Later he interested Mr. John Kluge, President and Chairman of the Board of the Metropolitan Broadcasting Corporation, in purchasing a white tiger "for the children of the United States." Now I was here at Rewa to select and escort the tiger to a new home at the national zoo.

As we sipped our tea, I asked His Highness the history of the seven white tigers in his "tiger palace." He explained that his family coat of arms (page 628) bore a white tiger because Rewa district was one of the few known habitations of these beasts, of which nine had been reported during the past fifty years.

The ninth cub, about nine months old, was caught in 1951. When mature, he was mated to a normal-colored, recently captured female. Three litters totaled ten cubs, all the usual color. He was then mated to one of his daughters, and in 1958 they produced four white cubs, one male and three females. In 1960, two more white males and a normal female were born.

We were to choose from the first litter, and there was no question that the first tiger we had seen was the one we wanted.

Maharaja Gives Big Cat a Name

It was His Highness who suggested that we name our tiger "Mohini"—one capable of enchanting. We call her the "Enchantress," for surely she has entwined us about her little claw.

The Maharaja's shikaris had already built a shipping crate for our prize and placed it in her feeding area so that she could become accustomed to it. The next step was to arrange transportation to the United States.

to her white sisters and brother in the courtyard at Govindgarh summer palace

Bert decided to stay with Mohini, learning a few local terms of endearment that the shikaris used. I signed over 100 hundred-dollar travelers checks to the Maharaja, happily divesting myself not of a money belt but of a money corset.

Mr. Arimardan Singh, private secretary to the Maharaja, promised to deposit the money immediately and prepare an official receipt so that the necessary export certificate could be issued by the Reserve Bank of India. He also got me a train reservation from Allahabad to Delhi.

"You will be very comfortable," he said. "We have arranged a first-class sleeping compartment. All you need is bedding."

Since I had none, Mr. Singh supplied a bedroll, and I caught the night train from Allahabad.

Breakfast was an experience: My order was taken at one station, delivered at the next, and the plates were removed at the third.

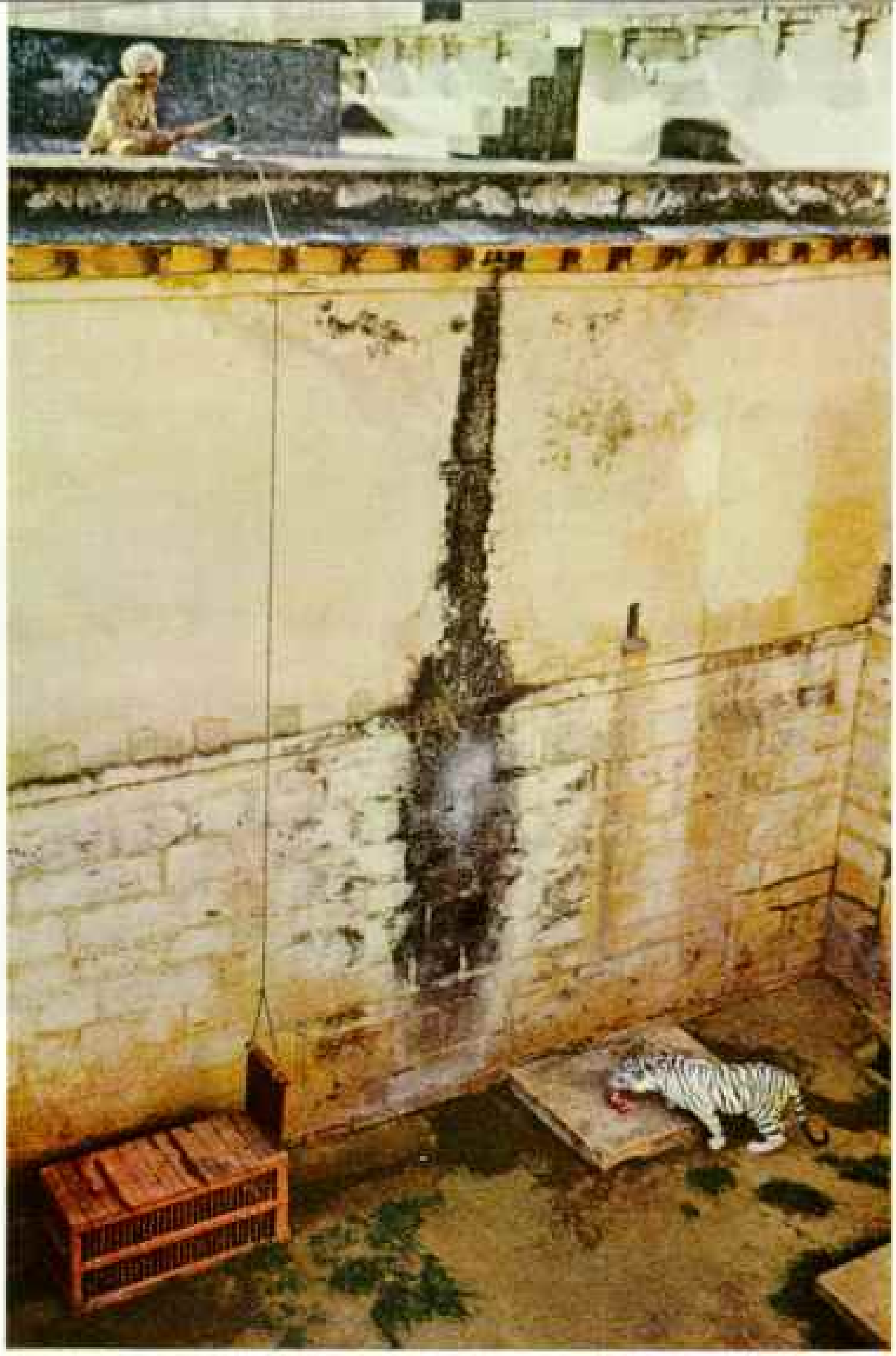
In New Delhi I arranged for transport to London by Air India. American Embassy officials agreed to get a clearance from customs. I hired a truck to pick us up in Rewa on November 27 and deliver us to New Delhi in time to make the 5 p.m. plane. Then, with a happy heart, I returned to Rewa.

Complication Threatens Departure

I arrived in time for tea on Friday, November 18. With a courtesy typical of his countrymen, Mr. Singh let me finish my first cup before he jolted me with the news that the bank had refused the travelers checks. I would have to cash the checks myself and then pay the Maharaja in rupees. While this could be done on Monday, it would delay issuance of the export papers.

Early Monday, Mr. Singh and I called on the local representative of the State Bank of

How to Cage a Tiger



AT HOME in the harem quarters of a palace, the white tigers of Rewa live in pampered luxury (opposite). By day they sleep in rooms where veiled beauties once lounged. At night they roam arcades and courtyards haunted by the romance of a bygone age.

To cage Enchantress for the author, the Maharaja ordered his shikaris, or huntsmen, to serve each tiger its meat in a special place. Enchantress's food was regularly dropped on a stone platform. At left, she feeds on half her meal, the remainder having been placed in the cage. When she nosed behind the bars to finish her food, the shikari on the wall cut the rope, and the cage door slammed shut.

Eleven bearers lift the 190-pound cat as she begins the journey that carried her halfway around the world.

PHOTOGRAPHS BY NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS J. ABERCROMBIE © N. G. S.

US CATALOGUE © NATIONAL GEOGRAPHIC SOCIETY

Winging across the Atlantic. Enchantress catnaps beneath the author, who takes a turn at tiger sitting. He or his assistant guarded the animal day and night.

India. After polite preliminaries, he inquired hesitantly whether I needed the $10,000 in cash, or if a paper transaction would suffice.

I said I simply wanted the money credited to the Maharaja's account. He sighed with relief.

"It would take some time to obtain that much cash," he said. "Forty-seven thousand rupees is quite a lot of money."

I agreed that it was a considerable sum in any man's currency. Realizing that I must have the tiger on the airplane in exactly one week, I decided that I personally would carry the necessary receipts and health certificate to New Delhi.

This time I reserved space on Indian Airlines from Allahabad to New Delhi. The kindly ticket agent in Allahabad arranged for me to nap in the hotel until time to leave. At midnight he awakened me; when I got downstairs, he was waiting to drive me to the airport. There he weighed my luggage, gave me my claim ticket, and prepared tea. Soon he excused himself to go and turn on the airfield lights. When the plane arrived, he flagged it to the ramp and, after introducing me to the pilot, proceeded to gas the aircraft. Then, giving the captain his flight documents, this rare individual in the age of super specialization waved us a fond farewell.

In New Delhi the U. S. Embassy staff procured my coveted bank certificate with no difficulty. One final piece of paper was necessary, the customs bill of lading, a mere formality. This, I was told, an Embassy representative would pick up Friday.

Again I departed for Rewa with a happy heart, arriving at the Maharaja's palace in time to celebrate at a sumptuous dinner—a double celebration, for it was Thanksgiving Day in the United States.

Cage Door Threatens to Bobtail Cat

The next afternoon was set aside for crating Mohini. The plan was to put her meat ration in the shipping cage. A rope held up the heavy door; when she entered, a shikari would cut the line, allowing the door to fall shut behind her (page 637).

I soon saw a flaw in the plan: The heavy teakwood door could guillotine her beautiful tail. My consternation rose when I realized

that no one could translate my fears to the head shikari.

I could not bear it; I left. I heard the door slam down and a startled roar from Mohini. My heart hit the ground. I was positive that we had a bobtail cat.

I dashed back to the observation point. The head shikari beamed. Bert clapped him on the back. We entered the yard to secure the cage door, and only then did I relax. The shikari had placed two small blocks under the door so that it could not completely close.

Within 30 minutes Mohini had finished her meat and was grooming her coat. A true aristocrat, she had adjusted to her new situation with dignity and aplomb.

Telephone Call Brings a Jolt

At Rewa about nine o'clock that evening, the phone rang. A U. S. Embassy official at New Delhi, after the usual pleasantries, said casually, "By the way, we're having a little trouble up here."

"What seems to be the matter?" I asked innocently.

"The government officials won't let your tiger out of India."

My spirits fell like the gate on Mohini's cage. I was speechless. Finally I collected my senses enough to ask what had happened. Customs, he told me, had been advised of a government ban on export of white tigers. The Inspector-General of Forests feared that Mohini's departure might endanger chances of perpetuating the strain in India.

Nothing could be done over the weekend. Our diplomat suggested that I leave the tiger in Rewa and come to New Delhi on Monday.

When the shock wore off, I reviewed the facts. First, I had a letter from the Indian Ministry of Commerce and Industry, issued before we left the United States, stating that there would be no difficulty in exporting the white tiger. Second, customs officials had previously assured the Embassy that white tigers could be exported. Third, the tiger was caged and ready to go, and transport arrangements to New York were completed. It might be some time before we could book cargo space again.

I decided to take the tiger to New Delhi as planned and try to get clearance. I phoned the United States Ambassador, Mr. Ellsworth Bunker, and told him that I was bringing the U. S. Government's tiger to New Delhi and would certainly appreciate all the assistance he could give me. He made an appointment for me with his counselor for political affairs, Mr. Wallace W. Stuart.

At 2 p.m. Sunday we loaded. Bert wisely insisted on padding beneath the tiger's crate. By the time I had explained this to Mr. Singh and the orders went down the chain of command, we ended up with two feet of straw in the truck bed.

Tiger Takes 500-mile Hayride

It was with real regret that we said goodbye to the Maharaja. Most of his palace retinue turned out to wave us off, and we needed only a brass band to make it complete.

The trip that followed was a 16-hour, unromantic, 500-mile hayride, the coldest and most uncomfortable journey I ever experienced. Mohini seemed warm and cozy enough in her well-padded crate, but Tom, Bert, and I shivered in the back of the truck, burrowing deeper into the straw as the night temperature dropped.

Passing through a village, we paused to watch an itinerant trained bear dance to his keeper's drumbeat. Was this a prophetic sight? Were we to become wanderers over

Mohan, father of Rewa's captive white tigers, prowls the palace grounds. Having blue eyes but lacking skin pigmentation, he is a semi-albino. Since such traits may be inherited, the author and the Maharaja hope to develop white tigers as a strain.

On the White House lawn, President Eisenhower surveys the tigress. Only white tiger in captivity outside India, Enchantress barely escaped an export ban. Here travel grime grays her coat; later she licked herself clean in typical feline fashion.

India with a white tiger as our meal ticket?

We arrived at the Embassy at 7 o'clock Monday morning, chilled, dirty, tired, and shedding straw. After shaving and changing clothes, I joined forces with Mr. Stuart and other Embassy officers in a do-or-die effort to obtain a release for our tiger by 5 p.m.

The next few hours were the most tense and hectic of my life. With two other American officials, Mr. Stuart and I made our way through official channels of the Ministry of Food and Agriculture. At each office we painstakingly explained the known genetics of white tigers and attempted to demonstrate that Mohini's export would not endanger India's future supply of these rare animals.

We first met disbelief, then skeptical curiosity, and finally sympathetic understanding. As time grew short, a high ministry official gave the word that meant so much.

"I will see that customs is telephoned," he said, "and given clearance for shipment of your tiger."

But there was another hitch. The customs officials refused to accept telephone approval. A signed document had to be procured; when it finally arrived at the airport, our plane was already loaded, and Bert and I were rapidly nearing nervous collapse.

India is a wonderful country and I hope to return. I must say, however, that I breathed a long sigh of relief when our plane, with Mohini, Barker, and Reed safely aboard, lifted its wheels from the runway.

Enchantress Will Stay White

Mohini slept most of the way to London, and she had plenty of company (page 638). At London we had a six-hour wait before boarding Pan American for New York. Mohini was quartered in a warehouse.

Two ground hostesses delivered meat for her dinner. As they watched Bert feed her, one told the other: "I like this beautiful white color, but mercy, you should see them when they grow up. They turn the loveliest shade of yellow!"

Turning to Bert, she asked in all sincerity, "At what age will she start turning yellow?"

He replied, "If this cat ever turns yellow, Dr. Reed and I will sure quit the zoo business fast!"

In New York, after press interviews and pictures, Bert put Mohini and her crate under shelter at the New York Zoological Park. Then, for the first time in four nights, we slept in beds.

Thursday we took our tiger to Philadelphia,

NATIONAL GEOGRAPHIC PHOTOGRAPHER © NATIONAL GEOGRAPHIC SOCIETY

where she was on display for three days before traveling on to Washington.

On Monday, December 5, 1960, on the White House lawn, Mr. Kluge, who had financed both the purchase and our trip, presented Mohini to President Eisenhower for the children of the country. Our Enchantress rose to the occasion with a few growls and one small ladylike roar (above). President Eisenhower remarked that the white tiger he saw in New Delhi the year before (one of Mohini's sisters) was whiter than Mohini. I explained that she was still dirty from the trip.

"Who," the President inquired, "is going to give her a bath?"

Happily, she does that herself.

Plants That Eat Insects

Flytraps, sticky sundews, and pitcher plants, whose pools drown victims, grow in a Washington, D. C., garden

Article and photographs
by PAUL A. ZAHL, Ph. D.
National Geographic Senior Staff

ON A SUMMER'S DAY a delivery truck drew up before our home in Washington, D. C., and deposited several large cartons marked "Rush!" My children, Eda Kristin, 11, and Paul, 8, helped me carry the boxes to our little brick-walled garden, where my wife waited with digging tools and sprinkling can to begin planting operations.

From one carton I removed a number of small plastic bags labeled "VENUS FLYTRAPS." Each bag contained a wet clod about the size of a grapefruit. On its upper surface, partly obscured by grass and moss, lay a flattened green rosette, just as it had been dug from a Carolina swamp a few days before.

"Doesn't look very dangerous to me," young Paul observed skeptically.

I had told Paul that Venus flytraps have leaves that snap shut viciously on anything that dares intrude. Each of our specimen's ten or more leaf traps was closed, probably because of jostling en route; the opposing rows of green "teeth" meshed tightly like the fingers of hands clenched together.

With the blade of a penknife, I pried several of the traps open, and in one discovered the body of a half-inch ant that had met an untimely death. Seeing the evidence, Paul was becoming more impressed.

I opened another of the plastic bags. Here, too, nearly all the traps had shut. One, however, had resisted the vibrations of the 300-mile truck ride from North Carolina. On the inner surface of its gaping jaws stood several stiff hairs—triggers that mean death for the unwary insect.

The family crowded round as I lowered the tip of a toothpick into the trap's jaws, barely touching the hairs. In the blink of an eye, the leaf halves swept together, their prongs interlocking so tightly that the toothpick stood erect when I released my hold.

The demonstration fascinated the children.

Doomed housefly, drawn by a secretion that rims the Venus flytrap's spiked jaws, steps into a botanical ambush. When he brushes the dark trigger bristles, the leaf halves snap shut. Once sprung, the leaf acts as a stomach, digesting prey in five to ten days. Glands that produce digestive enzymes color the reddish area.

Dionaea muscipula, actually more adept at capturing crawling insects than flies, inhabits Carolina coastal swamplands.

Fly at right tries to wriggle free. Eight trigger bristles—two more than the usual number—arm the trap opposite.

KODACHROMES © NATIONAL GEOGRAPHIC SOCIETY

I realized that they had been too young to remember much about the terrarium full of carnivorous plants that I had grown in our New York apartment six years before.* This time I had two terrariums, as well as a conservatory no bigger than a doghouse in our garden. We were prepared for both indoor and outdoor observation of the insect eaters.

Completing our shipment from North Carolina were plants of several other kinds that trap insects, numerous clumps of mosses and liverworts, and two 50-pound bags of acid soil. These were basic ingredients of a southern boggy lowland, a few square feet of which we hoped to re-create in a corner of our Washington garden.

Though insectivorous plants are unique in being able to eat meat, the leafy types still need sunlight. Accordingly I had made my conservatory lid of transparent plastic and its sides of glass. To ensure a warm and humid climate, I sealed the structure but left one pane adjustable for ventilation.

*See "In the Wilds of a City Parlor," by Paul A. Zahl, NATIONAL GEOGRAPHIC, November, 1954.

The Author: Senior staff member Paul A. Zahl ably employs camera and typewriter to provide fascinating glimpses into natural history. He is a research associate of Haskins Laboratories and the American Museum of Natural History, New York City. For his most recent NATIONAL GEOGRAPHIC contribution, see "How the Sun Gives Life to the Sea," in the February, 1961, issue.

Insects Beware! The Author Plants Living Traps for Unwary Ants and Flies

"Among the most puzzling phenomena in nature," Dr. Zahl terms the 450-odd species of plant carnivores. Found around the globe, traps range from microscopic nooses on tiny molds to Borneo's foot-deep leafy urns that can hold seven pints of water. The traps attract, capture, and consume small prey, apparently enabling the plants to thrive on nutrient-poor soils.

Here Eila Zahl unwraps pitcher plants while her husband transplants them in their Georgetown, D. C., garden. Glass-and-plastic conservatory re-creates the humid summer climate of the Carolina coast.

Fascinated, the Zahl children watch a housefly buzz dangerously close to a Venus flytrap.

Parlor terrarium houses sticky sundews and Venus flytraps. Dr. Zahl trowels space for *Sarracenia purpurea*, the common pitcher plant. Bowls hold sphagnum moss and soil from Carolina lowlands.

KODACHROMES BY PAUL A. ZAHL, NATIONAL GEOGRAPHIC STAFF © N.G.S.

KODACHROMES © NATIONAL GEOGRAPHIC SOCIETY

Pampered by indoor living, flytraps yawn for a beetle fed by hand

While we were busily setting our Carolina wards in their new homes, my daughter whispered suddenly: "Look, Daddy, a meal is coming!"

A common housefly circled a Venus flytrap, then settled near one of its open leaf traps. Perhaps attracted by odor or color, the insect crawled nearer the plant's open jaws. It was about to enter and, by brushing the trigger hairs, set off a true-life adventure before our eyes, when an airliner roared overhead. Away zipped the fly, leaving both us and the flytrap agape. Though deprived of seeing an actual capture, we had witnessed the plant's talent for luring its prey to the brink of death.

We left our botanical menagerie undisturbed for a few days while the plants adjusted to their new home. Meanwhile, I did some reading on the care and feeding of our new house guests.

Cupped Pool Holds Peril

Throughout the world, from tropical swamp to upland marsh, some 450 species of carnivorous plants flourish, utilizing curious equipment to attract, capture, and digest small forms of animal life. Some live in trees, some underwater, but typically they grow in soil that is wet and acid, and usually deficient in the nitrates and phosphates that plant life requires. It may be that carnivorous plants survive in poor soil because their prey provides enough basic protein to supplement the starches and sugars produced in their leaves by the process of photosynthesis.

Highly specialized leaves (not flowers as many cartoonists suppose) use three basic devices to capture food. The "steel-trap" type claps its leaf halves shut to imprison unwary insects. The "flypaper" species mire their prey in a sticky secretion. Victims of the "pitfall" plants tumble to their death in a cupped pool of water mixed with digestive fluids.

Birth of a flytrap occurs as twin cotyledons —seed leaves—emerge from their jet-black coat and sprout root hairs that anchor in the earth. Two weeks later (center) the plant, magnified about 15 times, is well rooted, though the seed husk still perches on leaf tips. Aged 50 days (bottom), it has a leaf trap resembling a toothbrush. Venus flytraps develop more readily from stem cuttings than from seeds. The author nurtured this seedling in a home terrarium.

All three trapping methods are found among the six carnivorous genera of the United States.

Insect-eating plants first came to the attention of the scientific world in 1760, when Governor Arthur Dobbs of North Carolina wrote to a European friend about a small, bizarre plant found in his colony's southeastern lowlands. Accurately, the governor described the plant's leaves as "like a narrow segment of a sphere, consisting of two parts . . . upon any thing touching . . . or falling between them, they instantly close like a spring trap, and confine any insect or any thing that falls between them. . . ."

The governor, who called the oddity "Fly Trap Sensitive," had no inkling as to how the traps were set off, or of what value any captured insect might be. In 1769 John Ellis, in a letter to the famed Swedish botanist Linnaeus, gave a more formal description of the species, affixing the Latin name *Dionaea muscipula*. A century later Charles Darwin, fascinated by the plant's rapidity of movement, spoke of it as "one of the most wonderful in the world."

Tests Reveal Electrical Activity

How the mere touch of a toothpick or an insect on one of the flytrap's minute trigger hairs can cause so violent a reaction is an open question. Plants have neither muscles nor nerves. What then is the source of the mechanical energy?

Plant physiologists, who have puzzled over the phenomenon for more than a hundred years, still cannot agree on the answer. Some think the power comes from a sudden release of osmotic, or fluid, pressure near the leaf's midrib. Others theorize that because the leaf halves do not grow at a uniform rate, tissue layers are under tension; when the tension is released, the leaf snaps shut.

How this tension develops and how the signal is transmitted from the trigger hairs are moot questions, although a recent study has shown tiny electrical disturbances during the action.

Any snare, no matter how skillfully constructed, is useful only if its intended victim can be lured. To this end, the Venus flytrap has special glands that apparently produce an enticing substance. Ants and flies, entering to dine, inadvertently step on or brush against the trigger hairs.

The leaf halves usually sweep shut in less than half a second; thus only the swiftest of insects can flee in time. Despite the plant's name, most of the traps I opened during my Carolina swamp expeditions held remains of ants, not flies. Paul and I, experimenting at home, found that a large specimen of either insect can sometimes squirm free (page 643). The tiniest victims, on the other hand, are often able to escape through gaps between the interlocking teeth.

To feed our outdoor plants, we removed the top of the conservatory every few days and allowed free entrance to any adventurous garden insect. We had no way of knowing how many or what kind were actually consumed.

Traps Survive Freeze, Flood, and Fire

Once every week or two, plants of the terrariums were treated by hand to netted flies or garden ants. At the end of the summer there was no noticeable difference between the condition of the outdoor plants and those kept indoors near a window.

My conservatory was unheated, and during the winter its occupants withered and turned brown after exposure to freezing temperatures. In the spring, however, nearly all produced lovely little flowers and many new traps.

Some of my garden plants, intentionally deprived of insects, survived for months, although waning considerably. Botanists believe that consumed insects serve carnivorous species much as nitrate fertilizer or compost aids more prosaic plants—contributing to maximum growth and vigor but not needed for subsistence. Exactly how the Venus flytrap digests and absorbs its prey has yet to be explained.

Another botanical mystery is the fact that, while some carnivorous species thrive widely, others grow only in restricted zones.

Why, for example, is the Venus flytrap native only to the Carolina coast? Though rising waters often cover them, traps appear to function nearly as well submerged as in the air, at least for a time. Drs. Patricia R. Roberts and H. J. Oosting, of Duke University, were first to report finding remains of small aquatic animals—planarian worms, May fly larvae, and even small newts—in the maws of flooded Venus flytraps.

Moreover, *Dionaea* seems quite resistant to surface fire, and is among the first plants to reappear on any burned-over area. Fires

Innocent-looking blossoms and buds belie the hazards lurking in Venus flytrap leaves.

Forceps-fed leaf trap snaps shut in a fraction of a second. Faint electrical activity occurring when prey disturbs the bristles apparently accompanies the release of tensions that hold open the leaf halves. Trap's unremitting squeeze sometimes approaches two ounces, overpowering its captives.

A mature plant may grow as many as a dozen traps. If deprived of insects, it will accept an occasional bit of meat. If overfed, the leaf turns brown and dies prematurely.

BORCHROMES © NATIONAL GEOGRAPHIC SOCIETY

that sometimes sweep the fields during drought may even help the species, for without the occasional removal of ground vegetation, the plant eventually would be stifled.

On my first trip to North Carolina, I stopped on an August day at the village of Elon College, set among rolling hills not far from Greensboro. On a low ridge just outside the town are the headquarters of the Carolina Biological Supply Company, where my friend Bill Pendergrass serves as head of the culture department.

Many a biology and premedical student is indebted to such organizations as this for the specimens he dissects and studies. Vertebrates, invertebrates, molds, fungi, protozoa, green plants, bacteria, microscope slides, chemicals, and laboratory apparatus are but a few of the 30,000 items listed in the company's bulging catalog.

"Last year," Dr. Thomas E. Powell, Jr., president of the company, told me, "we filled orders for Venus flytraps from every State in the Union. High school and even college biology classes find them fascinating.

"The species is protected under North Carolina law, but the State gives us a collecting license because our purposes are educational and scientific."

Baby Flytraps Open Shop Early

Dr. Fred W. Emerson, director of the company's botany department, showed me some Venus flytrap seeds—black enamel specks shaped like tiny eggplants.

"Normally," said Dr. Emerson, "they remain viable for only a few months after the June-July collecting, but the seeds last almost indefinitely if kept under refrigeration. Here," he said, handing me a small packet, "put some of these in one of your terrariums and see what happens."

I did. For nearly three weeks the seeds lay where I had gently placed them on the damp soil. Then one day a tiny growth appeared at the narrow end of some of the seeds. It was covered with delicate root hairs. Two weeks later, this root had turned downward and anchored itself in the soil of my seed bed.

I was absent from Washington through part of October and most of November. When I returned, I found the seedlings had developed into miniature Venus flytraps, complete with traps squarish in shape, so small that one could barely see them without a glass. Yet, remarkably, each leaf trap stood open as though ready to perform (page 647).

Botanists say that it takes as long as three years for a seed to produce a full-size flowering plant. Venus flytraps may be propagated more quickly from bulblike underground sections of the mature plant.

Plants Prove Hard to Find

My principal objective, however, was not to grow plants from seeds, but to obtain live specimens from the field. With Bill Pendergrass I set out in a small truck through Carolina tobacco country. In late afternoon we approached the coast near Wilmington, crossing stretches of sandy savanna patched with swamps and stands of longleaf pine.

