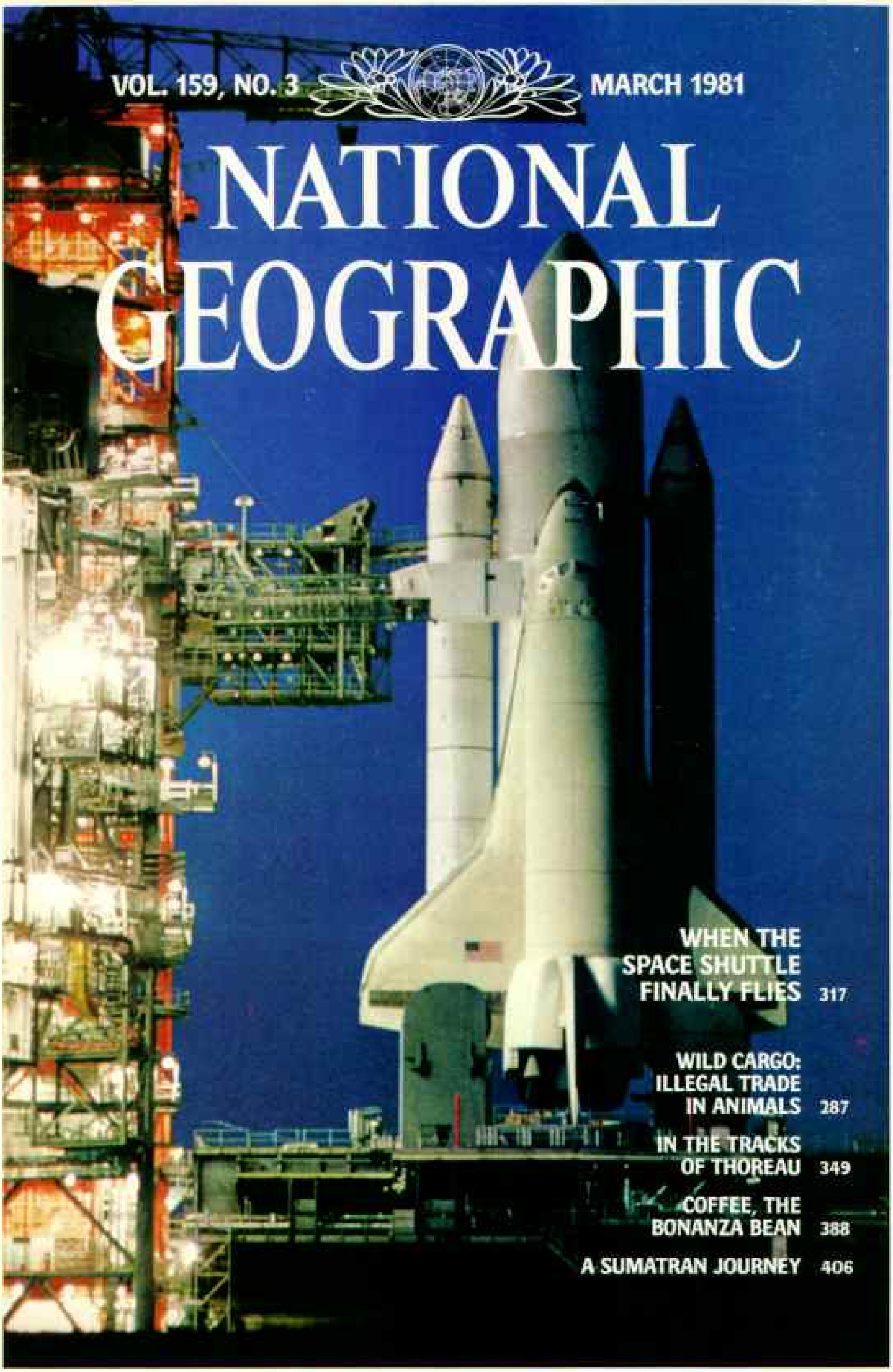
VOL. 159, NO. 3 MARCH 1981

NATIONAL GEOGRAPHIC



WHEN ORIA Douglas-Hamilton warned in our November issue that the trumpeting of Africa's elephants might be silenced forever by the predation of ivory poachers and the pressures of civilization, concerned readers responded.