Occasionally we stopped, pulled on rubber boots, and walked along the edges of the roadside marshes. But our search for Venus flytraps was fruitless.

"We're too late in the season to spot them easily," Bill said. "In May you can see their white flowers by the hundreds, but now the plants are overgrown by grass. I've known inexperienced people to hunt for them for days; yet all the time they'd literally been stepping on them."

Next morning we hit pay dirt. At our first stop, in less than two minutes of walking through dewy undergrowth, we came upon an unexpected prize. Here the ground glistened with hundreds of tiny jewel-like clusters, some as large as a half dollar and almost as flat. They were sundews—of the genus *Drosera*—that trap their prey by using the flypaper principle.

From the leaves of each plant sprang scores of hairlike tentacles; at the end of each a tiny droplet of clear fluid captured the rays of the sun like a lens (opposite). I touched a globule with a twig and drew it away. The sticky fluid threaded out like taffy.

Living Flypaper, the Sundew Wears a Deadly Tiara of Sticky Jewels

Droplets glisten temptingly on the leaf of *Drosera rotundifolia*. Some 90 species of the genus throughout the world dine on insect prey. Ruby-tipped tentacles bear complex glands that secrete mucilage and digestive enzymes, then absorb nutrients from victims. Two lowest stalks on this cluster have joined accidentally.

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

Dime dwarfs sparkling leaves of the common sundew. A giant Australian cousin grows yard-long stems.

Fruit fly meets sundew with fatal consequences. Entangled in gluey threads, the fruit fly stimulates tentacles to bend inward. Half an hour later (lower) the fly has become mired, and digestion begins.

Flower and bud at top nod harmlessly above sundew's mucilage trap.

BOOMERANGS BY PAUL A. ZAHL, NATIONAL GEOGRAPHIC STAFF © N.G.S.

Kneeling on the soggy turf, I was engrossed in examining a leaf under a twenty-power hand magnifier when Bill called, "Look here, Paul!" He had discovered a cluster of Venus flytraps, growing close beside the sundews.

The flytraps, about half the size of tea saucers, lay almost hidden in sphagnum moss. Their traps yawned invitingly, some as wide as 75 degrees, waiting for an adventurous insect to come along and touch the fatal trigger hairs. Here and there a trap was tightly sprung—telling its wordless tale of a successful catch.

Our own luck was as good. By noon next day Bill had collected specimens of eight species—carnivores all. A week later they were thriving outdoors in my conservatory and indoors in my terrariums.

Plant's Glue Mires Fruit Fly

In North Carolina, we had seen the steel-trap principle of *Dionaea* in operation. The flypaper-type plants appeared to use a wholly different method of ensnaring their prey. Back home in Washington, I decided to try an experiment.

With fine-tipped forceps, I lowered a strug-

gling fruit fly, netted in the garden, down over a sundew, barely touching some of the mucilage globules.

I watched as the tiny, red-eyed fruit fly put up a furious struggle to escape the sticky surface. The more the fly beat and squirmed, the more it stuck to globules from neighboring bristles. Soon it wallowed helplessly. Once or twice it seemed about to escape, but each time the adhesive proved too strong.

Then a second lethal action came into play. One after another, the bristles began bending around the fly, like the arms of an octopus in slow motion. It happened so gradually that I could notice it best by leaving the scene for a few minutes at a time, then returning.

Tightly and more tightly the tentacles squeezed. Within 30 minutes their grip was viselike; even the leaf surface cupped inward a bit, so that the fly was completely immobilized, if not dead. I knew that, simultaneously, digestive ferments were being secreted around the insect (page 652).

I didn't watch to the end, for within an hour or so the victim was an unrecognizable wad. After a few days of digestion and absorption, the leaf tentacles resumed their original alert positions, ready for the next unfortunate victim.

Later I tried feeding bits of nonliving material to members of my sundew family: sand grains, crystals of sugar, tiny pieces of bacon. Only upon the bacon did the tentacles close, but with much less speed and vigor than around the thrashing fly. A dead fly that I later dropped on the tentacle surface caused only an indifferent response, suggesting that the violent escape effort of a living victim may be an essential stimulus. Thus the plant growing naturally in the field does not waste its full efforts on chance dirt particles, raindrops, bits of foliage, and the like.

Gaping maw, its lip coated with nectar, lures prey into the trumpet plant's well of death. Leafy umbrellas ward off rain. If brimful, the slender tubes of *Sarracenia flava*, shown twice life-size, might topple from weight of water.

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Leaves Cup Bitter Pools

I took my wife and children along on one of my field trips to the South, this time to seek and observe pitcher plants. We stopped beside the road in an area of southeastern North Carolina described on the map as the Green Swamp.

"This is rattlesnake and cottonmouth country," I cautioned, "so watch where you step and where you reach."

Actually we saw no venomous snakes during our five-day trip. Rather, as we wandered some distance from the car that first day, what caught my eye were some slender stems rising knee high here and there through grass and moss. Each stem bore a distinctive flower with thick greenish-yellow petals. We had found our

pitcher plants—carnivores that use the pitfall method of insect capture.

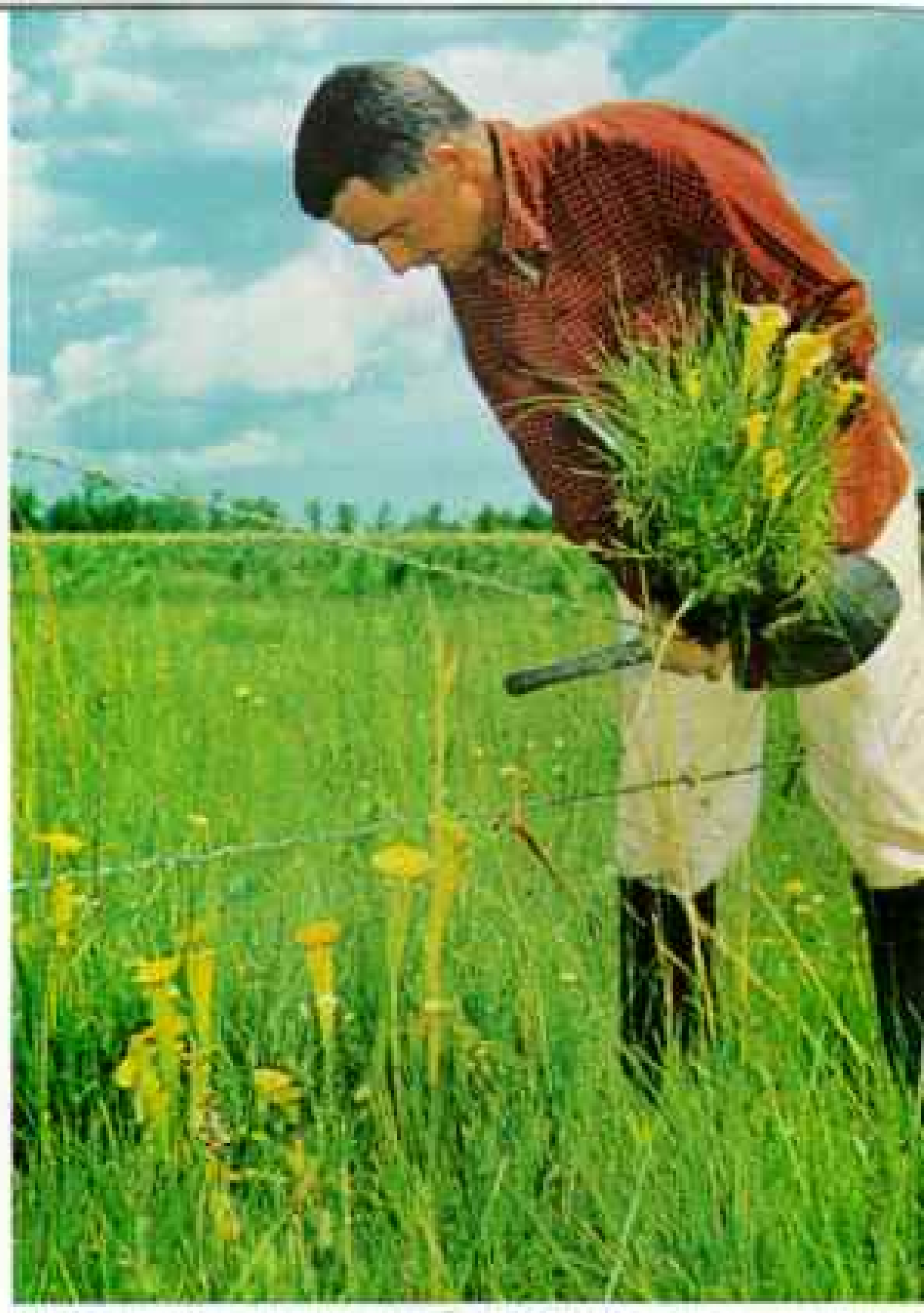
We separated the grass from around one of the flowering stems. There on the ground, cushioned deeply in sphagnum moss, lay a cluster of curious cornucopia-like structures—each a hollow banana-shaped horn, arcing upward and filled nearly to the brim with water. In one I saw the body of a fat spider drowned and floating (next page).

These horns of plenty were in fact the pitfall traps. Half of each horn's aperture was edged with a scalloped collar whose inner surface was covered with stiff bristles nearly prone and pointing ominously toward the water.

This member of the genus *Sarracenia*, together with two or three other species, inhabits bogs and savannas all along the east coast of the United States and Canada, northward as far as Labrador.

On a later field trip to Oregon and California, my family and I saw another pitfall-type trap—the magnificent three-foot-tall *Darlingtonia (Chrysamphora* Greene), or cobra plant. In the latter State, where laws protect the plant, we received permission to obtain leaves for study (pages 658-9).

These species, unlike the Venus flytrap and the sundew, have no independent movement. Capture is passive rather than active. Strong odors lure the insect into the horn of the plant. Having set foot on the bed of bristles, the intruder has no choice other than to continue forward and eventually to slip into



KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

Hunting insect eaters, botanist Bill Pendergrass appraises trumpet plants on a North Carolina field trip. Accompanied by the author, he collected representatives of eight different species.

Trumpet plant found in a bog near Wilmington, North Carolina, fascinates Mrs. Zahl and daughter Eda Kristin. Here they inspect leaf traps on a clump growing at the edge of a muddy pool.

the deadly pool below. In *Sarracenia*, the pool contains protein-digesting enzymes and bacteria. In *Darlingtonia*, bacteria alone disintegrate the victim, leaving the plant to absorb the nutrient matter.

Curiously, certain insects live boldly and unscathed in the dangerous environment of such death wells. One type of mosquito, for example, spends a considerable part of its life cycle in the well's lethal waters, somehow immune to the digestive enzymes there.

Certain small moths lay their eggs only on pitchers, and the larvae feed on the plant tissues. The larvae of some small flies feed on insects caught in the pitchers. And there are tiny wasplike creatures dependent as parasites on these inhabitants of the pitchers. A single pitcher may be a world in itself.

In Malaya, there is a spider that lives within a pitcher leaf and nowhere else, capturing insects lured to the plant and submerging itself safely in the pool below if threatened.

Some spiders post themselves near the

Drama unfolds beneath an observer's eye as an ant (below) struggles in a pitcher plant. Pitchers consume ants in enormous numbers.

Predator falls prey. "A spider lurking on the lip of this pitcher plant," says the author, "slipped into the pool below. Downward-curving spikes of *Sarracenia purpurea* barred its escape. Cause of death: drowning." Pool also holds a second victim.

Like a tank trap, the inner surface of *purpurea* bristles with spikes that cut off escape. The ant can only descend toward the deadly pool.

KODACHROMES © NATIONAL GEOGRAPHIC SOCIETY

Showy Cobra Plants Lift Hoods as if Poised to Strike

Unlike its reptilian namesake, the West Coast's *Darlingtonia californica* captures its prey passively. Mrs. Zahl, searching a slit leaf, uncovers worms, ants, flies, and other insects too deteriorated to identify. California's Mount Shasta, still snow-mantled in June, looms behind her.

Unfolding bloom at lower left surmounts the spotted hood that gives the cobra plant its name. Thin, translucent "skylights" crowning the trap delude winged victims. Beating futilely to escape, they tumble into the well. Few find freedom through the entrance beneath the hood.

Yellow-topped *Darlingtonia* crowd a roadside marsh near Florence, Oregon.

cupped entrance of *Sarracenia purpurea*, and there await insects lured by the plant. Even small toads and lizards sometimes sit near by, obviously to snatch unwary victims of the plant's attractions.

Fiction Offers Man-eating Trees

Although carnivorous plants capture varied fare in strange ways, none matches the giant plants in *The Patchwork Girl of Oz*. I quote from Frank Baum's classic story:

"Suddenly a leaf bent lower than usual and touched the Patchwork Girl. Swiftly it enveloped her in its embrace, covering her completely in its thick folds. . . .

"'Why, she's gone!' gasped Ojo, in amazement. . . . But, before he could think what to do to save her, another leaf bent down and captured the Glass Cat."

Then, of course, there is the fantastic "Man-eating Tree" of Madagascar, presented as fact to Sunday-supplement readers several decades ago:

"The atrocious cannibal tree that had been so inert . . . came to sudden savage life. The slender delicate palpi, with the fury of starved serpents, quivered a moment over [the girl's] head, then as if instinct with demoniac intelligence fastened upon her in sudden coils round and round her neck and arms; then while her awful screams and yet more awful laughter rose wildly . . . the tendrils one after another, like green serpents . . . wrapped her about in fold after fold, ever tightening with cruel swiftness and the savage tenacity of anacondas fastening upon their prey."

Should anyone encounter a specimen of *this* one, please notify me. I shall be delighted to make room for it, somehow, in my already overcrowded garden of carnivores.

ILLUSTRATIONS © NATIONAL GEOGRAPHIC SOCIETY

NATIONAL GALLERY OF ART (Chester Dale Collection) © NATIONAL GEOGRAPHIC SOCIETY

AUGUSTE RENOIR (1841-1919) *A Girl With a Watering Can*

One of the most popular paintings in Washington's National Gallery of Art, the canvas epitomizes the appeal and charm of the French Impressionists.

Great Masters of a Brave Era in Art

Chester Dale Collection and other French 19th-century paintings in the National Gallery demonstrate the stormy arrival of the Impressionist movement

By HEREWARD LESTER COOKE, Jr., Ph.D.
Museum Curator, National Gallery of Art
Smithsonian Institution

FOR THE MILLION people a year who visit the National Gallery of Art in Washington, D. C., French 19th-century painting has an irresistible appeal. The years since World War II have seen a crescendo of interest in the Impressionist and Post-Impressionist schools.

This trend goes far beyond the Gallery's marble walls. It is reflected in color reproductions that brighten walls of American homes, in publications and films about the loves and lives of the leading artists, in soaring prices paid for even the slightest Impressionist sketch. Crowds are drawn magnetically to exhibitions that feature names such as Cézanne and Renoir.

The Chester Dale Collection, the major part of which has been on exhibition at the National Gallery since the early 1940's, is universally recognized as one of the finest collections of Impressionist art ever assembled. It fills five of the eight rooms devoted to French 19th-century painting; the remaining rooms hold gifts and bequests from twenty-three other benefactors.

The total of a hundred-odd paintings offers the Gallery visitor an unforgettable experience. More than 25 million people from every corner of the earth have enjoyed these works of love and beauty.

Nation Enriched by Collectors' Zeal

Chester Dale, one of the founding benefactors of the National Gallery, began his career in New York with two noteworthy talents—a genius for business organization and a sure eye for quality in painting. With the first he built a financial empire; with the second, over a period of thirty-five years, he assembled a collection that is the envy of the art world. From the start his primary interest focused on French 19th-century painting.

During the late 1920's, with his artist wife, he became the astute patron of New York's Museum of French Art. This was the first private, nonprofit art gallery on this side of the Atlantic devoted to French painting. Together Mr. and Mrs. Dale watched the early growth of America's passion for Impressionist art. When a particularly fine example became available, the Dales did not rest until it was theirs.

The discrimination and enthusiasm of the Dales were shared by other collectors, with the result that today the United States possesses the world's greatest number of Impressionist and Post-Impressionist paintings.

Why should Americans in particular have been attracted? Perhaps it was a lack of clear-cut artistic traditions at home, or perhaps the chance-taking ebullience of a young nation.

Whatever the reasons, Americans were acquiring these paintings decades before most French collectors realized that choice works of some of their greatest artists were slipping across the Atlantic.

No one can specify the factors that make

The Author: Hereward Lester Cooke, Jr., has both practiced painting and written widely about it. An American graduate of Harrow and Oxford, and a Prix de Rome Fellow at the American Academy in Rome, he returned to the United States to teach at Princeton University and earned his doctorate there. The State Department sent him to Italy in 1959-60 as lecturer and curator for the first U. S. Government-sponsored, contemporary American painting exhibition in that country. His water colors and lithographs are in many public and private collections.

up a great epoch in art. The conditions, social, spiritual, and economic, that produce masterpieces seem so subtle and contradictory that they defy analysis. The fact remains that at certain times and places creative genius has flourished, while at others, when conditions were superficially similar, artistic work has been stunted and imitative.

Artists Surmount Despair and Poverty

To many social theorists, and to the artist struggling to earn a living, the problem has often seemed a simple matter of patronage. Where, in the modern world, are the Maecenases of ancient Rome, the Medici of Florence, or the popes and princes of the 17th century?

Curiously, the history of art indicates that the economic factor is not always of great importance. None of the artists whose works are reproduced in this article was ever a protégé of the rich and powerful. They, in fact, seem to illustrate the romantic concept that only by suffering can an artist produce great art.

Van Gogh's letters reveal a world of anguish that neither money nor recognition could cure. While voluntarily confined in an asylum at Saint-Rémy, he wrote to his brother about his painting "The Olive Orchard" (page 671): "It is a canvas painted from memory . . . because I need something far away . . . like a faint memory softened by time."

On-the-spot art lesson enthralls sixth-graders from a Virginia school during a guided tour of the National Gallery. Here Dr. Margaret Bouton, Associate Curator of Education, discusses Mary Cassatt's "The Boating Party" (page 664). Standing beside her, the author watches audience reactions.

LecTour, first electronic guide service installed in a United States art museum, transmits recorded lectures to Gallery visitors. Transistor receiver picks up long-wave broadcasts from antennas in the floor. Prepared by members of the Gallery staff, the 15-minute talks give facts about artists and their works. These art lovers study Camille Pissarro's "Peasant Woman."

EX CATHEDRA BY NATIONAL GEOGRAPHIC PHOTOGRAPHERS O. BRUCE STEWART AND JOHN E. FLETCHER © N.G.S.

Alas, Van Gogh could never find peace in faint memories. Tormented by the present, he committed suicide less than a year after he painted his tranquil orchard.

To read Claude Monet's letters is to glimpse another kind of torment—a life of hardship and sacrifice. When his son was born in 1867, he wrote: "Camille has given birth to a fine big boy . . . I am tortured knowing that his mother has nothing to eat."

Nor was this only a temporary dip in his fortunes. A year later he wrote, "I was born under an unlucky star . . . I have just been turned out of my room, naked as a worm. I don't know where I shall sleep tomorrow."

In spite of grim want, it apparently never occurred to Monet to lay aside his brushes and earn money for his family by other means; nor is there any record that his wife, seriously ill with tuberculosis, ever asked him to buy food before paints. If we consider Monet and his fellow artists, Gauguin and Renoir—the latter, until he was 30, rejoiced at getting a square meal—we might conclude that great art usually springs from poverty and tears.

Yet it is not invariably so. Degas was comfortably well off and could always indulge his fastidious tastes. Mary Cassatt, the Pittsburgh heiress, had an apartment in Par-

is, a country château, and a villa on the Riviera; if she sold a canvas, it was as a favor to the buyer. Toulouse-Lautrec, Corot, and Cézanne had private incomes.

It was certainly not the wolf at the door that frightened masterpieces out of these men. Pissarro probably spoke for the whole group when he wrote, "For me all sorrows, all bitterness and griefs are forgotten and even cease to exist in the joy of work." What was important was the unswerving devotion to a new vision.

In this sense the French 19th century had much in common with the Renaissance. The intense desire to record exactly the appearances of the external world led the Italians of the 15th century to discover the laws of perspective—the technique of rendering the third dimension—and the Flemish in the north to perfect oil painting. New horizons suddenly opened. In 19th-century France the revolution was no less complete, but in this case it was science that changed men's thinking with the invention of photography.

Art Faces the Camera's Challenge

In 1839 the world was thunderstruck by the revelations of a minor painter, Daguerre, who had a scientific turn of mind (page 666).

"From today on," cried Paul Delaroche, a leading artist of the day, "painting is dead."

"We have seen the views taken in Paris by the 'Daguerreotype . . .'" wrote a New York editor. "Their exquisite perfection almost transcends the bounds of sober belief. . . . There is not an object even the most minute, embraced in that wide scope, which was not in the original. . . . Think of that!"

Think of that from the artist's point of view. Painters since the Renaissance had claimed that one of the most important functions of the artist was to depict what his eyes saw; here was a process that did it in a few minutes.

No horse hitched to a landau ever looked at an early automobile with more fright than the mid-19th-century painter looked at the photographer. Prudish officials sought to restrict the subjects at which this new-fangled monster could stare—the nude body, for example.

As a result, the annual Salons

MARY CASSATT (1845-1926)
The Boating Party

Born of a wealthy, conservative Pittsburgh family, Mary Cassatt determined at an early age to be a painter. Ignoring her banker-father's reaction—"I would almost rather see you dead"—she toured European art museums before settling in Paris in 1874.

The Boating Party, *painted at Antibes on the French Riviera, shows the stylistic influence of Edgar Degas and Edouard Manet. The subject is a variation of the artist's dominant theme, motherhood.*

in Paris became replete with nudes sporting in fountains, swinging on the moon, or sitting in satiny boudoirs—safe from the inquisitive and competitive eye of the cameraman.

As the century went on, the battle intensified. George Bernard Shaw even claimed that photography had made painting obsolete.

"The camera has an eye without a hand," he wrote in 1902, "and that is how it beats even the stupidest painter." Earlier he had said, "As to painters and their fanciers, I snort defiance at them; their day of daubs is over."

Their day, however, was not over. The more intelligent artists met the challenge head on, and some openly enlisted the photographer as an ally. Portrait painters used the camera to short-cut long posing sessions. Others made studies of the body in motion to discover what actually happens when a

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COURTESY GEORGE EASTMAN HOUSE

First Known Photograph of a Living Person: a Study by Daguerre in 1839

A Parisian has paused for a shoeshine, unaware his picture is being taken. From a window, Louis Daguerre aimed his camera down the Boulevard du Temple. Because exposure took several minutes, moving objects made no impression on his silvered plate. Daguerre's remarkable process created a powerful rival to the painter.

horse gallops or a man jumps. Degas, for example, learned much from action photographs of ballet dancers and race horses.

By and large, artists took the measure of their adversary and divided up the market accordingly. Obviously, the portrait painter's job was jeopardized. Even worse was the plight of the reporter-artist, who sketched contemporary events on the scene or from lurid eyewitness accounts.

On the other hand, daguerreotypes were colorless. Despite ingenious efforts to add the third dimension (do you remember the stereopticon, the indispensable Sunday afternoon entertainment in Victorian parlors?), the images appeared flat as pancakes.

Perhaps the most important effect of photography was to make both artists and the public realize that nature does not always consist of carefully posed groups seen at eye level, as in Delacroix's painting of Columbus (page 678). One could show only a part of figures and objects, as Toulouse-Lautrec has done in "Quadrille at the Moulin Rouge" (page 683), and imagination would fill in the rest. One could show them from below, behind, or above, as Pissarro has done in his "Boulevard des Italiens" (page 668), or catch them in momentary, casual poses, as Degas with his "Before the Ballet" (page 685). The scope and meaning of visual reality was expanded and enriched.

As always in the history of art, when discoveries are made, artists search the past to see if others have explored the ground before. Mid-19th-century Parisians reacted with delight and surprise when they first looked seriously at Japanese wood-block prints and found that the "snap-shot" view had been used for centuries.

In their native country these gaily colored flimsies had served as handbills for plays; once the performance was over, frugal merchants turned them into wrappers for groceries. As tea wrapping, some of the bills found their way to Europe. Monet said he saw his first print wrapped around a mackerel on Le Havre's waterfront.

By 1870, the posters had become the rage in Europe—to the surprise of the Japanese, who found Occidental ways mysterious. Even in New York, crowds used to wait anxiously for vessels from the Orient, to get first choice of these fragile prints. The effect on art was immediate. Van Gogh's "La Mousmé," with its bold, sharp contours, bright, flat pattern on the dress, and the monochrome background, was inspired directly by Japanese wood-block prints (page 670).

A less obvious but no less direct derivation can be seen in the bright, flat colors and sinuous, sharp bounding line of Gauguin's "Fatata te Miti" (page 695).

Rarely have artists been the target of such vicious criticism as those whose works are reproduced here. They were ridiculed by the professional critics, the public, and the conservative artists alike. Looking at a peaceful domestic scene like Edouard Manet's "Gare Saint-Lazare" (page 673), it is hard to believe that such a calm and gentle painting could have aroused such indignation.

"Imagine Goya transferred to Mexico," wrote one outraged critic (who evidently thought Mexico as remote as Borneo), "and here he has gone out of his head in the middle of the pampas, and smears his canvases with chewed betel nut juice. . . . There you will

(Continued on page 670)

CAMILLE PISSARRO (1830-1903)
Boulevard des Italiens, Morning, Sunlight

Son of a Creole ironmonger, Pissarro became a pioneer of the Impressionists. Virtually banishing black from his palette, he filled each canvas with thousands of tiny, distinct brush strokes.

In 1897 he engaged a room in the Grand Hôtel de Russie in Paris to do a series of boulevard scenes. From his window on a winter morning, he captured the street's noise and bustle.

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Renoir Paints a Nude From a Wheel Chair

The aging artist worked in the hills near Cannes on the French Riviera. Claude, his youngest son, took the photograph.

A prolific artist, Renoir produced some 4,000 paintings and sculptures. Despite two decades of extreme physical pain from arthritis, he worked until his death in 1919.

Some historians say Renoir painted with the brush strapped to his wrist. Others insist he held it like a cigarette between the fore and middle fingers. This physical handicap never dimmed the painter's ability to express youthful joy and vibrant color.

DURAND-RUEL

VINCENT VAN GOGH (1853-90)
The Olive Orchard

Unsuccessful as an art dealer, tutor, and lay preacher, Van Gogh turned to painting to express intense emotions. Though his career as a creative artist spanned but a few years, he emerged as one of the great masters of his time. Today one of his pictures is worth many times what he earned in his lifetime.

While voluntarily confined in an asylum at Saint-Rémy in 1889, he painted these olive trees, which reminded him of the willows in his native Netherlands.

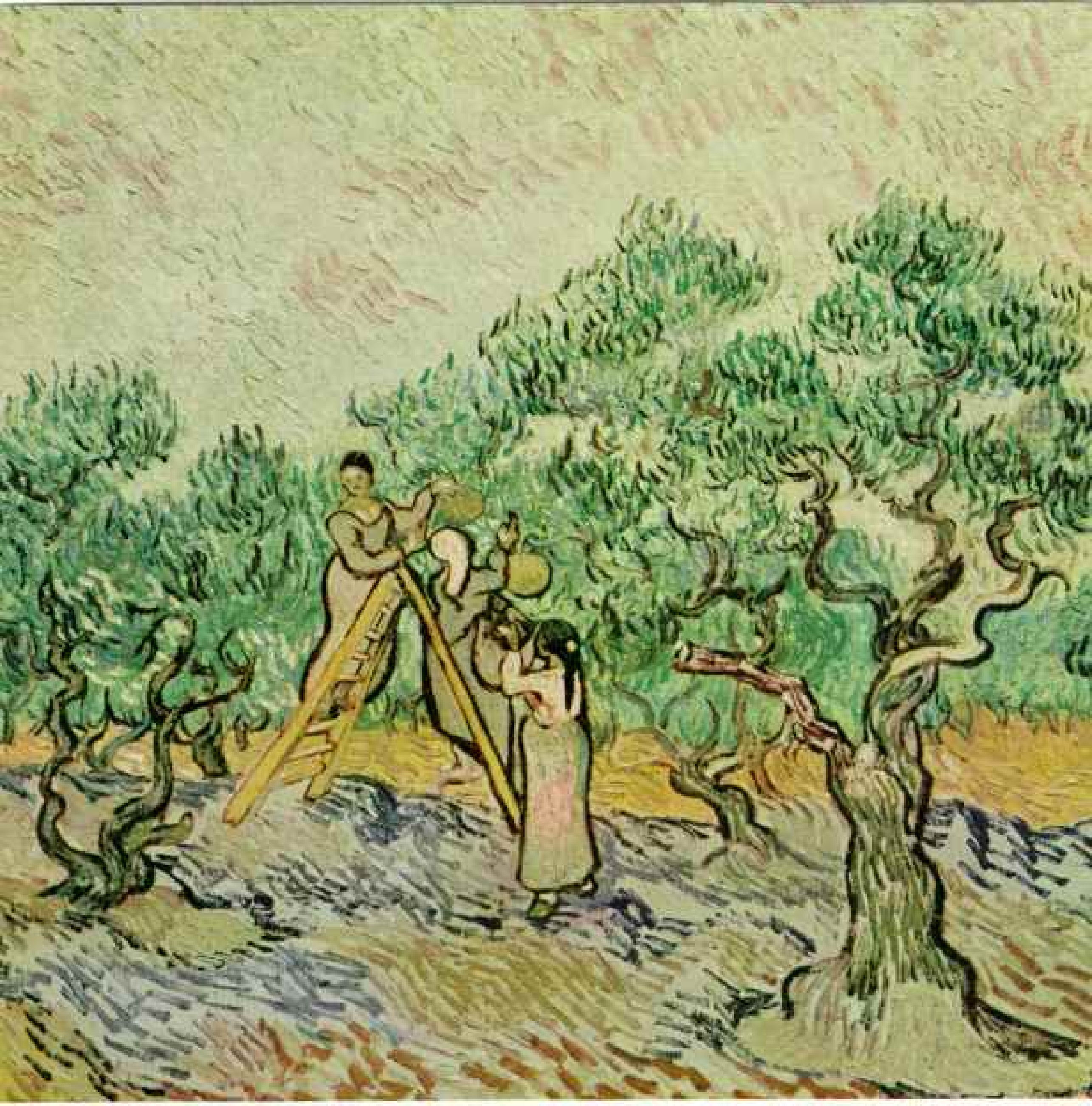
"The over-all color range is quiet . . ." he wrote to his brother Theo, "because I need something far away, like a faint memory softened by time." The following year he committed suicide.

La Mousmé, *Van Gogh's portrait of a country girl, reflects his admiration of Japanese art in its bold pattern, bright colors, and plain background.*

have M. Manet. . . . Never has an artist butchered his tones so or made more horrible grimaces with his lines."

The more dignified critics regarded the new painting as a dangerous epidemic and were too horrified even to express themselves.

"Let us not speak of them," one of them wrote. "Look and pass on." Even the name Impressionism began as the sneer of a



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critic who wished to deride the new style.

Manet, whose name is confusingly similar to that of the arch-Impressionist Monet, had received the most respectable academic training; hence when he suddenly cast aside the sanctified rules, he was regarded as the most dangerous of the rebels. Conservatives, aghast, found they had nurtured a viper in their bosom—one who could not be allowed to continue with impunity.

If we study carefully Manet's charming "Gare Saint-Lazare," we can perhaps understand why he horrified the academicians. First, there is no convincing sense of the third dimension. Behind the iron bars there is in fact a considerable drop to the tracks below, and yet it is only after we have identified the watchman's shed on the right that we are aware of this. An academic painter would have made this space quite obvious.

Secondly, there is no sense of texture; the girl's dress, the woman's features, the dog's face, and the cloud of steam are all painted with the same broad, brilliantly controlled brush strokes. Academicians were taught to differentiate between the softness of flesh, the crinkle of taffeta, and the glint of metal. Not finding these in Manet's work, they presumed he didn't know how to paint.

Thirdly, no moral uplift was depicted or stirring story told. The woman was a girl whom Manet had encountered casually and

AUGUSTE RENOIR
Oarsmen at Chatou

A humanist whose canvases expressed his zest for living, Renoir combined the delicate touch of the old masters with the radiant coloring of the Impressionists.

Renoir spent the summer of 1879 at Chatou, a holiday resort on the bank of the Seine. In this composition he captured summer sunlight shimmering on the river as Parisians enjoyed a day in the country. Juxtaposing glowing colors, he portrayed what the eye sees at first glance, blurring those objects beyond the fringe of vision.

Man in the white coat is Gustave Caillebotte, one of the first buyers of Impressionist art.

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EDOUARD MANET
(1832-83)
Gare Saint-Lazare

Manet's unposed subjects, his preference for unusual compositions, and his color contrasts—bright tones against velvety blacks—had a profound influence on artists of his generation.

Here his subject is a moment observed in life, the figures caught in casual, unstudied poses. The scene is a garden adjacent to a railroad yard. Victorine Meurent, Manet's favorite model, wears a modish straw hat and holds a puppy; she may have been reading to the child. Momentarily distracted by a passing train—suggested only by a puff of white smoke—the girl gazes through the iron grill.

who he thought might make a good model; the little girl, daughter of a fellow artist, is watching a train that has just gone by. No drama, no story.

Finally, the figures are asymmetrically placed, and are not even all in the picture. Manet, according to the professors, did not know the A B C of professional painting.

Manet was unconcerned. He believed that an artist could say everything he wished to express by painting a white cloud. He was interested in subtle and beautiful transitions of color and tone; whether these transitions occurred in a cloud of steam or a woman's face was relatively unimportant.

Corot Lent Fame to Friends

Manet, in particular, and the group as a whole, although voluntarily going to the slaughter by submitting canvases to the annual Salon juries, seem to have thrived in this vitriolic atmosphere and never showed any signs of mending their ways. The criticism they valued was that of other members of the group. It seems to have been a golden rule that, despite any personal animosities, one revolutionary painter helped another.

The tradition had been established by Corot a generation earlier. When he was about fifty, the tide of Victorian taste overtook him, and virtually every landscape he painted sold before it was dry. He shared his windfall with less fortunate colleagues. Advising and encouraging fellow artists, he did not hesitate to reveal his successful formulas. When one collector asked Corot to authenticate an obvious imitation of the artist's work, he felt so sorry for the purchaser that he repainted the canvas and gave it back without explanation.

Some artists whom he admired particularly, Corot supported outright. Daumier, who subsequently became the 19th century's greatest and most feared cartoonist, was one of these. His picture "Advice to a Young Artist," showing an older man counseling a young protégé, is supposed to be a tribute to Corot's generosity (page 680).

And so the tradition grew. Degas helped Mary Cassatt, Gauguin helped Van Gogh, and Pissarro helped whoever asked him.

"He [Pissarro] was such a wonderful teacher," wrote Mary Cassatt, "that he would have taught the stones to draw correctly."

The help was sometimes more than verbal. When Berthe Morisot (a pupil of Corot) was about to submit a painting of her mother and sister to the annual Salon (page 681), she asked Manet for a criticism.

"He arrived about one o'clock," she wrote to a friend. "He found the picture very good except for the bottom of the dress. He took the brushes and put on a few touches which made a great improvement. My mother was ecstatic.

"This is when my misfortunes began. Once he had started, nothing could stop him. He went from the skirt to the bodice, and from the bodice to the head, from the head to the background. He made a thousand little jokes, laughed like a madman, gave me the palette, took it again, and at last at five o'clock in the evening between us we had made the prettiest caricature that one can imagine. . . . I remained confused. My only hope is that it will be rejected."

Mlle. Morisot's misgivings were unjustified. The picture won acceptance and critical favor. Today we easily detect Manet's work by the broad areas of somber colors on the right-hand figure, as distinguished from the more delicate touch of the younger artist.

Flecks of Color Capture Light

An important influence toward the end of the 19th century was the theory of Impressionism. According to Paul Signac, an early devotee, the theory was born in London, during the Franco-Prussian War of 1870, where both Pissarro and Claude Monet were refugees from German invasion. Here, Signac relates, they became hypnotized by the glowing colors of the English landscapist Turner.

"They were first and foremost struck by his effects of snow and ice," Signac writes. "They told me that his marvelous effect was obtained not by painting a section with a uniform white, but by means of a number of little brush strokes of different colors, put one beside another and blending at a certain distance to produce the desired effect."

The two artists noted that the sparkle of

CLAUDE MONET (1840-1926) *Rouen Cathedral, West Façade, Sunlight*

Captivated by the atmospheric effect of the day's changing light on walls, Monet made more than thirty studies of the Gothic cathedral. Here the artist catches afternoon's hot sun blazing on lacy stone.

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CLAUDE MONET
Waterloo Bridge, Gray Day

"I love London. . . . but I love it only in winter," Monet declared. The chill mantle of mist and fog enveloping the city fascinated the painter. Against a backdrop of smoking factory chimneys, this Thames River bridge rises nebulous and full of mystery.

Bearded Monet, in the twilight of life, escorts a visitor about his studio at Giverny, where he worked on as many as ten canvases a day, despite failing eyesight. Once ridiculed, his paintings have become classics.

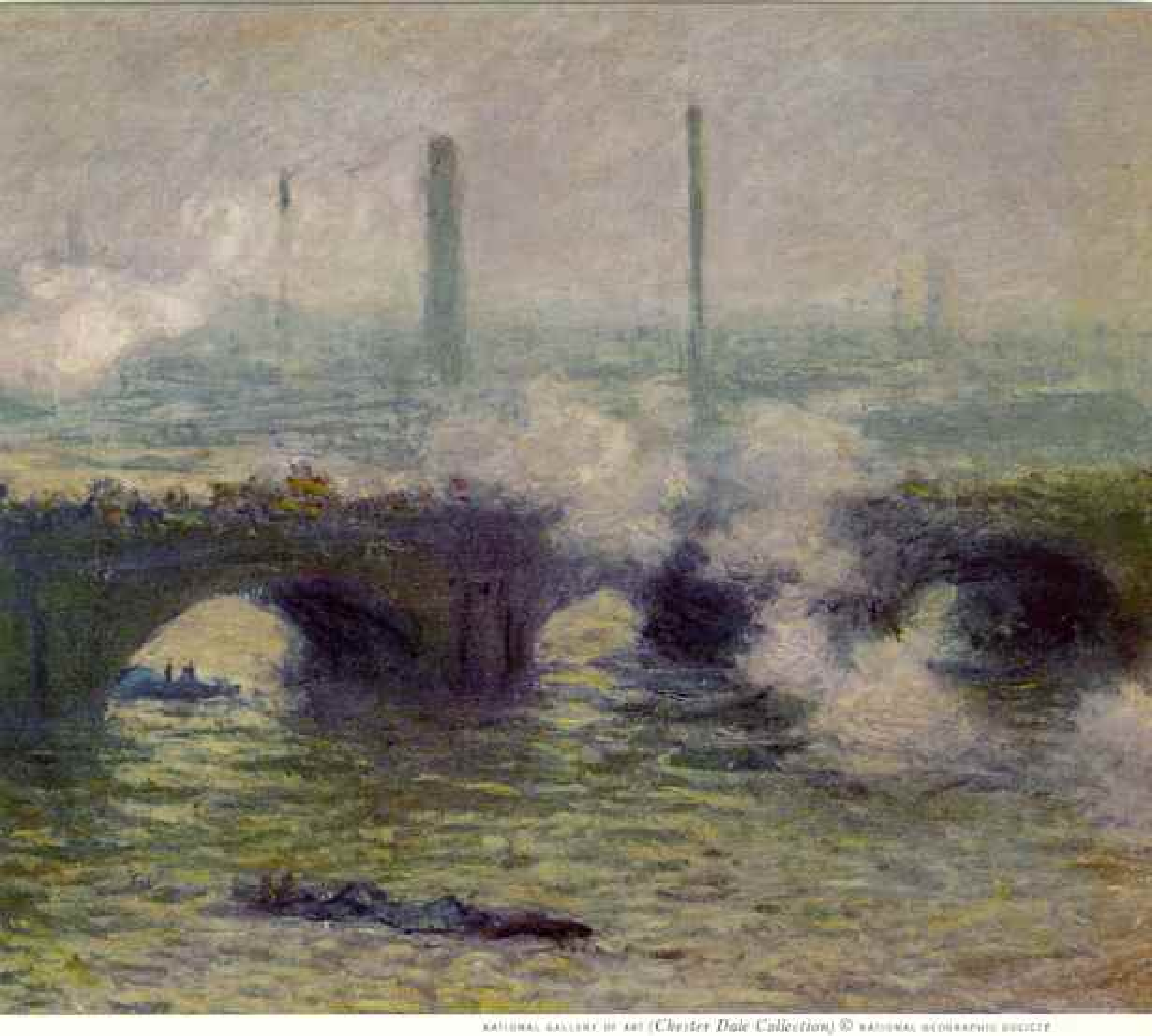
ROGER WOLLET

sunlight or the soft light of gloaming could be marvelously duplicated by juxtaposing tiny flecks of pure color.

Monet, the real founder of Impressionism, was also its greatest practitioner. Like the Chinese philosopher who sits gazing at the waterfall, seeking to divine the secrets of the universe, Monet sought to reveal in his shimmering canvases the universal laws that permeate and govern the world of nature.

"Never," wrote a critic, "has nature found a more eloquent . . . interpreter or a man with a deeper understanding."

Monet was fascinated by momentary atmospheric effects. The light and color that surrounds and transforms ob-



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jects, rather than the objects themselves, formed the subject matter of his most famous canvases. In order to arrest the swift, flowing stream of passing images and capture alive the transitory light falling on a particular object, he set up series of canvases and rarely worked on any one for more than half an hour at a time.

Brush Depicts Roughness of Stone

As Monet saw the light beginning to change in the slightest degree—they say he could tell the exact time of day by looking at the sky—he put the picture away and waited for another day when the atmospheric conditions were precisely the same. He painted Rouen Cathedral in this way (page 674).

Unlike his Romantic predecessors, he had no interest in the historical associations of this famous city where Joan of Arc was burned. Nor was he interested in the stained glass or carved saints. He focused only on the bright afternoon light as it is reflected from the warm gray stones of the cathedral.

Let us look closely at how he achieved this effect. Under the archway are flecks of pure blues, orange, olive green, brown, and mauve. There are no lines, and the paint seems to have been daubed on carelessly. But from a slight distance, we immediately see how wonderfully he has represented the blinding glare of sunlight.

A critic suggested that he must have "striven by thickness of paint and roughness of the handling to reproduce the very material quality of the stonework."

The light of a wavering winter sun fighting through the fog and smoke of London held equal fascination for him. What was wet, cold, and dirty to others, was for Monet a source of endless beauty.

"I love it only in winter. In summer it is fine with its parks, but that does not compare

(Continued on page 682)

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EUGENE DELACROIX
(1798-1863) *Columbus and His Son at La Rábida*

His daring use of color and his experiments with light brought violent criticism down on Eugène Delacroix, predecessor of the Impressionists. Here he re-creates the air of quiet mystery in a Spanish monastery as the Indies-questing Columbus gazes dreamingly at a map. Son Diego rests on the bench.

EUGENE BOUDIN
(1824-98) *Return of the Terre-Neuvier*

A cabin boy in his youth, Boudin painted seascapes from personal experience.

Returned from the Newfoundland fishing banks, this sturdy brig has beached on a Normandy tidal flat. Crewmen unload the harvest of cod into horsedrawn carts. Gray is the dominant color, as in most of Boudin's works.

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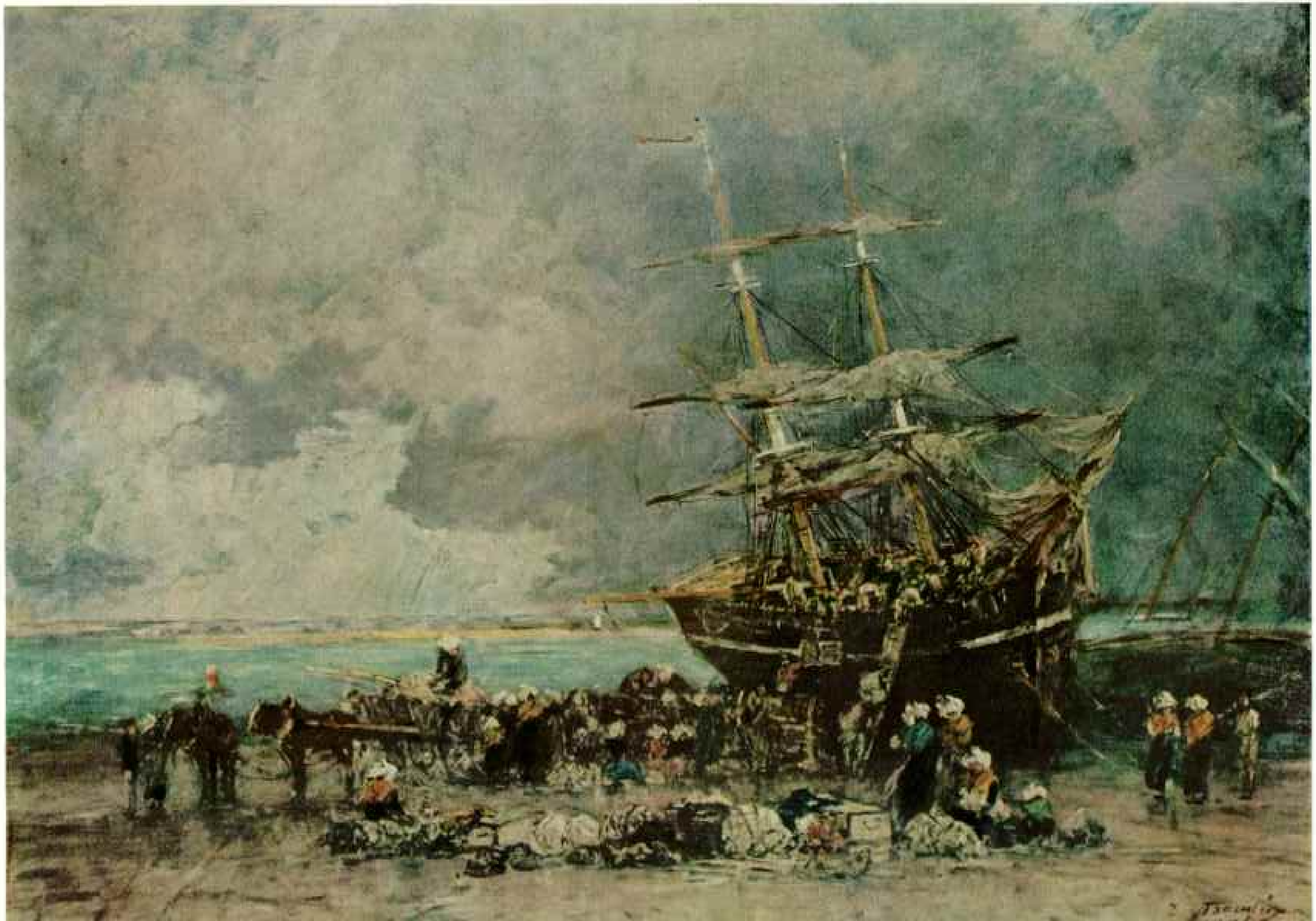

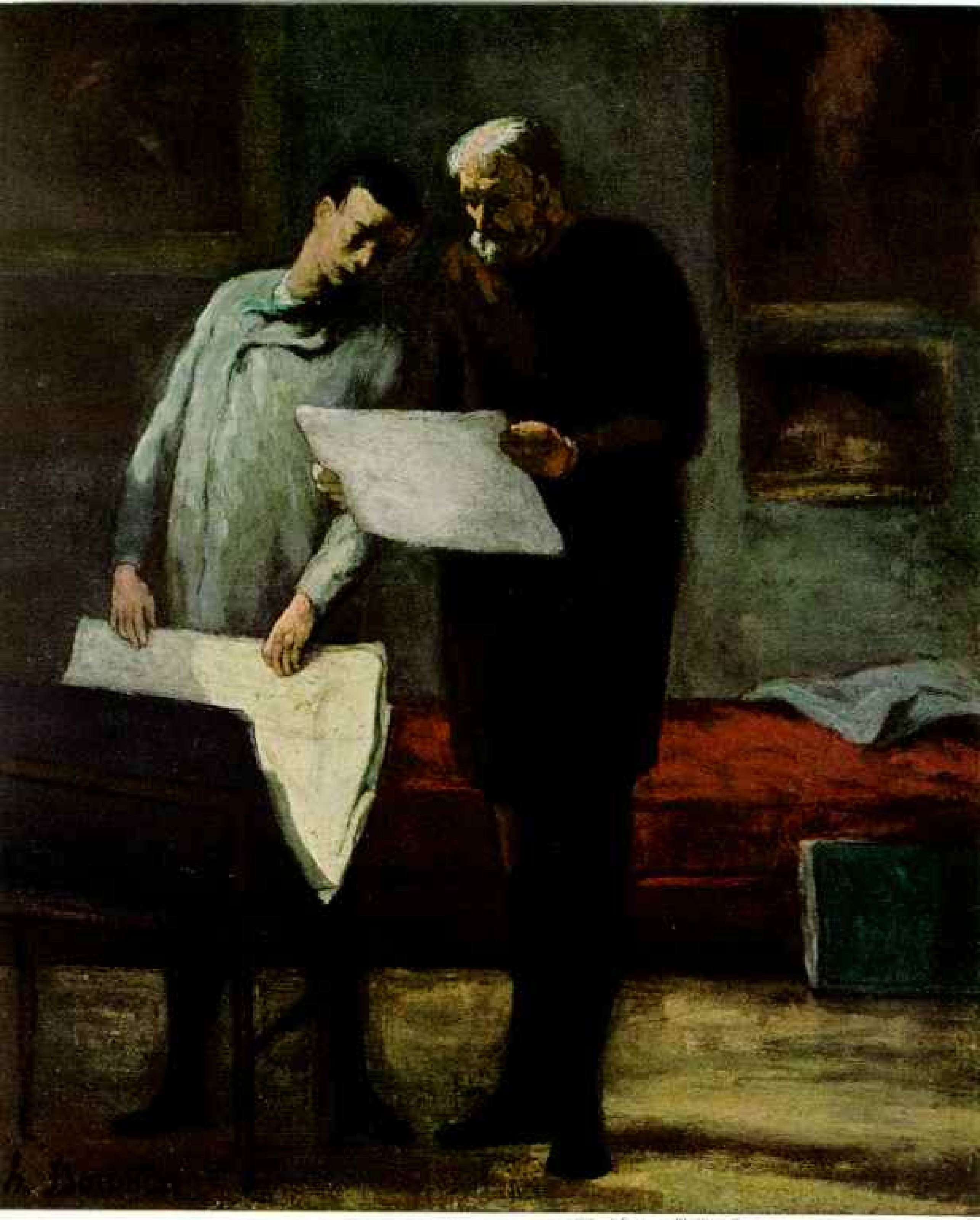

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HONORE DAUMIER (1808-79) *Advice to a Young Artist*

Satirist of manners and politics, Daumier produced more than 4,000 lithographs lampooning French society. From these caricatures he earned a meager livelihood, but his attempts to win acceptance as a serious painter proved fruitless. Posthumously, Daumier was recognized as a master of restrained and somber coloring, with a dramatic instinct for design. In this picture he establishes a mood, sympathetic and quiet, between youth and instructor.

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BERTHE MORISOT (1841-95) *The Mother and Sister of the Artist*

Midway in Berthe Morisot's career, Edouard Manet introduced her to the Impressionists, and under their influence her style changed noticeably. While finishing this picture for the Salon exhibition of 1870, she asked Manet for advice about her mother's portrait. Taking up palette and brush, he added a few touches to the hem of the skirt, then proceeded to repaint the rest of the figure. "Once started, nothing could stop him," Mlle. Morisot recalled.

(Continued from page 677)

with the winter with the fog, for without the fog London would not be a beautiful city."

When his London pictures were first placed on exhibition in 1904, some critics regarded them as artistic suicide. However, the art world soon began to understand, and the 37 canvases in the series are among his most popular (page 677).

Monet, after years of hardship, achieved world renown. When he died in 1926, Georges Clemenceau, World War I Premier of France, delivered the funeral oration and, in recognition of the artist's love for color and light, ordered that the traditional black drape over his coffin be replaced by one of bright colors.

Corot Led Break With Tradition

Among the first artists in France to break from the academic storytelling tradition in landscape painting was Corot. On a modest allowance from his indulgent father, he spent several years traveling through the hill towns of Italy. In Rome he shocked students at the famous French Academy by not rushing off to view the Raphael paintings in the Vatican; neither did he paint scenes from ancient history. Instead, Corot sketched the hills of central Italy with their ancient buildings basking in the warm sunlight.

"A View Near Volterra" is such a scene, painted from memory after he had returned to France. A classical painter might have introduced figures from mythology or the Bible. At Volterra the all-powerful Medici had established a grim fortress, where their political enemies languished in clammy cells. The site had also been a center of Etruscan civilization. For Corot these associations were unimportant. What mattered were the soft, golden light and the blue haze of distant hills. Only the cowled monk scarcely visible among the trees echoes the traditions of the Romantic school (page 687).

A side of Corot's art which few of his contemporaries knew is revealed by his figure studies. He painted these apparently for his own amusement, showing them to insistent visitors with apologies. Today Corot's figure studies are among his most prized works.

Little man, great artist, Henri de Toulouse-Lautrec left as his legacy a vivid picture of Parisian night life in the gay nineties. Deformed by boyhood accidents—his huge head and stocky body sat on stubby, childlike legs—the heir to one of France's proudest names forsook the aristocracy for the tawdry gaiety of Montmartre dance halls. A superb draftsman with an uncanny ability to capture fleeting images, he frequently painted on scraps of wrapping paper and cardboard he found in cabarets. Here, in his studio, he finishes one of his larger masterpieces.

PARIS MATCH, MARIE-CLAIRE

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HENRI DE TOULOUSE-LAUTREC (1864-1901) *Quadrille at the Moulin Rouge*

Hoisting her skirts, a professional dancer prepares to do the quadrille. Gabrielle, one of Lautrec's favorite models, appeared nightly at the Moulin Rouge, a popular Paris cabaret. She casts a disdainful eye at fashionable patrons.

EDGAR DEGAS (1834–1917) *The Races*

Unlike his colleagues, Degas did not rebel against tradition, and his artistic ideas differed strongly from theirs. Yet he at first exhibited with the rebels and rallied behind them. When a critic assailed their work, he likened him to an ape: "How could he understand! It is by the trees that he came to Paris!"

Horse racing provided Degas with a first-hand study of graceful motion. The swiftly changing patterns of the track charmed him. This picture is a detail of the original.