Rebekah Holman, 11, of Washington, D. C., wrote, "The article made me very sad." She enclosed three dollars, requesting that we send it to an organization that will use the money for the elephants: "I hope you can help these elephants and not let them become extinct before I die."

Thousands of other Geographic members sent contributions to the World Wildlife Fund's special elephant collection. In Wichita, Kansas, banker Robert Langenwalter appealed to a group of friends, the Cessna Aircraft Company, and King Radio Corporation for help in providing an airplane essential to patrolling the vast elephant habitat. The result: a $102,000 Cessna 185 contributed to the National Geographic Society for the Douglas-Hamiltons' work.

During his tenure on earth, mankind has dominated, exploited, domesticated, and come to love the animal life surrounding him. As boys, we grew up with the seeming necessity to prove ourselves as hunters—success often manifested in the Victorian trophy room with its dark walls sprouting the horns and stuffed heads of game. We spend millions each year for the status and the comfort of wearing coats of animal fur. And yet we share our homes and our lives with dogs, cats, birds, fishes, and all manner of beast.

Ironically this benevolent fascination for animals and their products also fuels the massive illegal international traffic in endangered species that threatens them. Staff writer Noel Grove and photographer Steve Raymer—at high risk—traveled the sometimes sleazy world of these animal exploiters to provide the shocking report that leads this issue. You'll see mounds of elephant tusks in a Hong Kong shop being cut up for ivory trinkets for tourists.

If the public's willingness to buy objects of ivory continues, at least some areas of Africa certainly will see the end of the elephant in Rebekah's lifetime.

Wilbur E. Garrett

EDITOR

NATIONAL GEOGRAPHIC

THE NATIONAL GEOGRAPHIC MAGAZINE VOL. 159, NO. 3

March 1981

COVER: *Two years late, the space shuttle stands poised on its launchpad at Cape Canaveral. Photograph by Jon Schneeberger.*

Will profit freeze the cry *of an endangered leopard cat in a Bangkok market* ***(left)*** *as it did for its stuffed kin, seized at the Honolulu airport* ***(above)****? Tough new international regulations aim at curbing illegal trade in the world's wildlife.*

Wild Cargo: the Business of Smuggling Animals

By NOEL GROVE

Photographs by STEVE RAYMER

BOTH NATIONAL GEOGRAPHIC STAFF

THE WHOLE OPERATION went off like clockwork, with Kannan serving as the mainspring.

P. Kannan, an agent of India's Directorate of Wildlife Preservation, wages a constant war against dealers in illegal reptile skins. A large, well-proportioned, benign-looking man, carrying a briefcase and tending toward open-necked sport shirts, he appears more an accountant than a detective. His shoes make an unstealthy *scritch* sound, one that must haunt the dreams of more than 20 Bombay merchants he has subpoenaed since early 1979.

The careful planning of the Indian law officer was evident when I stood in a Bombay shop bargaining for a legal jacket of cowhide. A man with a turban as black as his neatly trimmed beard walked in the door and bought a lizard-skin wallet; after pocketing the receipt, he showed the identification of a wildlife inspector.

Hunters become the prey *in Kenya, where rangers hold two suspected poachers caught near the Somali border. Their bows and poisoned arrows could bring down Africa's biggest mammals; sophisticated poachers use modern automatic weapons and, occasionally, helicopters for wholesale gathering of ivory and*

rhino horn. Until recently Kenya's game laws were rarely enforced, a common problem in most countries. The alarming decrease in some species, plus the sharpened legal teeth provided by the Convention on International Trade in Endangered Species (CITES), has inspired a crackdown on wildlife smuggling.

"You have sold goods that violate the Wildlife Protection Act," he told the startled clerk. "The agent in charge will arrive soon to begin proceedings."