Before the Ballet *explores another of Degas's favorite themes: the world of the theater, especially backstage life. "I want no funeral oration over my grave," the artist once confided to a friend, "I want them to say simply: he loved to draw."*

JEAN-BAPTISTE-CAMILLE COROT
(1796-1875) *A View Near Volterra*

Son of a Parisian milliner, Corot was the most widely acclaimed French landscapist of the century. His silvery scenes of later years anticipated Impressionism.

Before gaining recognition, Corot walked the Tuscan hills north of Rome. Years later, working from memory and sketches, he painted this recollection of the sun-bronzed countryside.

Perhaps in nostalgic remembrance of carefree days in Italy, his models are often dressed in Italian peasant costume, but as personalities they do not exist. In contrast, the inanimate objects in "The Artist's Studio" can be identified (page 688); for example, the painting on the wall above the easel is now known as "La Blonde Gasconne," and is the prized possession of the Smith College Museum of Art in Northampton, Massachusetts.

Impressionists Defied the Rules

The second ingredient of a great epoch in art is individual genius, and it would be hard to imagine a more bizarre group of personalities than those whose paintings are represented here: a Creole ironmonger's son (Pissarro), a renegade stockbroker (Gauguin), a Pittsburgh heiress (Mary Cassatt), a retired civil servant (Rousseau), a drapery salesman (Corot), a crippled viscount (Toulouse-Lautrec), and an epileptic Dutch preacher (Van Gogh). This motley group was united by the central desire to paint pictures according to new and revolutionary doctrines.

After the mid-century, the academic traditions slowly but surely strangled themselves with their rules and assumptions. There were set methods for composing designs, arranging colors, and for rendering the third dimension.

"Nowadays," wrote Renoir, "they want to explain everything, but if they could explain everything it wouldn't be art. Shall I tell you what are the two qualities of art? First, it must not be capable of being explained in words, and secondly, it must not be capable of being imitated. A work of art must seize hold of you, wrap you up in itself, and carry you away. A work of art is the vehicle of an artist's passion. It is the current which he puts forth which sweeps you along in the flood tide of his emotions."

Obviously, a painter with such beliefs flouted the academic rules. Renoir's "Oarsmen at Chatou" violates most precepts of his day (page 672).

"I arrange my subject," he wrote, "and then go ahead and paint it like a child. I want a red to ring clearly like a bell. If it doesn't turn out that way, I add more reds until I get it. . . . I have no rules and no methods."

The relaxed mood of Renoir's painting is, in fact, largely due to this informality. It is like dropping in on a party before the guests have had time to adjust their hats and pose.

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"I like pictures," said Renoir, "that make me want to wander about inside them." This is what we do in "Oarsmen at Chatou."

His "A Girl With a Watering Can" has a different appeal (page 660). Here he has pushed his art up to, but not over, the brink of sentimentality. With myriad flickering brush strokes he captures an unforgettable image of childhood. He gives us an adult's view down into the child's world, narrow and circumscribed by the flowering hedgerow. She ignores us and stares ahead, intent on her gardening problems. This charming canvas has for years been one of the most popular pictures in the United States.

One reason that most of the painters we are discussing incurred parochial wrath was their denial of the centuries-old dogma that subject matter was important. To our forefathers of a hundred years ago, it went without saying that a painter should illustrate a recognizable theme or tell a story, preferably one with a moral.

Delacroix was perhaps the finest of the Romantic school's painters; let us therefore look at his painting of "Columbus and His

Son at La Rábida" (page 678) through the eyes of our great-great-grandfathers and judge it according to their standards.

Columbus, desperate for financial help, followed the Spanish court in hope of an audience with Queen Isabella. On his way he stopped at the monastery of La Rábida. The mariner was at the low point of his career, and the staff and bundle by the wall and the rough cloak lying on the floor depict his poverty. Son Diego's toes stick out through his shoes, attesting to the plodding miles that the pair have walked.

Diego puts a hand on his father's knee, expressing love and confidence. Columbus, straight and energetic, studies the map on the wall, possibly one showing the overland route to the Orient. The friar, his imagination fired, stands behind the master mariner.

The result of the encounter was that the friar, who had been the queen's confessor, interceded for Columbus, and this was the turning point in the explorer's fortunes.

To Victorians such a picture would have been a reminder that even in life's darkest moments there is hope. In the Toledo (Ohio) Museum of Art, a companion picture, also by Delacroix, shows the turn of fortune's wheel. The explorer returns in triumph, laden with riches from the New World.

Emphasis Shifts From Storytelling

Now let us look at Boudin's canvas (page 679). At first glance this appears to have a similar dramatic content. Surely this vessel has been driven ashore by the black storm on the horizon, and survivors are being rescued by heroic coast guardmen.

We are wrong. When this was painted, 37 years after Delacroix's canvas, the artist no longer felt obligated to tell a story. This, in fact, is an ordinary fishing boat back from the Grand Banks of Newfoundland ("Terre-Neuvier" means "Newfoundlander"), that has been beached on the sands of the Normandy coast in order to unload cod.

By 1875 Boudin, like most of his colleagues, was no longer interested in drama. "The sea and the sky," he once said to Monet, his pupil, "are so beautiful as are the animals, the people, and the trees, just as nature has made them, with their individual characters and their real way of being, in the light and air, exactly as they are."

Although the brushwork may appear confused and careless, the maze of flying gray lines in the rigging is in fact as accurate as it is meaningful. Boudin, a seaman's son, had earned his living as a cabin boy.

His training as an artist was financed in a most unusual way. The town council of Le Havre became interested in the talented youth of the neighboring fishing town, and sent him to Paris for his art education. He returned their generosity by immortalizing the silver sands, gray stone houses, and stubby fishing vessels of the Normandy coast.

American Woman Joins Rebels

From the American point of view, the most interesting of this talented group is Mary Cassatt. Only now, more than thirty years after her death in 1926, are we beginning to realize that she was one of the most distinguished American women of her generation, and unquestionably one of the finest painters of mothers and children.

Her background was unusual for an artist. In New York's Pennsylvania Station there stands a bronze figure with a frock coat and severe features. Underneath is the inscription: "Alexander Johnston Cassatt, President of the Pennsylvania Railroad Company, whose foresight, courage and ability achieved the extension [of the line] into New York City."

This was Mary's elder brother. Her father was mayor of Allegheny City, now a part of Pittsburgh, and a power in finance. When she announced, at the age of 23, that she intended to become a painter, her family, visualizing artists as Bohemian mountebanks, was genuinely shocked.

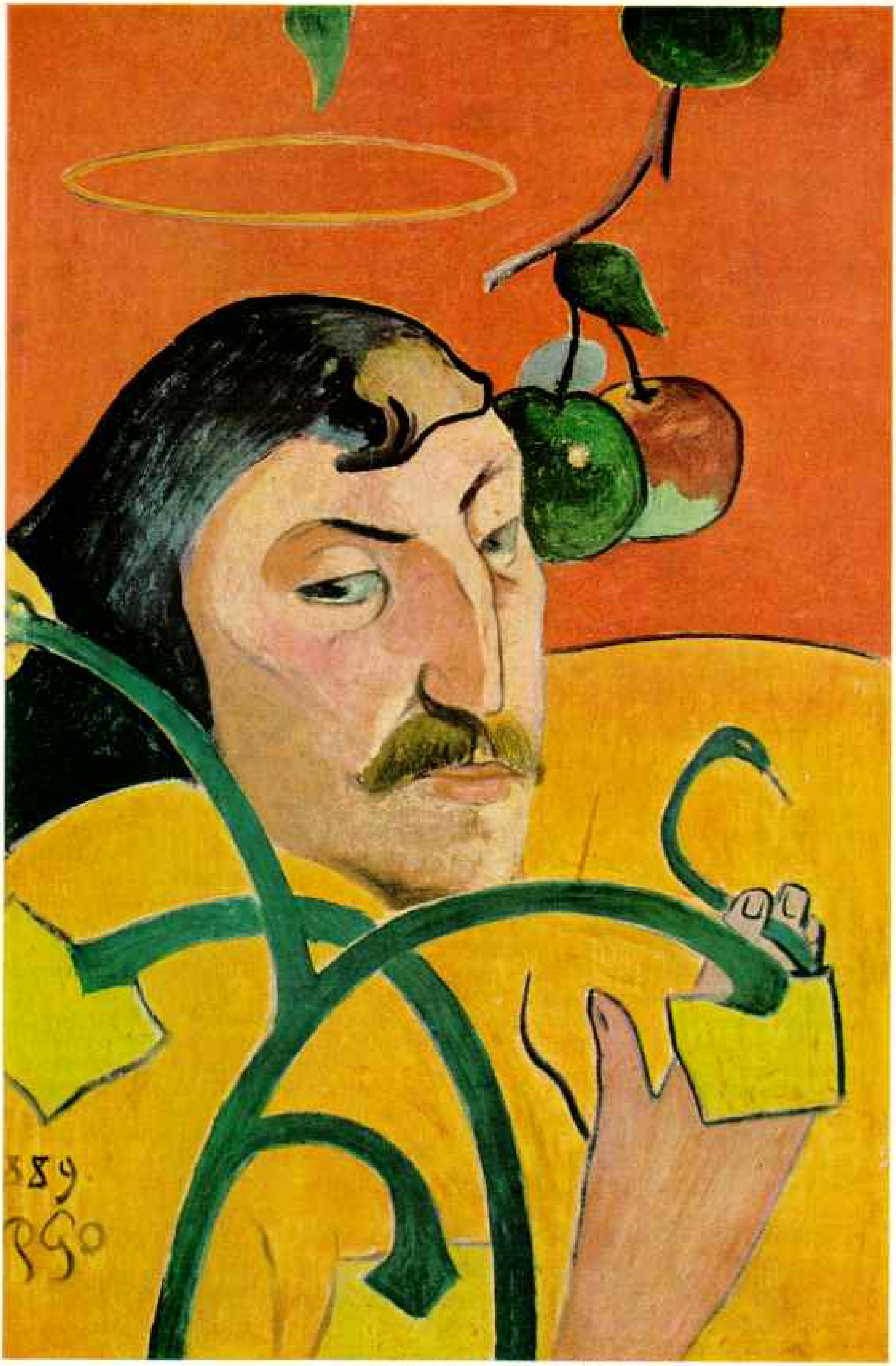
"I would almost rather see you dead," was her father's discouraging reaction.

Mary's decision took her first to the Pennsylvania Academy of the Fine Arts and then to European museums, where she copied the old masters. After six years in the Netherlands, Italy, Spain, and France, she settled in Paris when she was 29. Still uncertain of herself, one day she saw a picture by Degas in a shop window.

JEAN-BAPTISTE-CAMILLE COROT *The Artist's Studio*

As in his landscapes, subtle harmonies of color characterize Corot's figure studies. He liked his models in repose or in some quiet and unstudied action. This unknown girl sat for the artist in Ville-d'Avray, near Paris. The dog is unusual, for Corot disliked dogs.

NATIONAL GALLERY OF ART (Widener Collection) © NATIONAL GEOGRAPHIC SOCIETY



NATIONAL GALLERY OF ART (Chester Dale Collection) © NATIONAL GEOGRAPHIC SOCIETY

"I used to go and flatten my nose against the window," she later wrote, "and absorb all I could of his art . . . I saw art then as I wanted to see it!"

She became friends with the older painter and with others of the Impressionist group. After the usual buffeting from official juries, she decided to throw in her lot with them.

"Now," she wrote, "I could work with absolute independence without considering the opinion of a jury . . . I took leave of conventional art. I began to live."

Even Degas, who generally had a low opinion of the opposite sex, confessed privately to a friend, "I would not have admitted that a woman could draw as well as that."

Conscientious, ascetic, and with unattainable standards of perfection, Mary Cassatt, always in the shadow of her friends Renoir and Degas, waited until she was past 45 before having a one-man show. Meanwhile, out of her comfortable income, she bought canvases of fellow artists and persuaded her wealthy American friends to purchase their works. Several of the outstanding collections of French 19th-century art in America can be traced to her influence.

Recognition at Home Comes Late

She herself remained virtually unknown in America until after her death. When she visited Philadelphia in 1899 after having won important honors in Europe, a news item read: "Mary Cassatt, sister of Mr. Cassatt . . . returned from Europe yesterday. She has been studying painting . . . She is the owner of the smallest Pekinese dog in the world."

Since she rarely painted on commission, her subjects are generally unknown. It is only by a happy accident, for example, that we know when and where the canvas reproduced on page 664 was painted. "As for my painting, 'The Boat,'" she wrote to her Paris dealer, "I do not want to sell it . . . it was painted at Antibes, twenty years ago, the year in which my niece came into the world, and . . . that makes it a souvenir."

Although Mary Cassatt learned much from Degas, their points of view differed greatly. Degas saw in the ballet and horse racing brief moments of poetry in motion, threaded through with excitement and evanescent color. There is rarely an interest in individual personality. Dancers and riders were to him artists like himself, highly trained and skilled to thrill a distant audience, performers whose personal life and passions were cloaked behind the façade of professionalism. His paintings, which often appear to have been dashed off in the moment of inspiration, were in fact, like a dancer's pirouette, the result of long hours of study and preparation.

Gauguin: Genius at Eccentricity

Certainly our ideas about the artist in his relation to society were established in Paris during the 19th century. In previous centuries the artist had been considered to be a craftsman, a scientist, a poet, or a businessman, but in the 19th century he became an eccentric, and some of us still visualize a painter as a man with a beard and unkempt hair, who lives outside society in a garret. Eccentricity was, in fact, carefully cultivated by some of the major artists in Paris.

If we had met Gauguin, for example, we would have encountered an athletic man with a half-grown beard and a huge felt hat decorated with sky-blue ribbons. Over his dirty yellow trousers he wore a blue smock with mother-of-pearl buttons. On his shoulder sat a gibbering monkey, and his wooden cane was carved with writhing naked bodies.

During his early days as an artist, he shared a studio in Brittany with a Dutch baker turned painter. One room was converted into a sort of pagan shrine dedicated to Gauguin's slightly incoherent philosophies. Walls, ceilings, and windows were painted with bizarre designs, interlaced with framed mottoes. In a corner was a cupboard on which two portraits were painted, one of the Dutchman, the other of Gauguin. The one of Gauguin is now in the National Gallery of Art (opposite). With a sardonic smile he holds the serpent of temptation like a cigarette.

Over his head is a most undeserved halo. A few years earlier he had left his job in a stockbroker's office, abandoned his wife and

PAUL GAUGUIN (1848-1903) *Self-Portrait*

Eden's forbidden apples dangle invitingly beside Gauguin's haloed head; his hand holds the serpent of evil like a cigarette. He painted this satirical portrait on the cupboard door of his studio in Brittany. Later he quit civilization in quest of a primitive paradise.

five children, and, not being able to sell his works, lived on charity. This portrait seems to express perfectly his defiance and hatred of society's conventions.

"I have known extreme poverty," he wrote, "and all the miseries that follow. . . . With a little effort one can come to laugh at it all."

Later in his life he made a romantic dream come true, when he fled from civilization to Tahiti in the South Seas. There his scandalous behavior shocked the authorities, and he had to move to a more remote island. The canvases he sent back to Paris, although they did not sell easily, began to attract attention. He believed that in these pictures he was catching a primeval rhythm which suffused the world before civilized man came to spoil it. His letters spoke of "the tropical sun which sets fire to everything . . . in fabulous colors . . . this glow of light, purified and silent."

"As a painter," he wrote on another occasion, "I am a savage, a wolf without a collar in the wilds."

Looking at his "Fatata te Miti" (which means "By the Seaside" in Tahitian), we sense this savage energy and the rank organic growth of the jungle (page 695).

Finally he literally rotted away, and the police auctioned off his canvases to traders and government officials on the island. His pictures sold during his lifetime for about $50 apiece. A short time ago one brought more than $270,000 at an auction.

Rousseau Made Primitives Fashionable

An outstanding characteristic of the present-day art world is the widespread interest in so-called primitive art, whether done by children, prehistoric cavemen, uncivilized tribesmen, or civilized amateurs.

The first modern primitive to gain fame was Henri Rousseau, whose "The Equatorial Jungle" is reproduced on the opposite page. According to one writer, he had been a soldier in the ill-fated army of the Emperor Maximilian in Mexico and had seen teeming tropics around Vera Cruz. Many years later, as a retired civil servant, he divided his time between playing the violin and painting his conception of rank undergrowth and savage animals.

His plants are impossible, and no baboon even vaguely resembles the dark creatures lurking in the foliage. Yet, to him, these scenes were intensely real. Year after year he would load his huge canvases onto a push-cart and take them along to the Independents' nonjury show in Paris. Every year he would cart them away again, unnoticed and unsold.

It was not until the early part of the 20th century that a taciturn and intense young Spaniard named Picasso pointed out to his fellow cafe habitués that here was a simple, unspoiled vision, which for all its strangeness had more honesty and artistic validity than most trained artists ever achieve.

From that time on Rousseau's fame and imitators spread over the Western World. Perhaps one reason for the appeal in his paintings is that most of us secretly believe that, given the chance, we could do as well. This is an illusion. His paintings are as sophisticated as they are artistically complex.

Official Art School Bars Cézanne

Aloof from the galaxy of talent in Paris stands Cézanne, often called the father of modern painting. The natural son of a successful merchant and banker, he first attended law school and seemed destined to follow in his father's footsteps. In his early 20's, however, he became convinced that painting was his true goal in life.

The authorities at France's official art school, the Ecole des Beaux-Arts in Paris, turned down his application on the basis that he showed no signs of talent. With dogged determination, he attended less august schools. His real education as an artist, however, was in the museums.

"The Louvre," he said later, "is a book that teaches us how to read." With sketchbook in hand, he spent long hours studying, copying, and probing the secrets of the old masters.

During the Franco-Prussian War of 1870, with something less than valor he evaded the call to arms and hid near the village shown in his "Landscape in Provence" (page 694). As a painter, however, he showed the courage of a lion and a not inconsiderable arrogance.

With supreme confidence in his destiny, he once said, "Compared to me, my compatriots are asses. I detest them all." Aided and encouraged by his attractive wife, he lived in almost complete seclusion near his birthplace in Aix-en-Provence in the south of France, devoting his life to distilling a new elixir of art.

"To work and not to worry about anybody else," he said, "and to become strong, that is the aim of the artist."

HENRI ROUSSEAU (1844–1910) *The Equatorial Jungle*

Fanciful baboons peer out amid bizarre flowers and leaves in a landscape by the first modern primitive artist to gain world-wide fame. A retired civil servant with no formal art training, Rousseau interjected his own dreams and fantasies into his nature studies. A biographer relates that after painting sinister beasts lurking in an imaginary jungle, the artist would rush trembling to the studio window to assure himself that he was not in the wilds. Rousseau boasted of having taken part in the expedition that Napoleon III sent to Mexico to help Emperor Maximilian, but many historians doubt he ever left France. His technique appears naive, but critics rate his works deceptively subtle. 693

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PAUL CEZANNE
(1839-1906)
Landscape in Provence

Often called the father of modern art, Cézanne developed a new way of depicting form and depth in nature.

For two decades the artist was a laughingstock; critics labeled his work "atrocities in oil." Today his slightest sketch commands a fortune; one canvas recently sold for $616,000.

"The main thing in a picture is to achieve distance," Cézanne held. "By that one recognizes a painter's talent."

In this scene, the interweaving browns and greens of the foreground resolve into solid, grass-covered earth.

SUITA PAINTINGS NATIONAL GALLERY OF ART (Chester Dale Collection) © NATIONAL GEOGRAPHIC SOCIETY

PAUL GAUGUIN
Fatata te Miti

"I'm going to Tahiti and shall die there," the 42-year-old Gauguin wrote to a friend. "My art you love is only a seed. At Tahiti I hope to let it grow in primitive, savage soil."

Instead of the "ecstasy" he dreamed of, Gauguin struggled against constant poverty and agonizing disease. Nonetheless, he produced many of his finest works during his years in the South Pacific.

Fatata te Miti, *which in Tahitian means "By the Seaside," was painted in 1892 on the first of two trips to Tahiti. A tree root swelling across the width of the picture frames bathing girls and spear fisherman. Tropical flowers appear as vivid splashes of color. Shadows purple the sand.*

NATIONAL GALLERY OF ART (*Chester Dale Collection*) © NATIONAL GEOGRAPHIC SOCIETY

HENRI FANTIN-LATOUR (1836-1904) *Still Life*

Unlike the work of his radical contemporaries, Fantin-Latour's art had wide appeal. A perfectionist, he arranged this composition like a Dutch old master. Colors, shapes, and textures are convincingly exact.

More than fifty years after his death, it is still not easy to grasp the magnitude of the revolution he brought about. The contrast on this and the opposite page perhaps helps to explain it. In Fantin-Latour's beautifully painted canvas, the fruit is so faithfully rendered that it can almost be tasted. Cézanne's apples, on the other hand, are definitely not to be eaten; yet they are solid and weighty. Each object is shown as it might feel to the touch of a blind man.

The explanation of this heightened reality is found in Cézanne's own cryptic words: "Art is a harmony parallel to nature."

His interest was not only what our eye sees but what our intelligence tells us must be there. He threw away the copybook of perspective. Note in the still life that the top of the carafe is shown as though seen from above, while the neck is seen from the side. Cézanne shifts his point of view, and knits the different aspects together like a patchwork quilt.

"Our art," he wrote, "should convey the thrill of nature's continuity, with the appearance of its changes. It should enable us to feel nature as eternal."

Of all the mysteries in Cézanne's art, none is more elusive than his use of color, and again his own words provide the key. "Each color touch," he said, "must contain air, light, the subject, the plan, the character, the drawing, and the style; in a word, all that constitutes a painting."

With his modulated planes of color, Cézanne invented a new way of depicting na-

ture. During his lifetime, only a handful of specialists grasped the new vision of the world that the morose, bellicose little man from Aix had conjured.

"I want to paint nature," he was quoted as saying, "as though no one had ever painted it before." He kept his word, and in so doing did more than any other artist in the modern world to usher in a new era of painting.

"To have great poets," Walt Whitman once said, "there must be great audiences, too." A work of art is not only a demonstration of the talent of an artist; it is also an examination of the spectator. Today pictures by the Impressionists and Post-Impressionists are among the most popular of all paintings.

Few of their contemporaries believed that these rebels had accomplished anything significant, but 60 years later we realize that they illuminated a most glorious chapter in the history of art.

How is it possible for values to change so completely in such a short time? The only real test for great art is time, and its passage has made the artists whose works are reproduced on these pages rank among the great names in art history. The throngs of visitors to the National Gallery of Art show no sign of altering this judgment.

Other accounts of the National Gallery of Art in the NATIONAL GEOGRAPHIC include: "The Nation's Newest Old Masters," November, 1956; "Your National Gallery of Art After 10 Years," January, 1952; and "American Masters in the National Gallery," September, 1948, all by the present director, John Walker.

PAUL CEZANNE *Still Life*

This painting offers a striking contrast to Fantin-Latour's tabletop tableau. Cézanne's objects are abstract; they seem to take on a new density of substance with the weight of gold and the hardness of granite.

NATIONAL GALLERY OF ART (*Chester Dale Collection*) © NATIONAL GEOGRAPHIC SOCIETY

World globe, first offered by the National Geographic Society, embodies new concepts in representing the round earth (opposite). A precision instrument, it provides ingenious measuring tools previously available only to professional cartographers. Users can plot courses of giant rockets such as Atlas (above), solve geographic problems, measure distances, and track satellites such as *Tiros I*, which photographed the Gulf of Oman and more distant Persian Gulf (below).

NATIONAL GEOGRAPHIC ANNOUNCES

A Globe for the Space Age

By MELVILLE BELL GROSVENOR
President and Editor

ONE DAY SOON—perhaps sooner than you expect—a giant rocket, trailing fire and bearing human hopes, will hurl the first astronaut into orbit. Tense, exciting hours will follow. Scientists will measure the journey in thrust and miles, humanity in heartbeats. And thousands of members of the National Geographic Society will plot the space explorer's path on a remarkably simple and versatile device: the first world globe designed and offered by your Society.

This precision instrument of geography has been months in the making. Last year, trying to trace the route of a staff man on assignment to Antarctica, I found that the rigid axis of the $250 globe in my office got in my way. Antarctica could be seen clearly only by upending both globe and stand. I called in Chief Cartographer James M. Darley, his assistant Ralph E. McAleer, and our cartographic engineer, Wellman Chamberlin.

"This globe was fine for yesterday's world," I told them, "but it won't do for the Space Age. You use a free-standing globe with some ingenious attachments for making our Geographic maps. I need one like it—and I'm sure our members would want one too."

The result (right) is unlike any other globe now available to the public. One geographer has accurately called it "the globe with a thinking cap."

A convenient 12 inches in diameter, the ten-color globe is drawn to a scale only slightly smaller than that of the Society's 42-by-29-inch wall map of the world. It comes complete with a "Geometer"—a transparent cap with a multitude of uses—and other unique measuring tools designed by our cartographers.

A booklet contains simple, clear instructions for use of the globe and an index of 4,179 place names. Key numbers printed on the globe's face greatly increase its usefulness by locating place names quickly.

Earthquakes tear at Chile, and the Red Cross rushes drugs and doctors. Your globe shows the swiftest routes of mercy planes and ships.

The Navy announces a new 1,700-mile range for the Polaris; your Geometer shows what targets are within reach from any spot in any ocean.

A Tiros satellite photographs a dramatic, curving coastline. Tilted to the proper angle, your globe affords the same vantage—plus the names of cities and seas in

EXTACHROME (OPPOSITE) BY ROBERT SARGENT, NATIONAL GEOGRAPHIC STAFF. ON BACKGROUND OF PHOTOMAP COPYRIGHTED © N. G. S.


NATIONAL GEOGRAPHIC GLOBE
NORTH
ATLANTIC
OCEAN

Great Circle Ring instantly shows the shortest course and distance between any two points. Merely rotate the globe until both points touch the ring, then read the mileage.

clear, specially designed Geographic map lettering.

Most important, this globe adds a whole new dimension to the Society's program for spreading geographic knowledge. The globe offers geography in the round.

The latest information fills the precisely drawn map that covers this sphere. Ocean areas—71 percent of the globe's surface—are not merely a solid-blue waste. They show the newest discoveries of oceanography: profiles of ocean floors, seamounts and trenches, continental shelves, soundings, and currents.

Political boundaries are as timely as headlines; Africa, for instance, shows the names and boundaries of all the newly independent nations, as of February 15, 1961. Drawn to a generous scale of 660 miles to the inch, the globe is easy to read, yet a handy size.

To ensure accurate assembly, the globes will undergo National Geographic inspection. The manufacturer, Replogle Globes, Inc., of Chicago, Illinois, prepared special dies to meet Society standards.

"I was fascinated by the ingenuity, simplicity, and flexibility of its design," Dr. Hugh L. Dryden, Deputy Administrator of the National Aeronautics and Space Administration, wrote me. "This brilliantly conceived general-purpose globe for the Age of Space is a great contribution to the dissemination of geographic knowledge."

Capt. Alan Villiers took one look and exclaimed: "I could navigate the open seas with that globe!"

Dr. Robert Campbell, Chairman of the Department of Geography at George Washington University, said of the new globe: "It has the accuracy and flexibility demanded by experts, and it can be used just as easily by the youngster."

And Dr. Fred L. Whipple, Director of the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts, not only commended the Society for developing its "uniquely useful" globe, but added:

"We have immediate need for these instruments, and want several as soon as possible!"

The globe which has aroused such enthusiasm in these distinguished scientists and educators is cradled freely in its stand; any point on earth can be turned upright. Until a few years ago, such flexibility was unnecessary; little was known or shown about the polar regions.

Now the Arctic Ocean is traversed by nuclear submarine and even by regular commercial airlines. Permanent scientific stations dot Antarctica. The new Geographic globe reveals a wealth of recent Antarctic data—discoveries never before shown on any general map, flat or round.

For example, Burke Island, named for Adm. Arleigh A. Burke, and the Ellsworth Mountains, named for explorer Lincoln Ellsworth, appear for the first time. Ice soundings in Marie Byrd Land disclose a sub-sea-level channel that may divide the continent.

The Society's free-standing, classic globe design was first fashioned by the ancient

Members of the Society may obtain **National Geographic Globes** for their own use or as gifts at $16.85 each. The first printing is limited, so orders should be sent promptly; globes will be shipped postpaid as orders are received. Members may request later billing, or remittances may accompany orders.

Ten-color, glossy-finished globe: 12 inches in diameter; 37.7 inches in circumference; scale 660 miles to the inch; complete with Geometer, scaled Great Circle Ring, supporting stand, and instruction booklet containing index of 4,179 place names and detailed illustrations showing the many uses of the globe. Address National Geographic Society, Dept. 63, Washington 6, D. C.

Outlines of nations may be grease-penciled on the surface of the transparent Geometer—the globe's "thinking cap"—to compare areas, just as this young lady measures the United States against Antarctica.

Scales and concentric circles embossed on the Geometer allow computation of distance, direction, and area.

Great Circle Ring determines time, distance, latitude, and longitude. When upended, the stand forms a cup for the globe. Free of mounting rods, the ball tilts and rotates to any position.

Drawn to a scale of 660 miles to the inch, the ten-color globe outlines the borders of the world's newest nations. Oceans show soundings, depth contours, and currents.

PAINTING BY ROBERT CARES, NATIONAL GEOGRAPHIC STAFF © N.G.S.

Greeks. Mariners like Columbus and Magellan in the first great Age of Discovery navigated with such globes of wood. As centuries passed, most globes became skewered, rigidly inclined at an angle of 23° 27' to show the earth's tilt in relation to the sun. Your Society's globe can easily be set at this angle by touching the dashed lines of the Tropics with the Great Circle Ring.

But this is only one feature of your new globe for the modern Age of Discovery. The Geometer solves geographic problems in an instant. On it you can read the azimuth, or bearing, between any two points on earth. Its grid scale gives a quick estimate of surface areas. Circular scales show the range of intercontinental rockets.

Even the stand holding this sphere has special uses. The transparent Great Circle Ring shows instantly the shortest distance—along the great-circle course—between any two points on the globe. And the upended stand frees the globe for convenient use of the plastic Geometer, the ingenious thinking cap (above).

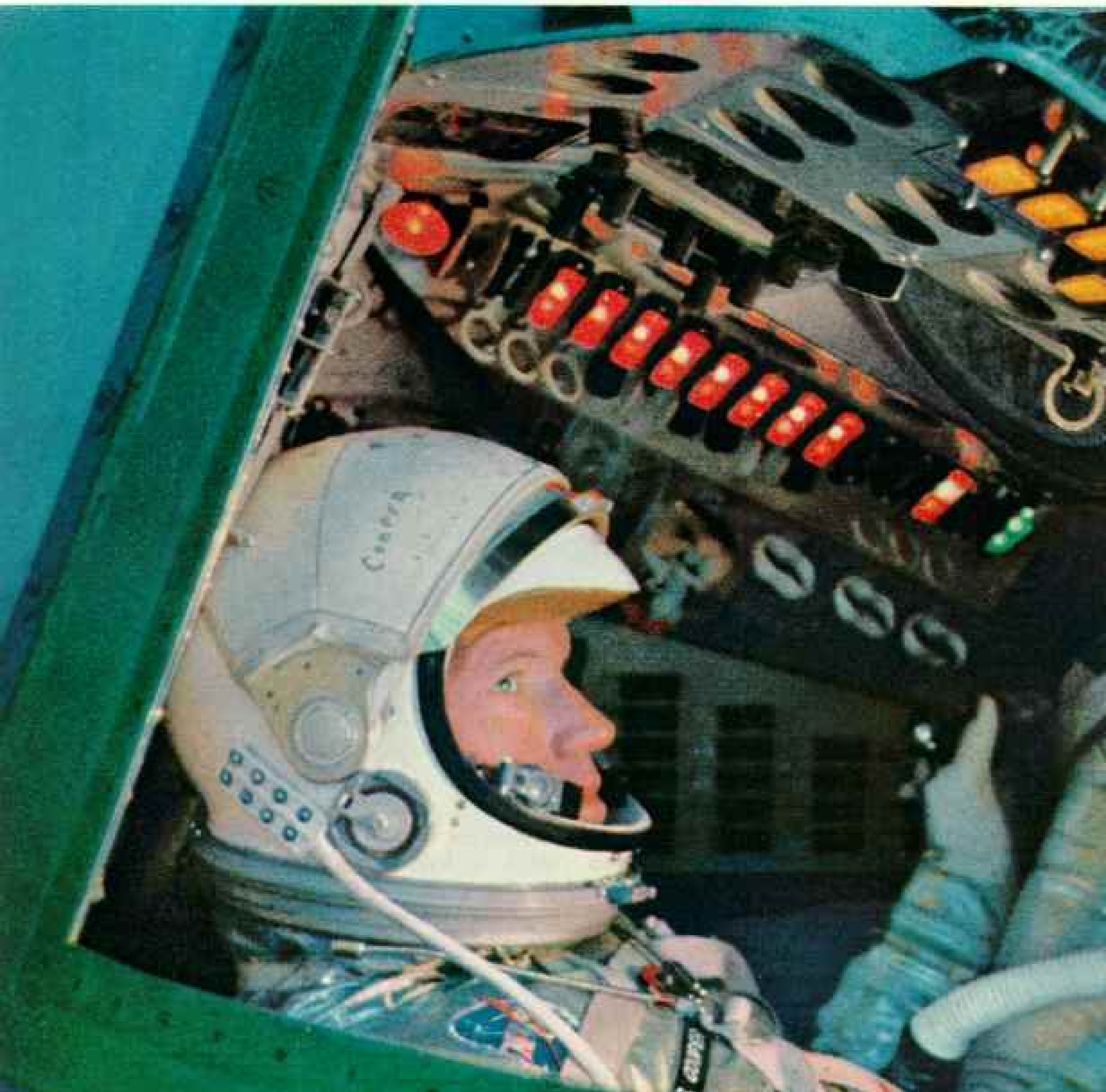
Whether the child uses this globe by himself or with an adult's help, it is sure to whet his taste for learning. He can take the whole world in his hands and study global geography under the nearest reading lamp.

He can visualize his own universe. In the same scale, the moon would be a baseball 30 feet away, and the sun a giant balloon 109 feet in diameter and 2¼ miles distant. Just as children learn from model airplanes and trains, so a model of the earth—a true working model—excites the imagination and spurs a lasting intellectual curiosity.

In furtherance of the Society's aims, we offer members this important instrument for the study of geography. Our globe has been proved by the daily work of scientists. I am sure you will share my conviction that it is the most useful globe available today, and another great achievement of our cartographic staff.

SIX-MONTH INDEX AVAILABLE

As one of the privileges of membership in the Society, an index for each six-month volume of the NATIONAL GEOGRAPHIC will be mailed upon request to members who bind their issues as works of reference. The index to Volume 118 (July-December, 1960) is now ready.



EKTACHROME BY NATIONAL GEOGRAPH

Project Mercury astronauts poise for their rocket assault on the unknown

COUNTDOWN

PHOTOGRAPHER LUIS MARDEN FOR THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FOR SPACE

By KENNETH F. WEAVER, National Geographic Senior Staff

THIS IS the Year of the Astronaut, the year when a few hand-picked men hope to brave the mysteries of a new and forbidding world.

As these words are written, the seven superbly trained astronauts of Project Mercury wait expectantly for their epochal assault on space. Three have been named, and one will be chosen, for the historic first flight. Their equipment is ready: the silver space suits, modern armor against heat and vacuum; the blue-gray funnel-shaped spacecraft, a miracle of compact engineering; the gleaming Redstone rockets, reliable steeds proved by scores of ruthless tests.

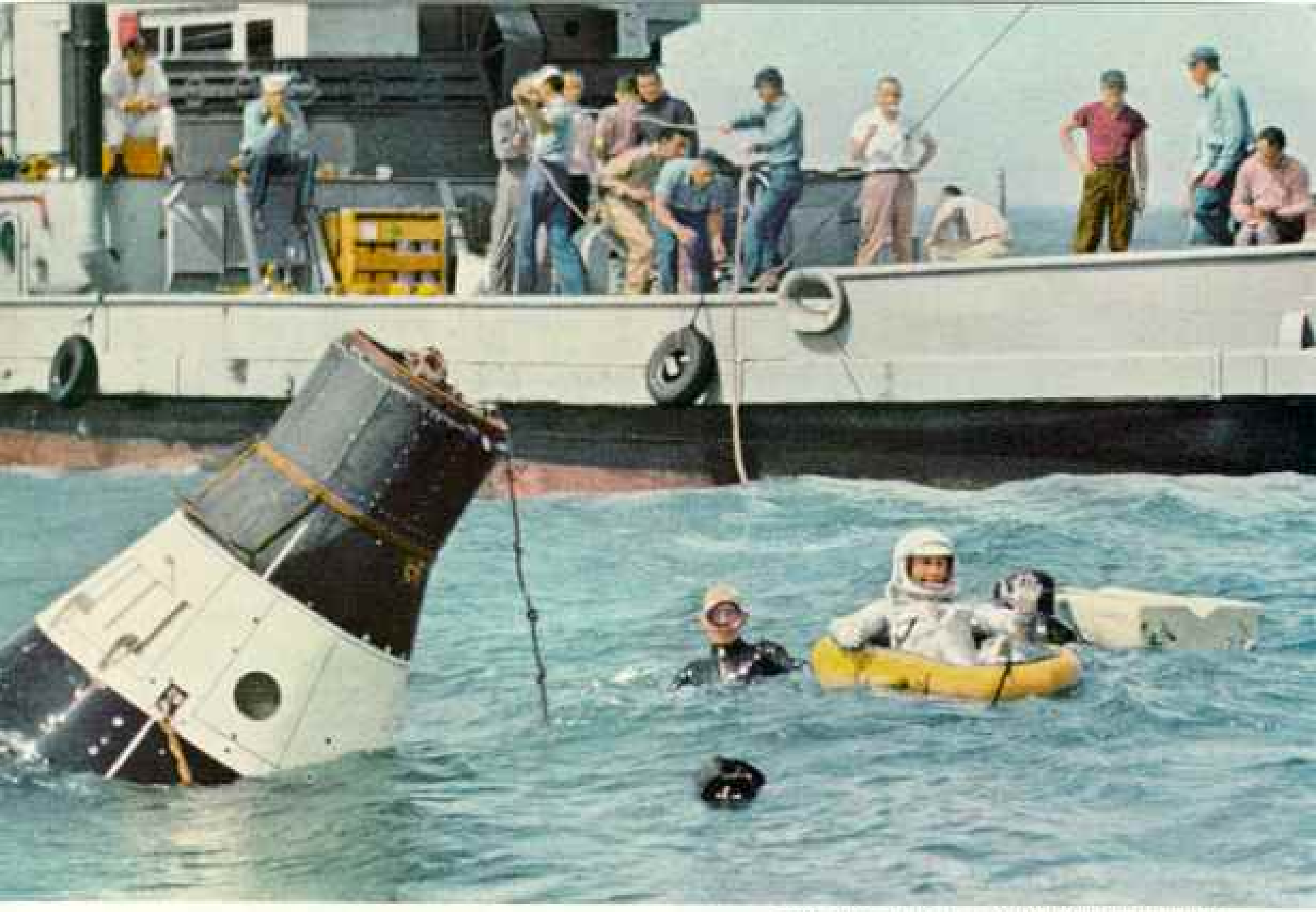
Ham Gets a Round-trip Ticket

Already the world knows that a Mercury spacecraft can carry a living being to space and back safely. A diaper-clad chimpanzee named Ham, couched in a special pressure chamber and wired with devices to register heartbeat, temperature, and breathing, made the trip with the same spacecraft and rocket a man will use. Between his legs some wag had placed a card: "Have missile, will travel."

During flight Ham incessantly pulled levers in response to the winking of colored lights. He performed flawlessly. And at journey's end, when he glimpsed the apple that was his reward, he flashed a smile that delighted the millions who waited for the news that he had suffered no ill effects.

What man will be first to follow Ham? By the time you read this, the headlines may well have made his name a household word. Glenn? Grissom? Shepard? (Perhaps it will be Ivan Ivanovitch; the Russians, too, are racing spaceward.)

But no matter who is first, others are to follow in swift succession. Each astronaut hopes to make a brief Redstone flight that will loft him more than a hundred



CATALINA PHOTO BY LIFE PHOTOGRAPHER RALPH MORSE FOR NASA

Practice dunking trains astronauts for a watery escape from Project Mercury's man-in-space capsule. Here, in the Gulf of Mexico, Astronaut Virgil I. Grissom floats on a rubber raft as he might do after a rocket voyage through space. Within a year the National Aeronautics and Space Administration hopes to put a man into orbit.

miles high, put him into flight like a rifle bullet, and some 16 minutes later drop him into the ocean several hundred miles down the Atlantic Missile Range from Cape Canaveral, Florida.*

Not too many months later, the National Aeronautics and Space Administration (NASA) expects several astronauts to mount the mighty Atlas missiles which can thrust their Mercury spacecraft into swift orbit around earth. Each man will make a valiant contribution to the conquest of space.

I shall never make that trip into the black realm of space, but I know in some small degree how these men will feel. I have huddled in the tiny cockpit of their spacecraft and handled the unfamiliar controls. I have ridden their strange training devices, and through a periscope watched the earth as it would appear a hundred miles away.

Lack of Oxygen Starves Brain

I have entered an altitude chamber and "climbed" to the threshold no man crosses alive without a pressure suit. I have removed my oxygen mask briefly in rarefied atmosphere and felt my brain go sodden for lack of the breath of life.

I have watched the astronauts at work and play, and my experience has given me an immense respect for their devotion and skill. Not only are they prepared to make whatever sacrifice may be required to accomplish their mission, but in addition they accept as daily routine a hundred little tortures and discomforts that would drive an ordinary man out of his wits.

At the George C. Marshall Space Flight

The Author: Science has fascinated GEOGRAPHIC senior staff member Kenneth F. Weaver since high-school days, when he turned his attic into a chemistry and physics laboratory. For the GEOGRAPHIC, he has reported on radio-carbon dating (August, 1958) and 17-year locusts (July, 1953). Forthcoming articles will discuss radio astronomy and contrast modern and ancient Athens.

*See "Exploring Tomorrow With the Space Agency," July, 1960; and "Cape Canaveral's 6,000-mile Shooting Gallery," October, 1959, both by Allan C. Fisher, Jr.

Center in Huntsville, Alabama, I saw Redstone rockets being prepared for manned flight. "Old Reliable" they call the Redstone, because of its phenomenal seven-year record of success. The Mercury version is an elongated Redstone similar to the Jupiter-C that launched America's first satellite, Explorer I, into orbit.

This rocket appears deceptively simple. Its single bell-shaped engine, capable of producing 78,000 pounds of thrust for more than 140 seconds, hangs beneath a long white storage tank of some 6,500 gallons capacity (page 708). One compartment holds the fuel, alcohol. The other contains liquid oxygen (LOX), for in airless space a rocket must provide its own oxidizer to burn the fuel.

But this is no ordinary storage tank. Dr. Joachim Kuettner, one of the famed band of German rocket experts who developed the Redstone, explained the special care taken in the rocket's manufacture.

"As these thin sheets of aluminum are curved and welded," he told me, "each seam is minutely inspected by X-ray to make sure there are no invisible flaws that might give way under the extreme stresses of flight.

"Every component we use bears a special seal representing the winged god Mercury. This symbol constantly reminds assembly-

Astronaut slides into his life raft from a bobbing capsule during a simulated emergency. In a normal landing he would wait for a recovery team to release him through a side hatch. To squeeze through the top of the telephone-booth-sized cabin, he removed a wing of the instrument panel, pressure bulkhead, and other equipment. 705

line workers that a man's life depends on their product."

The tank and plumbing that deliver LOX must be scrupulously clean: Workmen handle them with surgical gloves. Scientists told me that so much as a fingerprint left on a valve seat could cause the valve to explode as it slammed shut, so violently would the oxygen combine with the tiny amount of oil in the fingerprint.

Fiction's Spacemen Would Be Amazed

Atop the rocket rides the Mercury spacecraft, commonly called the capsule. Missile workmen speak of "mating" the rocket and capsule, and they perform the wedding with explosive bolts that can divorce the two with great speed when the time comes.

Hundreds of wind-tunnel tests and an investment of several hundred million dollars have produced this strange blunt craft, so unlike the streamlined rocket ships of fiction. Except for the fact that it has no engine of its own, it is more complicated than any aircraft (opposite).

Its 10,000 components are assembled under hospital-sterile conditions in a "white room" (page 711). On my first view of such a room, I thought I was looking into an operating theater. Every workman wore a white cap and gown, and those without special white footgear covered their shoes with plastic bags.

The completed capsule is delivered to Canaveral in a plastic sheathing and is hustled into another white room. During the trip to the gantry and throughout the mating process, the same superclean conditions are maintained.

The spacecraft weighs hardly more than a ton and measures nine feet high by six feet wide at its broadest. Even empty it offers less room than a telephone booth. Yet the variety of equipment in this cramped space reminds me of the string of clowns that pour out of a midget car at the circus:

Astronaut's couch
Seven miles of wire
Multiple communications systems
Oxygen for 28 hours
Air-cooling system
Navigation aids and a control system
Periscope
Instrument panel
Parachutes and other recovery gear
Collapsible life raft
Batteries good for 48 hours
Infrared horizon scanner
Tape recorder
Autopilot
Two cameras

And there are duplicates—even triplicates—of many of these things for safety's sake!

Just how safe is the spacecraft? When I broached this matter to Harry C. Shoaf, a project engineer for the capsules, he reacted violently, exploding upright in his chair.

"Why, I'd trust my own child in it!" he snapped.

Re-entry Heat Turns Sides Cherry Red

At Langley Air Force Base near Hampton, Virginia, where the astronauts make their home base, I took a long and careful look at this unique spacecraft.

Corrugated shingles of nickel-cobalt alloy, much thinner than a dime, cover the conical sides. They allow for expansion as the surface heats to a cherry red under the frictional torch of returning to the earth's atmosphere after orbital flight.

On shorter, ballistic flights the sides do not get nearly so hot. When I examined a capsule that had gone through one of the early Redstone tests, I discovered that the painted words "United States" had barely blistered.

The six-foot rounded disk that forms the capsule's blunt end is the largest piece of beryllium ever forged. It is called a heat shield, but for the brief Redstone flights this term is almost a misnomer; surface heat may rise to as much as 600°F., but so rapidly does it spread throughout the thick disk that the average temperature of the shield stays at an unbelievably low 100°.

On the swifter Atlas flights, a plastic shield will handle the several thousand degrees

(Continued on page 711)

Snatched From the Sea, a Spacecraft Settles to Rest on a Carrier

A successful test shot in December, 1960, sent the Mercury craft arching 125 miles high. For orbital flights, a saucer-shaped shield dissipates the heat of re-entry and holds the cabin to temperatures bearable for a space-suited astronaut. Such shields are made of glass fiber and a plastic similar to that on kitchen counters.

HS EKTACHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER DEAN CONGER FOR NASA


MARINES
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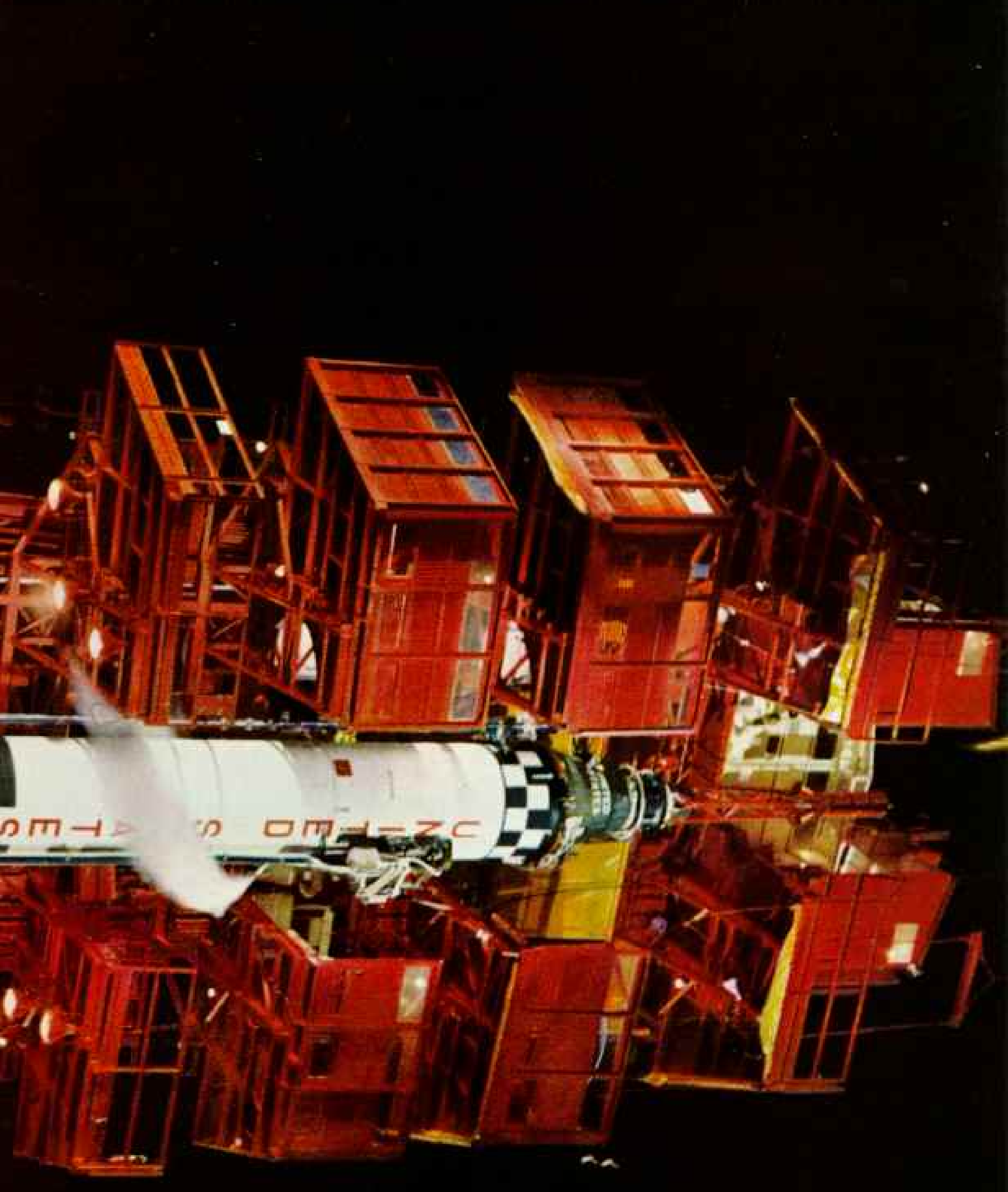
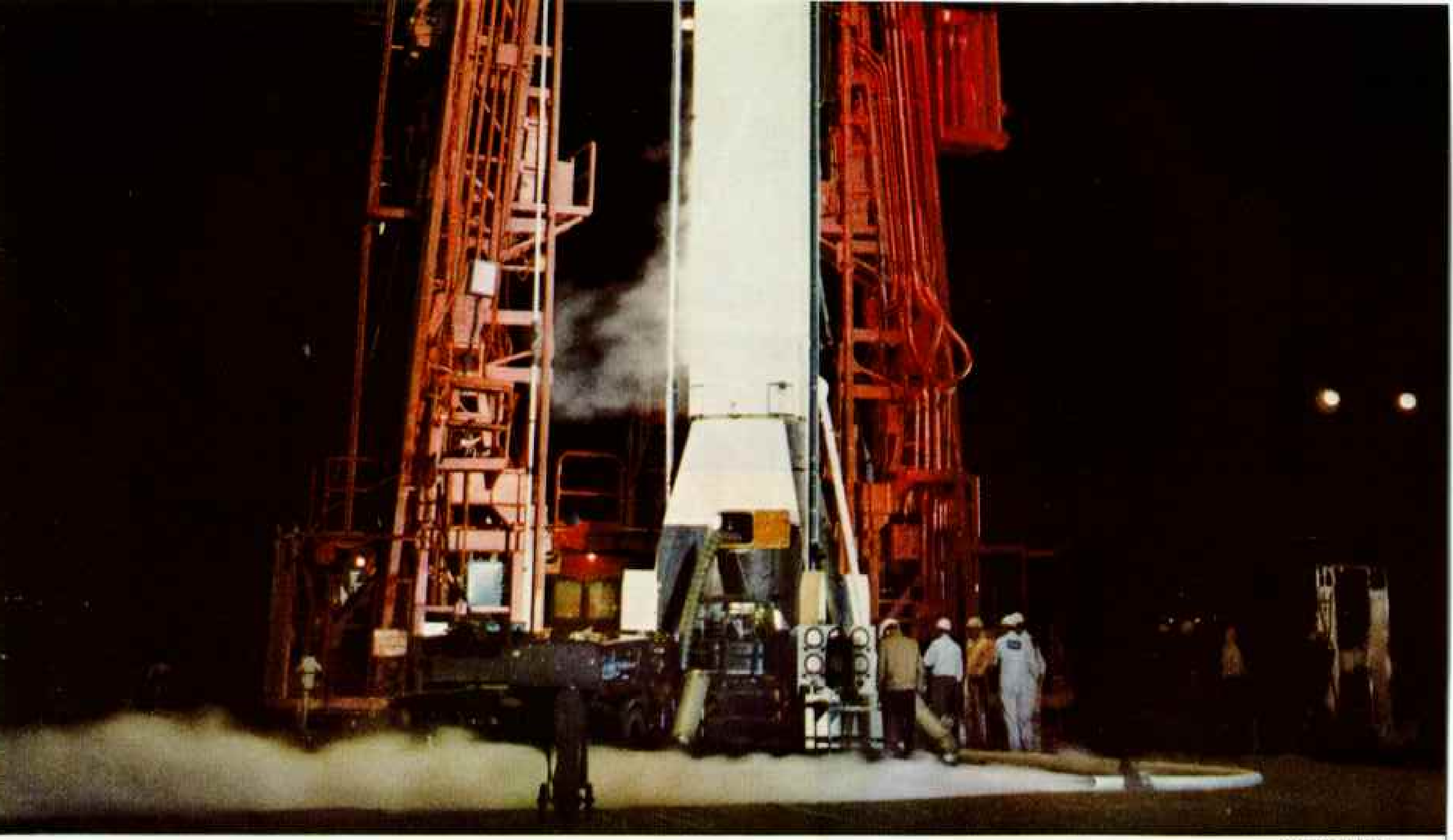
UNITED
STATES
NAVY 51





EKTACHROME BY NASA

Escaping oxygen spurts from a Redstone aimed starward at Cape Canaveral, a Mercury spacecraft on its nose. In such firings, the towering gantry rolls away, and the rocket blazes down the Atlantic Missile Range. Redstones drive capsules on short runs; orbital shots will require the more powerful Atlas.

Hospital cleanliness marks the "white room" at McDonnell Aircraft plant, St. Louis, Missouri, where Mercury capsules take shape. Men use extreme precautions against dust or metal particles that could cause a failure in the craft's equipment and electrical connections.

Canaveral technicians (upper left) check a nickel-and-cobalt-hulled capsule.

Flaming engine of an escape tower mechanism skyrockets a dummy capsule in a test at Wallops Island, Virginia. Its thrust can free a spacecraft should the booster malfunction during powered flight. Once clear, the capsule jettisons the tower and lands by parachute.

EXTERIOR BY MCDONNELL AIRCRAFT CORPORATION

(Continued from page 706)

produced by re-entry from orbit. This resin-and-glass-fiber shield gradually melts and vaporizes in a process called ablation, thus carrying away the intense heat. I ran my hand across one of these ablative shields after it had returned from space, and found the charred and pitted surface to be rough as ultracoarse sandpaper.

Twin Shields Bar Space Perils

Inside the spacecraft's outer skin, an inch and a half of insulation and an air-tight inner hull of titanium keep the astronaut secure from heat, cold, and vacuum.

As I sat in the astronaut's seat, my legs (which are longer than any astronaut's) were pushed up toward my chest. The instrument panel, with its hundred-odd dials and switches and warning lights, stared at me from a variety of colored panels (next page), just two feet from my face. Yet I felt no claustrophobia; skillful design has produced a surprising degree of comfort.

My hands fell naturally on two levers. On the left I grasped the abort handle, sometimes called the "chicken switch." It can fire the three-nozzled escape rocket on a tower atop the spacecraft to hurl craft and astronaut to safety if something goes wrong with the booster rocket (opposite). On the right I held the sidearm controller which can stabilize and orient the capsule in flight.

In Langley's air-lubricated spacecraft simulator, I lay back in a darkened room and tried this control lever to experience some

Spaceman's view of his instrument panel: Mercury capsule's banks of switches, lights, and dials look complicated, but are simpler than a jet plane's. The astronaut can follow his flight from launching to rescue by watching lettered signal lights at left. Piloting normally is automatic, but adjacent handles allow manual control. Round periscope screen at lower center gives the man a view of the world beneath; the novel earth-path indicator above the screen traces his orbit. He keeps the capsule upright by firing steam jets until cross marks align in the roll-pitch-yaw gauge (top). Dials and switches at right control conditions in the capsule. Abort light (top, left) flashes red should the launching go awry. Escape procedure works automatically, but the astronaut can trigger it by hand.

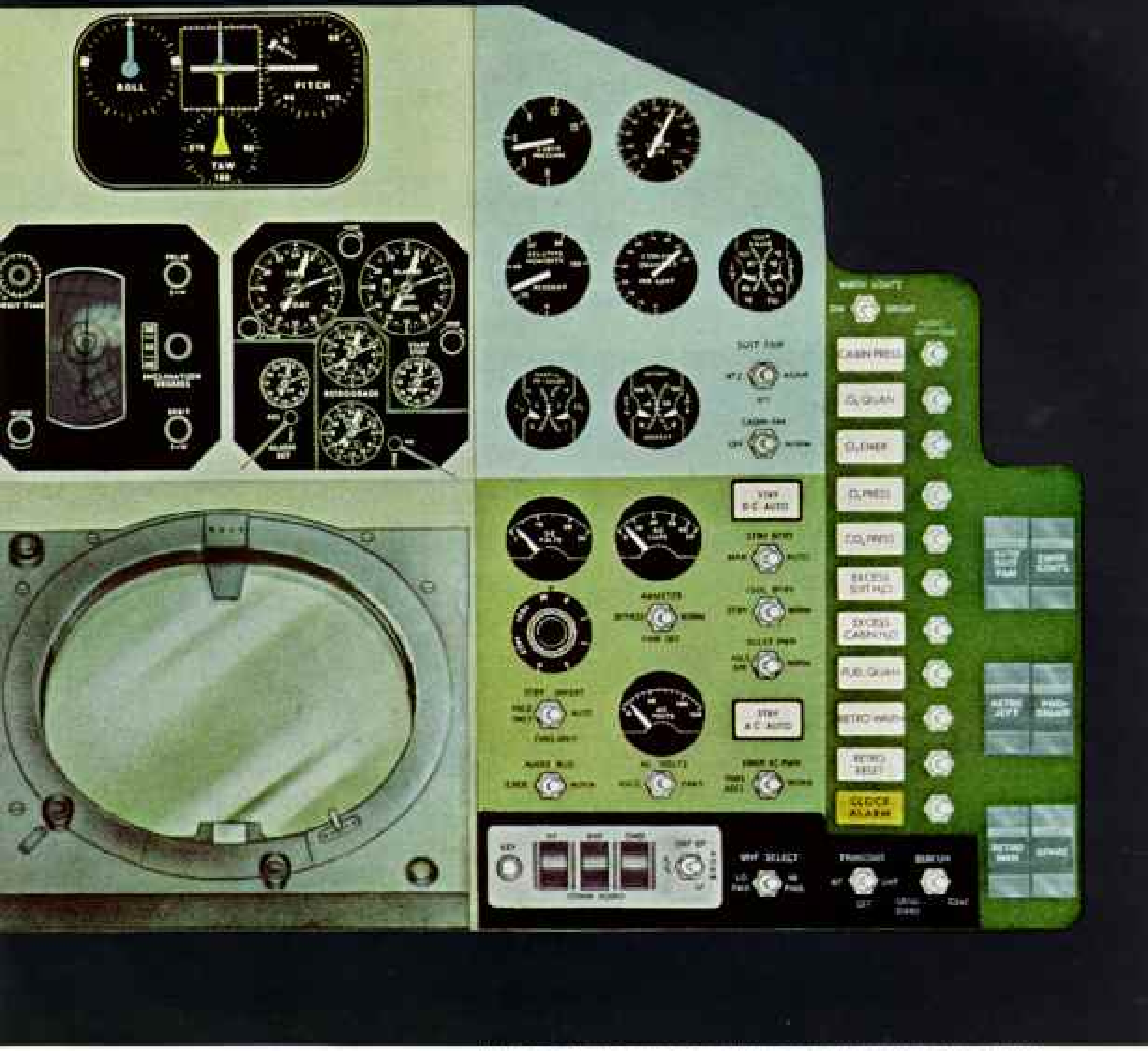
Tiny globe of earth-path indicator rotates as the capsule orbits. Bull's-eye on dial face shows the astronaut's position; arrow spots his landing place should he fire retrorockets for return to earth.

of the sensations the astronauts expect to feel in flight.

The heart of the trainer is a molded couch poised on a large steel ball and cushioned by a layer of compressed air. Any movement of the man in the couch may tilt it topsy-turvy or send it spinning, although the Mercury capsule itself is not that sensitive.

Jeremy B. Jones, who helped to design the trainer, explained how it works as he strapped me in.

"You have a series of compressed-air jets that will turn you in any direction you wish," he said. "Push the sidearm controller forward and back, and you will pitch. Twist it, and you will yaw. Throw it left or right, and you will roll. Hit it with short bursts, or you will move too fast. You can rest your



NASA (ABOVE) AND ROSEMARY RY LOIS MAHON, NATIONAL GEOGRAPHIC STAFF, FOR NASA

hand on the switch at left, but don't press it!" he warned.

"And keep your eye on the earth." He pointed through a lens to the map covering a strip 1,900 miles wide that swept past at five miles a second, duplicating the view from an orbiting spacecraft.

Problem: Make the World Stand Still

A blast shook the room as he turned on the air, and I felt myself floating free. Jerry carefully adjusted a series of weights until I was properly balanced, and then let me go.

"O.K., you're on your own," he shouted over the roar of the air.

Nothing happened at first, and I congratulated myself. Earth hung serenely in my viewer, neatly bracketed by four black lines. Then my nose itched, and unthinkingly I lifted my hand to scratch it. Immediately the trainer tilted sharply, and my insides seemed to slosh around. More important, the world was rolling away to the left—I had to act quickly.

I threw the handle left in a series of spurts. Air hissed, and hissed again. Sure enough, I was coming around. But now my head was tilting backward, and the earth was pitching away from me. I tried to correct for pitch, and to my dismay I began to roll again and to yaw besides. No matter which way I threw the lever, the combination of motions of the trainer defied my efforts, and I got only a series of loud hisses for my pains.

"You want to try retro-firing?" Jerry called

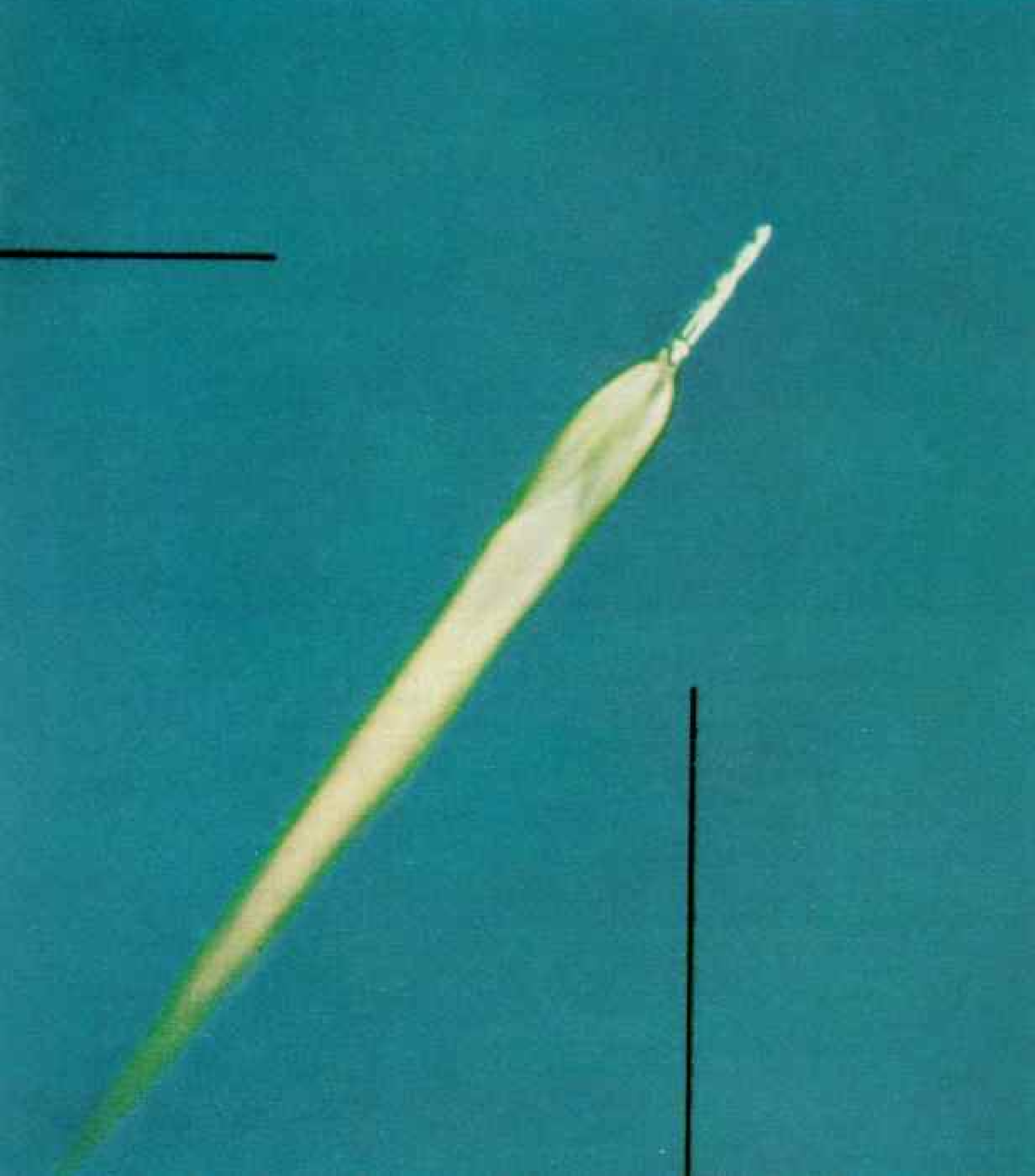
(Continued on page 718)

Space Shot

Spewing a cometlike tail and gulping a ton of fuel every three seconds, a mighty Titan soars into the sky's blue arch off Cape Canaveral. This two-stage intercontinental ballistic missile, as tall as a nine-story building, could launch a 2½-ton satellite or drop a payload on a target nine thousand miles away. A network of Titans, to be mounted in underground silos, is being rushed to completion by the Air Force.

Here the camera catches the missile at an altitude of 25 miles. Black lines are tracking cross hairs.

RECOLORING BY UNITED STATES AIR FORCE



4 **Disappearing speck** of Titan second stage races away from main booster at 5,000 miles an hour. Altitude: 50 miles. The camera that made these remarkable photographs mounts a 500-inch lens—creating an image 250 times the size of that from a typical 35-mm camera. Such instruments can discern letters four inches high at a distance of eight miles.

2

Wavering plume signals burnout of Titan's first stage. Delicate colors often lace broadened rocket trails in the atmosphere's outer reaches.

Biggest U. S. intercontinental ballistic missile, the Titan has the launching thrust, or power, of 15,000 automobiles. Engineers call its take-off roar "white noise"—a play on the fact that white in the color spectrum includes all hues.

3 **Titan's second-stage** engine ignites in a far-off burst of flame after separation from the spent first stage. Both sections burn liquid oxygen (LOX) and RP-1, a high-grade kerosene. Newer Titans now a-building will use hydrazine and nitrogen tetroxide as propellants. Easier to handle than LOX, these liquids flame when brought together.

Spaceship's edges glow cherry red from buffeting by air molecules—an artist's conception of the proposed Dyna-Soar glider on return from orbit. This manned glider, its name coined from "dynamic soaring," may test-fly in 1964. The Boeing Company has a contract to build it.

Dyna-Soar will shoot toward space atop the nose of a Titan. Its design aims to combine the speed of a missile with the control of a bomber.

SCOREBOARD OF SATELLITES IN ORBIT

By February 15, 1961 twenty-three satellites were exploring space. Their delicate instruments were discovering cosmic secrets that will permit man to penetrate this fathomless area. At the same time they were resolving mysteries of our own planet.

Besides these satellites, numerous pieces of space junk such as rocket bodies, nose cones, capsules, and final stages have been carried into orbit with the spacecraft. All orbits are drawn to scale. Planets and satellites on diagram at right occupy positions as of May 1, 1961.

Scoreboard at right gives each orbiter's inclination, or angle to the Equator, and period, or time it takes to circle the earth. These factors permit the successive courses of any earth satellite to be determined by use of the great-circle ring of the new National Geographic Globe.

LUNIK II - Lunar impact, September 13, 1959

10 & 11

2

VENUS PROBE - Scheduled to reach planet in late May; date was later moved ahead

3

12

16

8

13

4

Explorer VI's orbit, 26,000 miles at the apogee, leaves the page.

5

6

JOHN LOTHROP, STAFF ARTIST

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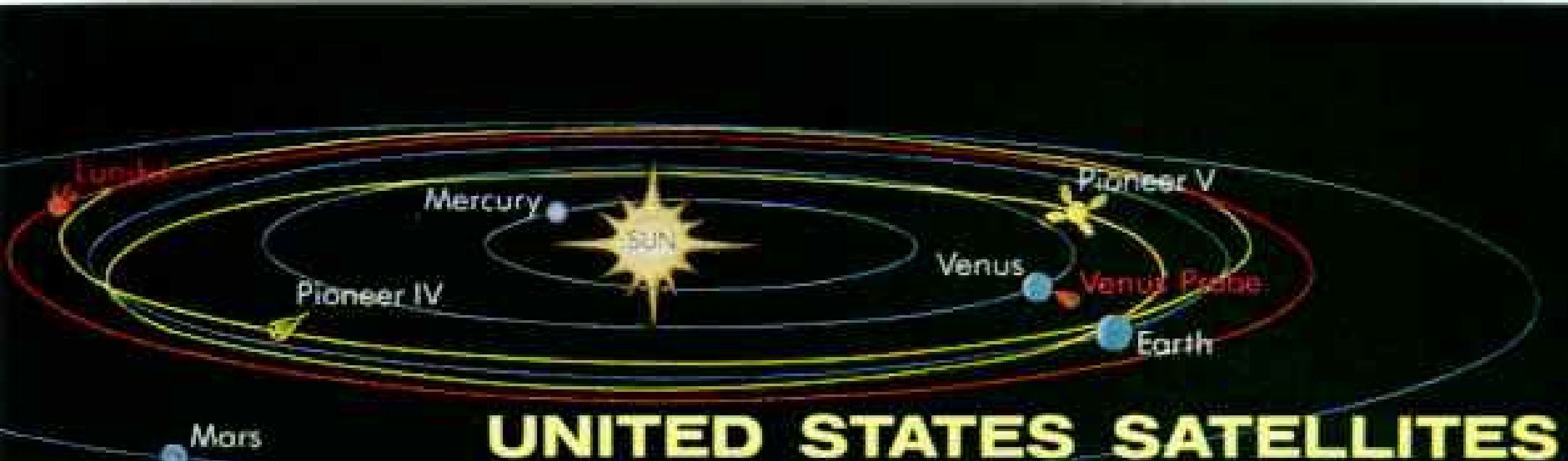


UNITED STATES SATELLITES

EARTH ORBIT

1 EXPLORER I
Launched January 31, 1958. Brought to light the doughnut-shaped Van Allen inner radiation belt encircling the earth. Inclination 32°. Period 107 minutes.

2 VANGUARD I*
March 17, 1958. Tiniest satellite (3¼ pounds) detected the earth's pear-like shape. First to use solar cells for electric power. Inclination 34°. Period 134 minutes.

3 VANGUARD II
February 17, 1959. Forerunner of the Tiros series developed a wobbling motion in orbit that interfered with interpretation of data. Inclination 33°. Period 125 minutes.

4 EXPLORER VI
August 7, 1959. Highly elliptical orbit permitted mapping of Van Allen outer belt. Silicon cells on extended paddles generated power from sunlight. Exact orbit uncertain. Inclination 47°. Period 12½ hours.

5 VANGUARD III
September 18, 1959. Fixed the location of the lower edge of the Van Allen inner belt. Magnetometer charted the earth's magnetic field. Inclination 33°. Period 130 minutes.

6 EXPLORER VII*
October 13, 1959. Detected continent-wide weather patterns and shed new light on radiation bursts from the sun, a peril to man in space. Inclination 50°. Period 101 minutes.

7 TIROS I*
April 1, 1960. Observed global weather conditions. Two TV cameras took more than 22,000 pictures of clouds and earth. Inclination 48°. Period 99 minutes.

8 TRANSIT 1B
April 13, 1960. This artificial star transmitted signals from which ships and aircraft could determine exact positions. Inclination 51°. Period 95 minutes.

9 MIDAS II*
May 24, 1960. Infrared sensing devices would make it possible to detect hostile rockets. Inclination 33°. Period 94 minutes.

10 TRANSIT IIA*
June 22, 1960. Main payload of first dual satellite advanced the practicability of navigational satellites. Inclination 67°. Period 102 minutes.

11 TRANSIT IIA PIGGYBACK*
Smaller payload paralleling its carrier's path, measured solar radiation in the upper ionosphere.

12 ECHO I*
August 12, 1960. Millions have seen this 100-foot aluminum-coated plastic balloon, which by reflecting radio waves demonstrated the feasibility of a global communications network. Inclination 47°. Period 117 minutes.

13 COURIER 1B*
October 4, 1960. Simultaneously collected and stored 72,000 words per minute until commanded to transmit them to earth. Inclination 28°. Period 107 minutes.

14 EXPLORER VIII
November 3, 1960. Investigated the structure of the ionosphere and broadcast a record of micrometeorite impacts. Inclination 50°. Period 113 minutes.

15 TIROS II*
November 23, 1960. Later version of Tiros I measured solar heat absorbed and reflected by the earth. Wide-angle camera went awry. Inclination 49°. Period 98 minutes.

16 SAMOS II*
January 31, 1961. From hundreds of miles, the improved Samos will scan earth with the fidelity of the human eye at 100 feet. Inclination 90° (assumed). Period 95 minutes.

SOLAR ORBIT

PIONEER IV
March 3, 1959. First U. S. deep-space probe achieved earth-moon trajectory and gathered information on the Van Allen outer belt.

PIONEER V
March 11, 1960. Received and sent radio signals for a record 22½ million miles. Now swinging between orbital paths of earth and Venus.

SOVIET SATELLITES

EARTH ORBIT

17 SPUTNIK IV
May 15, 1960. Forerunner of manned flights. Malfunction caused ship to orbit rather than return to earth. Inclination 65°. Period 93 minutes.

18 SPUTNIK VII
February 4, 1961. Secrecy surrounds the launching of this seven-ton spaceship, the heaviest to date. Inclination 65°. Period 90 minutes.

19 SPUTNIK VIII
February 12, 1961. While circling the earth, this satellite launched a half-ton spaceship -the Venus probe- into solar orbit. (See note below). Inclination 65°. Period 90 minutes.

SOLAR ORBIT

LUNIK I (MECHTA)
January 2, 1959. First solar orbiter studied radiation and magnetic fields between earth and moon.

VENUS PROBE*
Sputnik VIII's piggyback payload contains a guidance system designed to alter its solar orbit, directing it to Venus.

* Still Transmitting

? Shapes not disclosed by Soviets.

Compiled by Eugene M. Scheel

as he stabilized my craft. Innocently I agreed.

"O.K., just press the switch by your left hand and wait thirty seconds."

The seconds ticked by, and I braced myself. The craft shuddered under three overlapping blasts of air. They represented the "ripple firing" of the three retrorockets used to slow the capsule in its headlong flight so that gravity can pull it back to earth.

With each thunderclap, I felt as if a giant hand were pushing my couch in a new direction. My frantic but inexperienced efforts to get back on course were futile, much like the overcorrections of a cadet learning to fly.

Astronaut Handles an Emergency

Later I watched Astronaut Alan B. Shepard, Jr., operate Langley's procedures trainer, a mock-up spacecraft that duplicates nearly all the operations and problems of actual flight. As gauges in the trainer showed that the capsule was beginning to tumble, his wrist and hand flew smoothly in a series of compound motions that swiftly brought the indicators back to normal.

Small comfort it was to me that Shepard's quick reflexes came from much practice on the trainer, backed by long experience as a jet pilot.

While I watched the flickering lights and dials outside the procedures trainer, James W. Prim III, the instructor, punched buttons to create artificial crises for the astronaut inside. Buzzers and red warning lights told Shepard what the troubles were: a dead battery, oxygen leaking, parachute not working, and so on. In each case he quickly threw in an emergency system or took over manual controls to solve the problem.

A tinge of drama livened one exercise. As I listened on the headphones, with the hum of the computers and other electrical machinery around me, I could easily imagine that I was in the blockhouse during a shoot, that Prim was one of the monitors at a control console, and that Shepard was in his capsule atop a rocket.

"Count is at T minus 50 seconds, and counting," droned Prim.

"*Roger,*" replied Shepard.

"Check your periscope—fully retracted?"

"*Periscope retracted.*"

"Ready switch on?"

"*Ready switch on.*"

"T minus 10 seconds. Minus 8 . . . 5 . . . 4 . . . 3 . . . 2 . . . 1. FIRE!"

Within moments Shepard's voice—calm and sure—began a crisp report of the progress of the flight.

"*Clock is operating.*"

"*O.K., 20 seconds, 1,000 feet, 1.5 g's.*" He referred to the increasing pressure of acceleration, known as g-force.

"*Trajectory is good.*"

"*Twelve thousand feet, 1.9 g's.*"

"*Inner cabin pressure is 5 p.s.i.* [pounds per square inch], *altitude 44,000, g-level 2.7.*"

"*One hundred thousand feet at two minutes and five seconds.*"

Jim Prim suddenly pushed a button marked "Oxygen." Almost immediately Shepard's voice took on a note of urgency.

"*Cabin pressure decreasing! Oxygen is apparently leaking!*"

Moments passed as the astronaut tried to switch to an emergency supply.

"*It's still leaking. It's going to zero-flow rate!*"

Then, suddenly, the end of the mission:

"*Abort because of oxygen leak! Abort! Abort!*"

As Shepard's voice rang in my ears, a large red light flashed on the panel in front of the instructor. It read "Mayday," the international radio call word that signals distress.

But I knew that Shepard was in no distress, that he would not be even if this were a real flight, for the escape rocket would tear him free from the booster, and parachutes would break his fall into the sea. Recovery forces—ships, planes, and helicopters—would surely spot the capsule within minutes and rush to the rescue.

Space: "A Friendly Neighborhood"

Space is often called the most hostile environment man has ever attempted to enter. At the 120-mile altitude of the normal Mercury flight, the sun bears down in spotlight fashion with no atmosphere to soften its intensity. Those few molecules of air that find their way so far out provide an atmospheric pressure about one half-billionth that of sea level. Only the astronaut's sealed and pressurized capsule stands between him and instant death in this cruel environment.

I have called space "cruel," but when Astronaut Scott Carpenter saw the word in my story, he protested.

"I don't think of it that way at all," he objected. "In space there's none of the turbu-

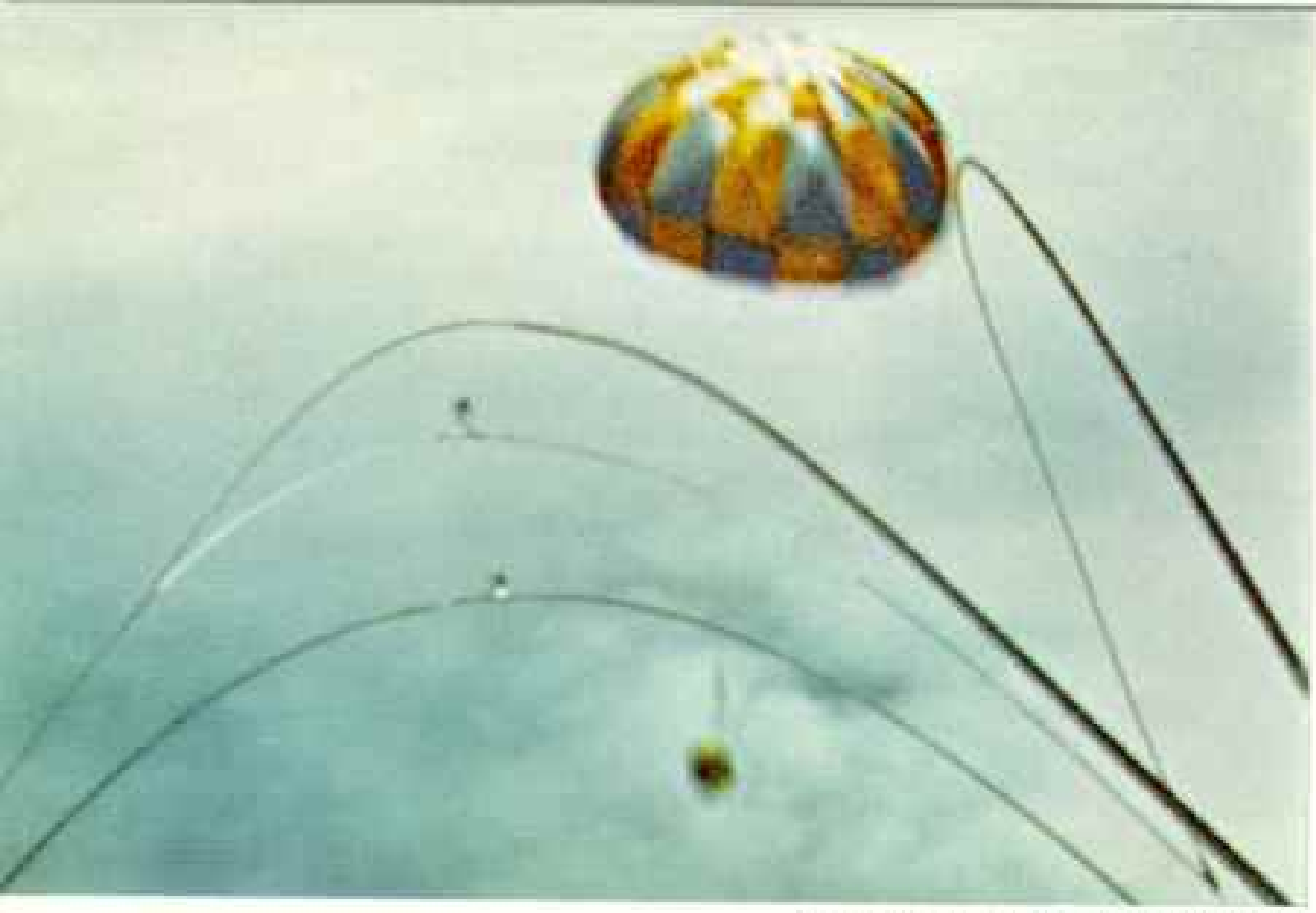
Flying Boxcar Snatches a Capsule Falling From Orbit

Dragging a loop on steel tubes, a Fairchild C-119 swoops at its parachuting target over the Pacific. The Air Force developed the retrieval technique to snare Discoverer satellites returning to earth. Aerial recovery saves instruments from the jar of an ocean landing.

Snared parachute and payload drag in the plane's slip stream after a successful catch; the crew will winch it aboard.

These pictures record practice runs on dummy spacecraft dropped by planes. For an actual recovery, turn the page.

ENGRAVING BY U.S. AIR FORCE



Historic catch. Drama unfolds in these pictures of man's first air recovery of an object shot into space.

Gold-plated Discoverer XIV, ejected from orbit over Alaska, parachutes into a 36,000-square-mile drop zone near the Hawaiian Islands.

Patrol plane misses on one try (top), then connects with grappling gear (center). Silhouetted crew (bottom) reels the catch in through the hatch.

lence that bothers planes, none of the heavy waves of the sea. Once you get there, I think it will be very peaceful, and all you'll have to do is keep pressure on your body and you'll be O.K. It's really a very friendly neighborhood."

In any case, the astronauts are taking no chances on losing that all-important pressure. Should a leak develop or a meteorite pierce the cabin wall, the astronaut's suit immediately inflates as his second line of defense.

In the Navy's Air Crew Equipment Laboratory at Philadelphia, Astronaut Walter M. Schirra, Jr., showed me the suit and helmet he will wear during flight. Based on the pressure suit worn by Navy jet pilots, it has been refined for Mercury purposes. All astronauts specialize in some phase of the project; the life-support system is Schirra's specialty.

"Basically it's just a rubber bag restrained by a nylon outer garment hand-tailored with a nice drape," Schirra explained. "We're not looking for style, but we do want maximum comfort and mobility. Even the shoes are nylon for lightness, because we're not going to do any walking in them.

"You'll notice that the fingers of the gloves are curved to make

Capsule on a cord. Dropping into the air on its 17th circuit around the earth, Discoverer XIV swings on a nylon line 8,500 feet above the sea. A "backstop" C-119 follows the catch plane. Had this attempt failed, the satellite might have vanished in the clouds below. Gold plating on the 84-pound capsule helped reflect the heat of air's friction. Like other Discoverers snagged in flight, the satellite carried devices to gather data about space.

it easier to hold the control handles. After all, no one keeps his fingers really straight. At the same time we found we had to leave one finger straight so we could push buttons on the instrument panel."

Suit Holds Pure Oxygen

Schirra showed me how oxygen is piped into the suit and circulated around the astronaut's body to cool him. Finally the gas exhausts through a port in the helmet to be reconditioned. Carbon dioxide, water vapor, and odors are removed, and the cooled oxygen recirculates.

Beginning at least an hour before launch, the astronaut breathes pure oxygen for the duration of his flight. This prevents the bends, the dread disease of divers and of high-altitude flyers.

Schirra traced for me the electrical wires plugged into the suit to carry special sensors to the astronaut's body. These devices measure heartbeat, breathing, and temperature during flight. Their information is continuously radioed to the ground via telemetry, together with approximately 150 other measurements of pressure, noise, vibration, acceleration, temperature, and so on from booster and capsule.

As we talked, a strange pro-

cession passed by: a man wearing a Mercury suit and helmet, a doctor, and an attendant carrying a sort of suitcase connected to the pressure suit by a flexible hose. From the suitcase issued a loud buzzing noise.

The space-suited stand-in for the astronauts had just emerged from five hours in an altitude chamber under heat and pressure conditions of a Mercury launch, orbit, and return. His buzzing box contained an air compressor that ventilated his suit.

Temperature of 275° Melts Pounds

As I watched, attendants lifted off the white helmet, unfastened a lengthy zipper, and carefully removed the $4,300 suit. The doctor detached the series of electrical leads plastered to the subject's body with suction cups and adhesive tape.

"How was the trip?" I asked.

"Not bad at all. They ran cabin wall temperature just to 160°F. today. But I have been up when wall temperature reached 275°, and after it was over I had lost four pounds."

Fortunately the astronauts should never have to experience such oven heat. Even in the Atlas flight, air cooling and insulation should keep cabin air temperatures below 160°. The silver suit radiates heat away from the astronaut's body, and the flow of cool oxygen holds suit temperature to a maximum of 85°.

"How about noise during launching?" I asked Schirra.

"We're well within human tolerance on sound," he told me. "The noise would destroy the hearing of a man standing beside the launch pad, and likely do a great deal of other physical damage. But inside the spacecraft we won't be deafened even temporarily."

But there are a multitude of other hazards of Mercury flights. I talked about them with Dr. Robert Voas, a psychologist who assists the astronauts in their training.

"No one sneers at these dangers," he assured me, "but we think we have most of them under control. Radiation? No, the astronauts will fly far below the Van Allen radiation belts. Meteorites? We don't fear them in such short flights. Heat? We'll be surprised if that even bothers the astronaut until he's waiting for rescue. Then he may perspire in his rubber-lined pressure suit, just as in a steam bath, because the air-conditioning system works best only in the vacuum of space."

The g-force is another matter. During both launch and return, the astronaut suffers the heavy pressure of acceleration and deceleration, measured in g's. His weight, equal to one g, is multiplied to a maximum of about 12 times during return.

For the average man, 12 g's would be thoroughly unpleasant; probably he would lose consciousness before that point.

At 12 g's his body weighs close to a ton, and he cannot lift his arms. His face sags out of shape as if an iron mask were smashing it. His eyes suffer from a shortage of blood, and "tunnel vision" sets in; the victim's angle of sight is drastically narrowed. Breathing comes harder and harder. Finally vision blacks out—and so does the man.

The astronauts, however, are familiar with acceleration force through repeated exposure to it in the human centrifuge.

Remembering how dizzy I used to get on carnival rides such as the "merry-mix-up," I asked Astronaut John H. Glenn, Jr., if the centrifuge nauseates its riders.

"You don't really get dizzy if you look straight ahead," he told me. "But if you turn your head, your gyros get so tumbled that you lose all orientation."

By "gyros" he meant the semicircular canals in the ears that govern equilibrium.

Doctor Loses Balance for Weeks

Dr. Carmault Jackson, one of the astronauts' physicians, gave confirmation.

"On one of my first centrifuge rides, at about 11 g's, I turned my head to look sideways. The g-forces were so great that I could barely force my head back again. Using John's word, my gyros were 'tumbled.' They stayed that way for nearly five weeks. If I so much as stooped to tie a shoelace, I would feel as if I were tumbling."

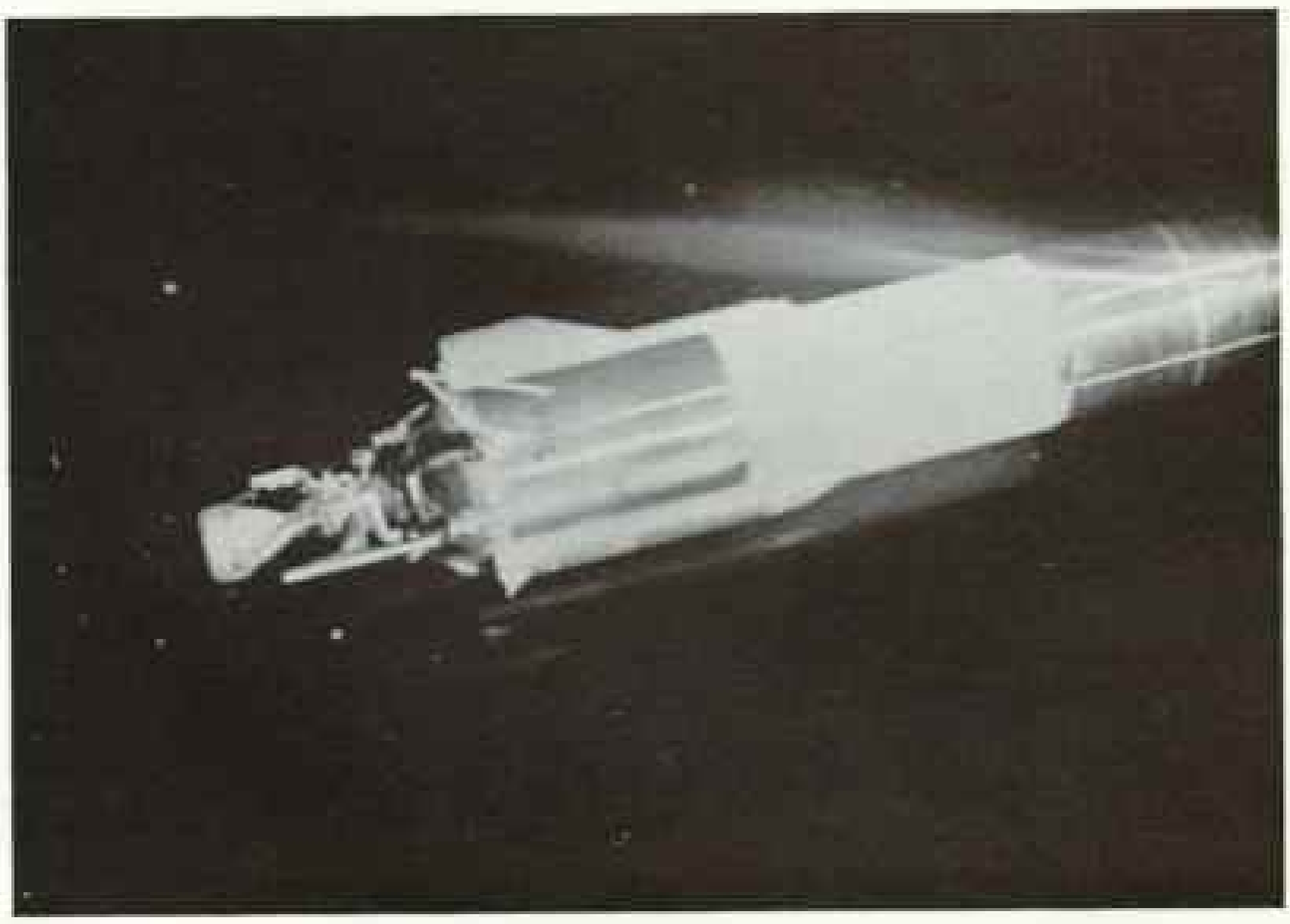
Scott Carpenter told me that all fighter pilots learn to tense their muscles when taking g's in order to avoid blackout.

"I use the same technique for Mercury," he explained. "As soon as the acceleration sets in, I begin to tense up and start exhaling in short grunts. The doctors say this keeps blood flowing to the brain, which improves vision and helps maintain consciousness.

"All of us have survived 16 g's or more, and less than that should cause no trouble."

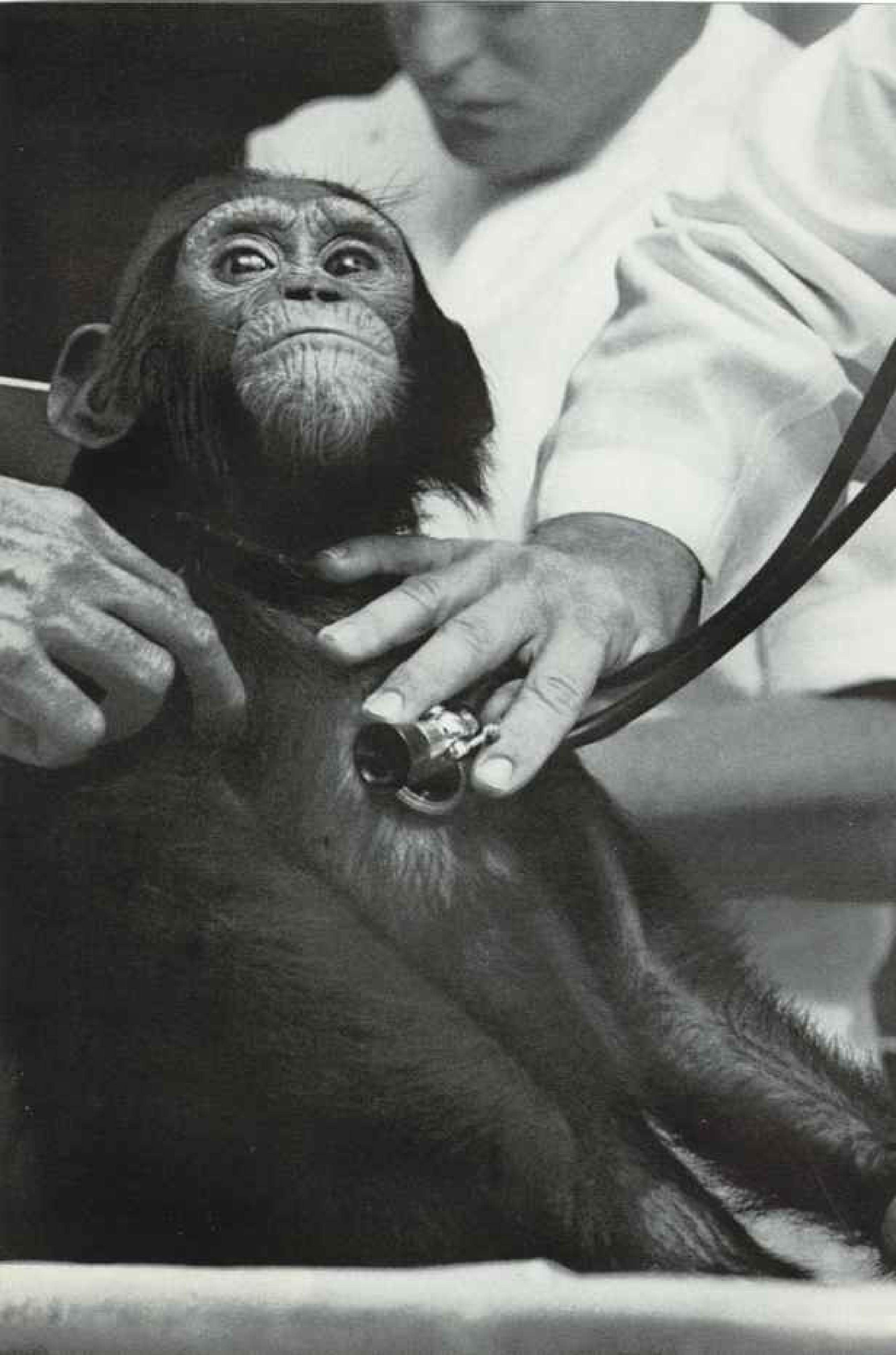
Zero g, or prolonged weightlessness, is something again. This condition exists for about five minutes during a Redstone bal-

AN EXPLORER BY GENERAL ELECTRIC



Dawn routs the dark in a remarkable photograph made from an Air Force nose cone 630 miles above the earth. The camera, looking north near Puerto Rico, caught glimpses of the Atlantic and several types of clouds.

Tumbling in space, an Atlas booster section trails the nose cone it launched. Cameras in the payload made this and the cloud picture above during a 5,000-mile flight from Cape Canaveral. White spots are stars. Frost sheathes the booster's waist—an oddity in moistureless space.



listic flight and four and a half hours during a three-orbit Atlas flight. Weightlessness comes when the velocity of the spacecraft exactly neutralizes the pull of earth's gravity.*

More uncertain is the effect of abrupt change from weightlessness to heavy deceleration on returning to the earth's atmosphere. That is one of the big questions a manned flight will answer.

The experience of Ham, the astro-chimp, may throw light on the matter. I watched moving pictures of Ham taken by an automatic camera during last January's flight.

The 37½-pound animal showed remarkable aplomb. As long as his red light was on, he banged away at the right-hand lever. At no time did he miss the 20-second deadline that would have brought him a mild electric shock. And when the blue light flashed on, he always turned it off with his left-hand lever within the allotted five seconds.

Rarely did the routine vary. When the escape rocket fired and extra g-force set in, Ham laid his head back and bared his teeth momentarily. Again, during descent, he reacted even as do you and I on an airplane flight, opening his mouth and yawning to clear his ears (page 729).

Whatever the stresses of a Mercury flight may be, the astronauts keep in superb physical condition to meet them, and they are not worried. Neither is their flight surgeon, Dr. William Douglas.

*For a report on zero g, see "Aviation Medicine on the Threshold of Space," by Allan C. Fisher, Jr., NATIONAL GEOGRAPHIC, August, 1953.

(Continued on page 730)

School for Space Monkeys

THE NONCHALANT CHIMPANZEE undergoing a doctor's stethoscope examination belongs to a highly select colony in training for space travel. Its members owe their position to the fact that in mental and physical make-up chimpanzees are reasonably like humans. From the way a chimp reacts under space conditions, scientists can guess how the astronauts will perform. Already one chimp has made an epochal trip. Others are to follow, pioneering the way for man's flight to the planets.

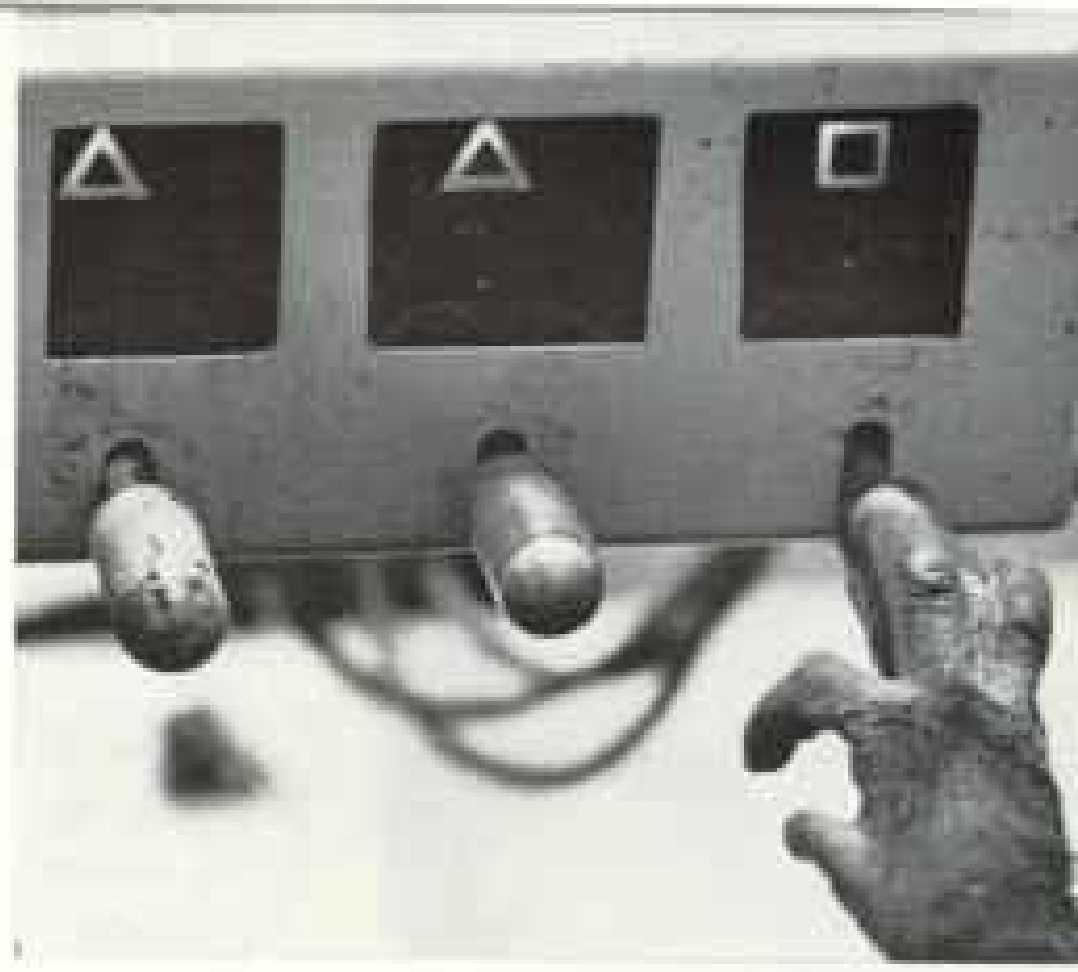
Captured in Africa and culled to meet stiff requirements for intelligence, personality, weight, and age, the chimpanzees get their training at the Air Force's Holloman Aeromedical Laboratory in New Mexico. In response to flashing lights, they learn to pull levers. To experience weightlessness and acceleration, they ride planes and rocket sleds. By sitting for hours in small chambers, they become accustomed to a space capsule's isolation. And they are showered with medical attention and the tender care that seems as vital to chimpanzees as to children.

Pictures of chimpanzee training on this and following pages were furnished by *Life* magazine. Project Mercury photographs taken by National Geographic cameramen Luis Marden and Dean Conger appear also in other publications in a pool arrangement with the National Aeronautics and Space Administration. The Society offered the services of the two photographers to NASA, which in turn has made their pictures available to all newspapers and magazines.

RALPH CRANE, LIFE

Preflight Training

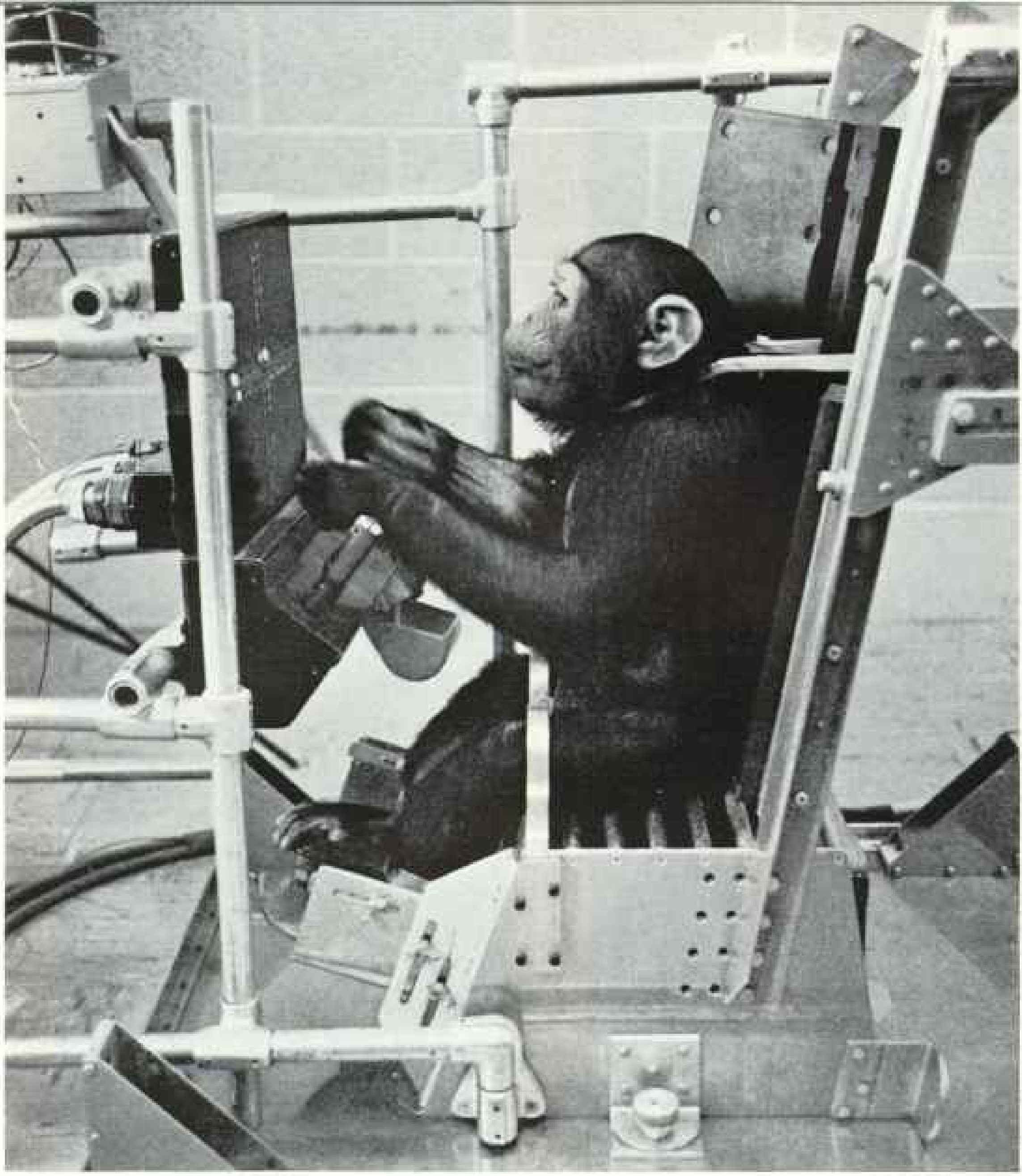
FRIENDLY NUZZLE with his doctor brightens an eye examination for chimp Billy at the Holloman Aeromedical Laboratory. The lab now has about 40 apes in training, with 12 to 18 advanced enough to take part in a space shot. Numbers change because some animals fail the learning or isolation tests, or outgrow the weight limit —50 pounds for Project Mercury, the maximum that the capsule's specially contoured chimp couch will accommodate.



Pressing a lever under odd symbol scores a correct answer. In some tests, an error triggers a mild shock.

Sip from a water tank tops a tasty reward—banana-flavored tablets won by work at lever-pulling tasks.

PHOTOGRAPHS BY RALPH CRANE, LIFE



Fingers fly as Bobby Joe trips the handles of a training machine. Correct response to flashing lights drops reward pellets into the cup beneath his hands. Chimps develop skill in such tests; one made only 28 errors in 7,000 pulls over a period of 70 minutes.

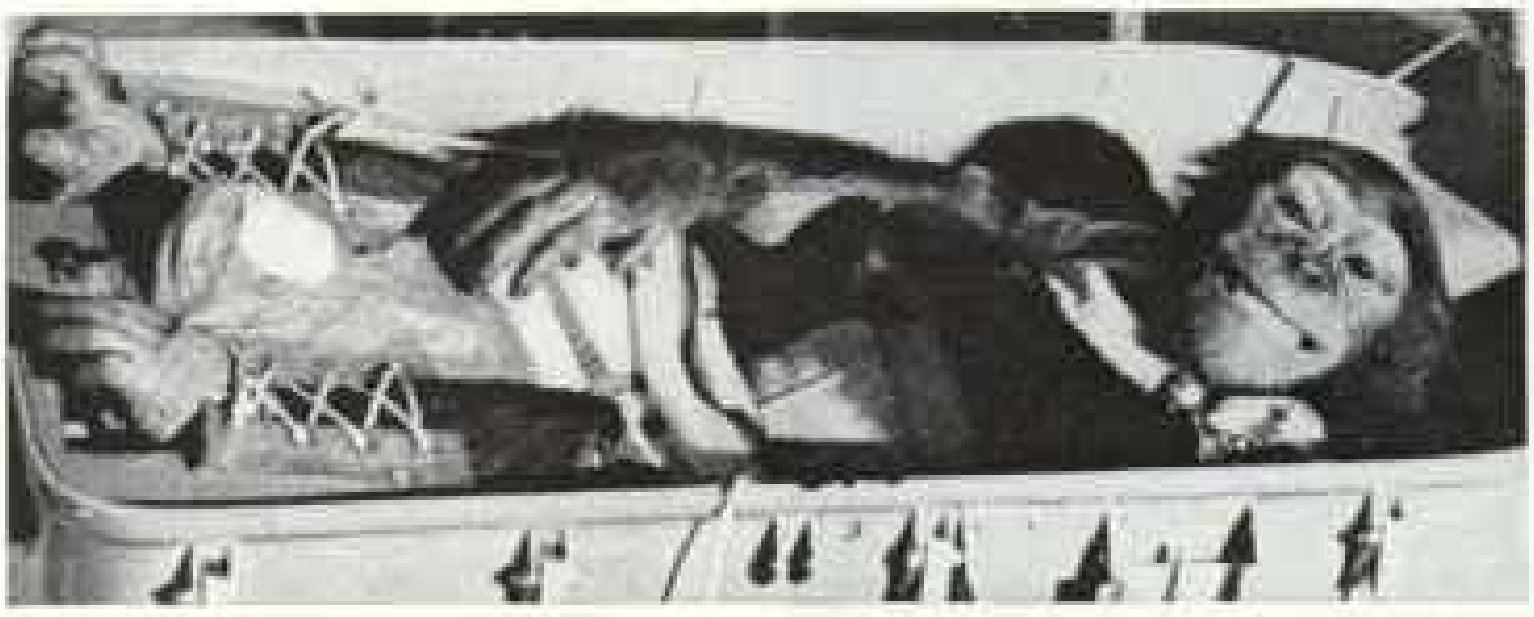
Because young apes accept training more readily, Holloman employs only those less than four years old.

Morning lineup sees a spooning of antibiotics in raspberry-flavored gelatin. Close affection grows between each ape and his handler.

[illegible] EKTACHROMES BY NASA (BELOW) AND THOMAS R. SMITH, NATIONAL GEOGRAPHIC STAFF

Redstone roars from its Cape Canaveral launching pad with a chimpanzee in the Mercury capsule atop its nose. Twisted by the winds, a contrail blooms in the air's cold upper layers. A quirk of sunlight causes the wide, straight shadow against the sky.

Ham the Chimpanzee Rides a Rocket Into the Unknown



Grinning chimp lies laced in his space couch. Its molded contours and restraining harness protect him from the brutal stresses of blast-off and reentry. The couch's lid contains the levers Ham must work as a test of his reactions in space.

Lid fastened, Ham's coffin-shaped cradle is thrust into the Mercury capsule atop a 60-foot Redstone. Headsets permit gantry men to talk with ground crews. The chimp's pressurized container has a plastic window through which a camera mounted in the capsule filmed Ham's facial expressions (below).

Though weightless in space, the chimpanzee shows no distress.

Bared teeth greet extra g's that multiply Ham's weight 17 times, contorting his mouth.

NASA

Ham yawns to clear ears, a trick humans use in airplane flights.

NASA

Ham's Capsule Drops in the Sea; Helicopter Hovers to Rescue Him

Whitecaps churned by the aircraft's blades ring the Mercury craft after its return from space. Seamen paddling a rubber dinghy from the destroyer *Ellison* run a close second in a race to retrieve it.

In its 16-minute, 5,800-mile-an-hour trip, the spacecraft soared 156 miles and spanned 414 miles. Because the booster's fuel burned too fast, the capsule flew higher, farther, and faster than intended.

Helmeted airman leans from his helicopter to snare the capsule. Held by a safety belt, Marine Lt. George F. Cox uses a long pole to guide a hook into a loop on the spacecraft. NATIONAL GEOGRAPHIC photographer Dean Conger, on loan to NASA, fastened an automatic camera above a waist door to get this unusual color picture.

Landing damage let the spacecraft tip. Eighteen inches of water lapped at the ape's couch, but did not penetrate.

Dye from the floating disk turns the sea from blue to green around the capsule.

"They will find the stresses well within their own tolerance limits," he told me, "but their limits certainly are different from those of an average man."

Everything in the capsule is completely automatic. As Walter Schirra puts it, "If all goes right, the astronaut could sit with folded arms. The fact is, however, that the astronaut will do many things in order to learn: test his ability to maneuver the capsule, note his reactions to the space environment, watch dials and gauges, and observe earth and sky from a new vantage point outside the atmosphere. He will add the human values of observation and judgment that no machine can supply."

Schirra tells a story that illustrates the importance of having a man with the machine in space:

"A marvelous new passenger plane takes off from Los Angeles. As it reaches flight altitude, a voice comes on the loudspeaker:

"'Ladies and gentlemen, this is your captain. Welcome aboard. You are now cruising


UNITED

NASA

Chimp's Capsule Gets a Helicopter Tow

Unplanned firing of the Mercury's escape-tower rocket gave an extra boost that accentuated the overshoot. As a result, Ham felt greater acceleration stress—17 g's—and longer weightlessness—6½ minutes—than anticipated. Nevertheless he busily pulled his levers—proof that man can make the same flight successfully.

Here the rescue helicopter leaves the pickup site and heads for the mother ship.

Ham Greets Rescuers With Nonchalance

Arms folded jauntily, every freckle standing out, the chimpanzee awaits release from his couch aboard the recovery LSD *Donner*. Long hours of training paid off: Ham quickly recovered from his eight-hour ordeal. His reward: a big red apple.

When the couch was sealed, a NASA physician placed the card near Ham's feet. It reads: "Have missile, will travel."

AS EXTRACTED BY HENRY BURROUGHS, ASSOCIATED PRESS

at an altitude of 35,000 feet. My voice is coming to you by recording, for I am back on the ground. I am not needed in this machine because it is fully automatic, and with a machine nothing can go wrong . . . can go wrong . . . can go wrong . . .'"

And that is why we have astronauts!

Space Exploration Is Expensive

Recently one of the Nation's rocket experts received a letter protesting the time and money spent on space projects.

"Why do men want to go out into space anyway?" the letter asked. "Why don't people stay home and watch television the way God intended?"

And a Russian workman complained in a letter to *Pravda*: "What do sputniks give to a person like me? So much money is spent on sputniks it makes people gasp. If there were no sputniks the government could cut the cost of cloth for an overcoat in half and put a few electric flatirons in the stores. Rockets, rockets, rockets! Who needs them now?"

No one can deny the heavy cost. During the 1960's the United States Government alone is expected to spend from 30 to 50 billion dollars on space programs for both civilian and military purposes.

As this magazine goes to press, the United States has successfully fired 34 satellites and space probes (pages 716-17). Eighteen still swing their way through the celestial vacuum; ten continue to broadcast information that sets straight age-old misconceptions of the universe.

During this decade, NASA plans some 260 major launches. The armed services and private industry also plan ambitious tests of new fuels, rockets, and satellites. On drawing boards and in assembly plants I have seen developments that only yesterday would have been dismissed as fantastic nonsense.

Within the next six to eight years scien-

NATIONAL GEOGRAPHIC PHOTOGRAPHER DEAN CONGER FOR NASA

Back From Space, Ham Gets a Shipboard O.K.

Bigger than any animal previously shot into space, 37½-pound Ham drew his pioneering assignment because preflight tests showed him the best fitted physically and psychologically of six chimp candidates.

Sensors taped to his body recorded temperature, breathing, and heart beat. Readings jumped only briefly in the flight.

Here, in *Donner's* sickbay, Maj. Richard E. Benson and M. Sgt. Paul Christen remove the network of wires. A bruised nose was Ham's only injury. Tests several weeks later showed him as keen and fit as ever.

tists seriously hope to hit and explore the moon with unmanned spaceships (Ranger, Surveyor, and Prospector); to orbit Mars and Venus (Mariner and Voyager); to send a three-man spacecraft around the moon and back (Apollo).

With a telescope-in-the-sky and with orbiting geophysical observatories known as OGO and POGO, they hope for keys to the riddle of how the universe was created.

Is it worth the price? What I have seen and heard convinces me that it is. Already we have reaped substantial benefits.

NASA's Tiros satellites, with their thousands of pictures of cloud formations, can save billions of dollars through more accurate weather predictions.* Courier, the Army's fast-talking ball-in-the-sky, promises a fantastic fleet of communications satellites. The Navy's Transit satellites offer a system that will enable planes, ships, and submarines to navigate with unheard-of sureness.

In recent months I have visited research laboratories, industrial plants, and rocket ranges, to see how far we have come on the road to the stars.

My memory is filled with the awesome sights and sounds of the young Space Age: The volcanic rage of the many-engined Saturn, most powerful rocket in the Free World; the majesty of an Atlas intercontinental ballistic missile, standing sentinel-proud on the California coast while deer pick their way daintily through the near-by scrub; the tense faces of men in the electronic fortresses they call blockhouses, waiting through the final countdown.

Experiences to remember, yes. But none to compare with the memory of the Mercury-Redstone bathed in oxygen vapor and glowing with an unearthly floodlit shimmer, waiting in the predawn darkness for a rendezvous with a chimpanzee named Ham.

The sun's first rays lightened the sky behind the shimmering rocket, and I recalled the words of British scientist-author Arthur C. Clarke:

"Our civilization is no more than the sum of all the dreams that earlier ages have brought to fulfillment. And so it must always be, for if men cease to dream, if they turn their backs upon the wonder of the Universe, the story of our race will be coming to an end."

*See "Our Earth as a Satellite Sees It," by W. G. Stroud, NATIONAL GEOGRAPHIC, August, 1960.

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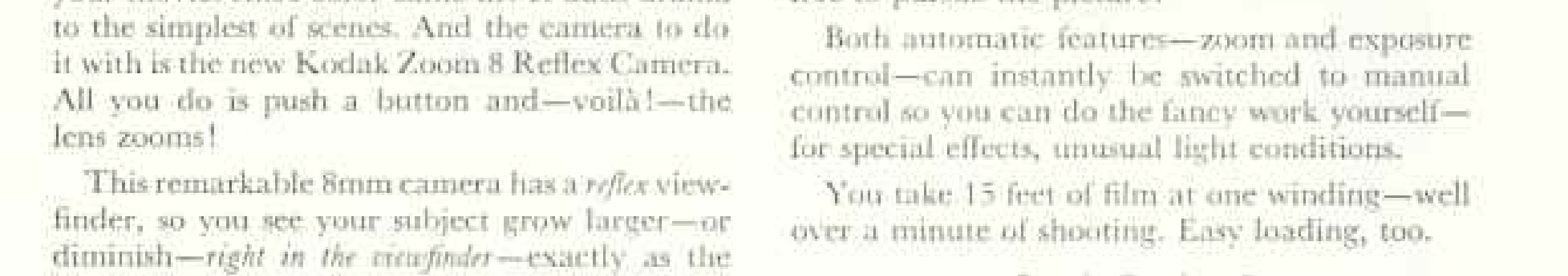
Put this superb camera through its paces. You'll appreciate the advances and refinements that make the Kodak Zoom 8 Reflex such an extraordinarily fine movie camera. It's priced at less than $200, or as little as $20 down at most dealers'. See your dealer for exact retail price.

Price is subject to change without notice.



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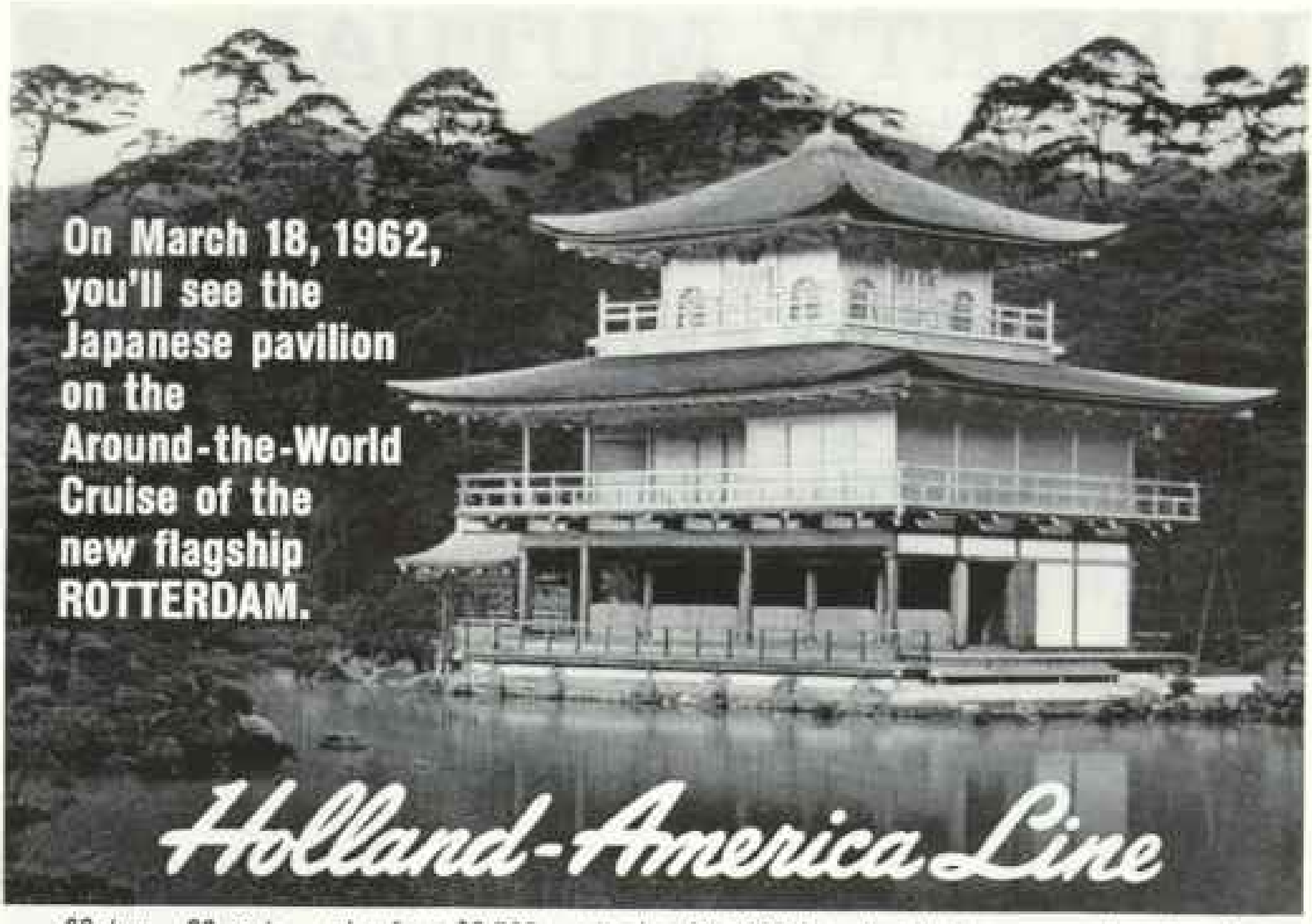

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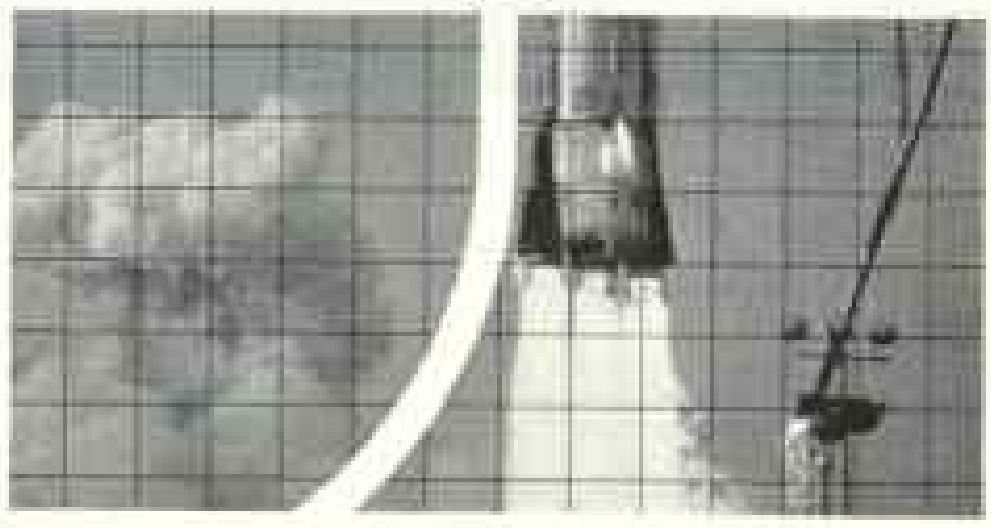

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The temptation is great, when you are counting calories, to skimp on breakfast —or skip it altogether. This is perhaps the worst thing you can do.

A breakfast of only juice and coffee can sabotage your whole weight control program. It gives you too few calories to carry you through the morning and short-changes you completely on protein. You are so empty before noon that there is usually the compulsion to overeat at lunch and dinner.

Why Breakfast Is Vital

When you wake up in the morning your body is run down. It needs fuel to help it get going.

No matter how low a calorie quota you have set for the day, nutritionists agree that you should get 20 per cent or more of those calories at breakfast. Protein, vitamins and minerals are also required to support body cells and tissues while excess fat is being torn down.

New Special K Breakfast

A breakfast that can satisfy these demands has been worked out by ranking nutritionists at an outstanding university and diet specialists at Kellogg's of Battle Creek.

This breakfast is built around a unique high-protein cereal—Kellogg's Special K.

Special K was "invented" by this same team several years ago. When served with milk, it provides a significant amount of complete protein, as well as other dietary essentials.

The Special K Menu

Half a medium-size grapefruit
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1 ounce (1½ cups) Special K with 1 teaspoon sugar
4 ounces skim milk
Black coffee or tea

This complete protein breakfast adds up to 240 calories.

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The special K Breakfast is easy to fix. It's ready before your coffee is cool enough to drink. And most folks agree that it is quite delicious, too—one that can be enjoyed month after month.

And because Special K with milk gives you complete high-quality protein, you have a feeling of well-being. Your body has been pleasantly nourished so you aren't plagued by hunger an hour or two later.

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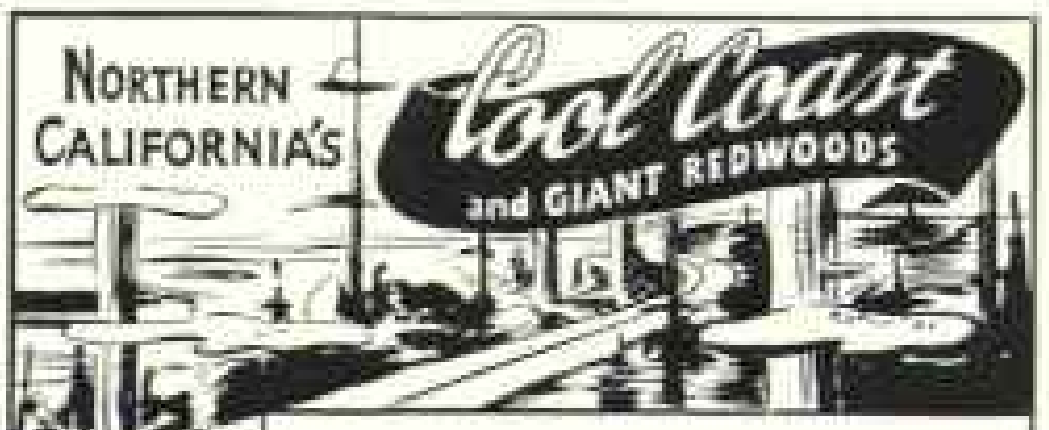

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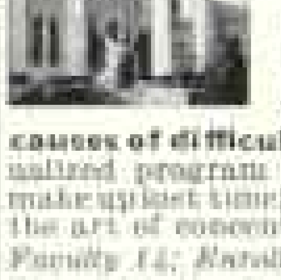
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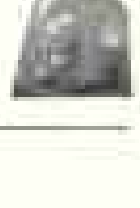

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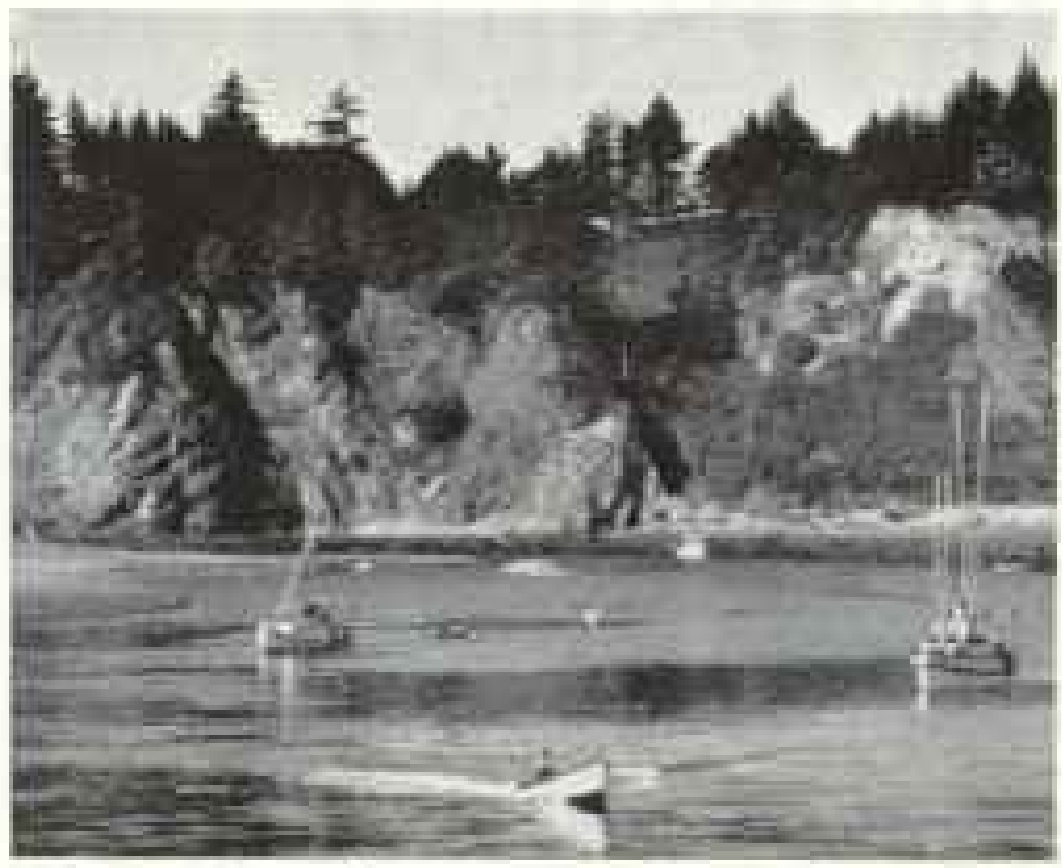

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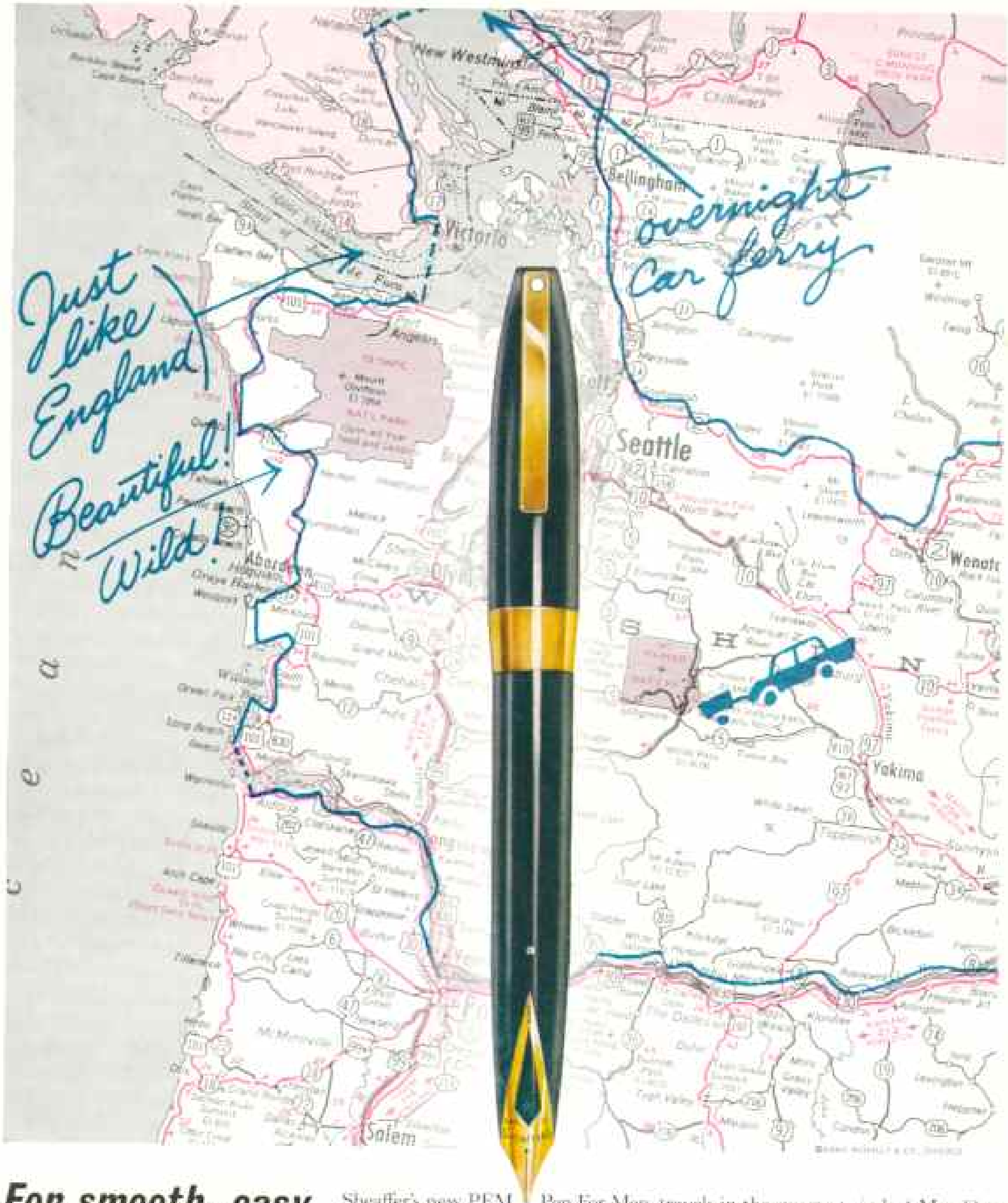

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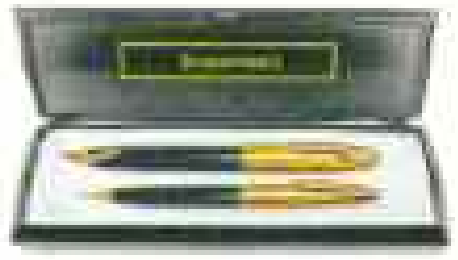

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