From outside the shop came the *scritch scritch* of Kannan's shoes, an ominous sound like the creak of a slowly opening door in a horror movie, promising soon-to-be-disclosed details, probably unpleasant.

Unpleasantness for those trading illegally in wild animals and their products is escalating around the world. Within the past decade government after government has passed laws to restrict or prohibit the sale of wildlife seriously depleted by hunting and habitat destruction. With legal channels pinched, animal dealers have resorted to nefarious schemes to continue the flow.

Wildlife is big business. Exotic-bird collectors will pay $10,000 for a hyacinth macaw. At Saks Fifth Avenue in New York I tried on a pair of trendy western boots trimmed in lizard skin. The price? "Two hundred thirty-five," the clerk said, with an archness suggesting that most of his customers didn't bother to ask.

At Harrods department store in London I peered into a display case at wallets of crocodile hide selling for more than £250 apiece (about $600). In Paris, Christian Dior's

director of fur design, Frédéric Castet, let me fondle a downy coat made from the belly fur of 17 lynx and priced at $100,000. "We make only two a year because of restrictions on lynx trade," he explained. "But we could sell many more."

These items are being sold legally. But somewhere in the dim beginnings of their trail through commerce, they may have been acquired illegally.

The hyacinth macaw, for example, is found principally in Brazil, which bans its export. Most shipments to the United States come from Paraguay and Bolivia, which have very few. Ornithologists familiar with

A fortune in ivory *surrounds carvers in Hong Kong as they saw off the jagged root of a tusk; soapy water lubricates the blade. Nearly a ton of ivory from some 50 elephants arrives daily. Only exports sanctioned by the country of origin can be accepted, but documents can be forged, and proof of origin becomes obscure as ivory passes through numerous ports.*

*Popularity of scrimshaw by Hawaiian artists (***below***) has increased the kill of Pacific walruses. Alaskan traders circumvent laws that limit tusk sales to Eskimo artisans by shipping them to Hawaii with minimal Eskimo scribblings on them.*

Dr. B. T. Chitre

ORIGINAL

Hall No. Phone

Date

VETERINARY HEALTH CERTIFICATE

(Wherever it may Concern)

This is to certify that I have this day

1) Animals

2) Birds

examined the following :

belonging to Shri/Smt.

I have found that the animals/birds are free from any infectious or contagious diseases and are medically healthy.

The Animals / Birds are vaccinated against

Dr. B. T. Chitre
B.V.Sc.
Veterinary Surgeon

the area say that most of these macaw shipments were smuggled across the border from Brazil. The lizard boots, the crocodile wallets, and a host of other wild animals or their products may have the same questionable legal history.

According to the latest figures from the U. S. Fish and Wildlife Service (FWS), some 422,000 live birds and more than 1.1 million reptiles and amphibians were imported into the United States in 1979. Raw wildlife hides and skins totaled 11.8 million. Of individual items made from wild animals, 129.6 million were imported that same year.

This fascination with wildlife within the affluent nations of the world adds to the disappearance of animals in the less developed countries. In between stand the illegal traders, willing to circumvent wildlife-protection laws to satisfy the demand and their own pocketbooks.

FWS estimates that for every ten shipments of wild animals or their products that enter the United States by proper channels, at least one and perhaps as many as four shipments enter illegally, at a large profit to the smuggler. The recent trial of a Philadelphia animal dealer revealed that Fiji Islands lizards, purchased illegally in the Far East for $20 a pair, were sold in this country for $550. The U. S. Department of Justice estimates the total value of such entries as anywhere from 50 to 100 million dollars a year.

Wildlife smuggling is costing the U. S. millions of dollars to control and is denying income to the treasury of any nation that would otherwise receive duty from legal imports. It has spread diseases that would have

Animal sleuth *P. Kannan holds a cured tiger skin taken from a foreign diplomat at a Bombay airport. Exorbitant prices paid for extremely rare animals often make them irresistible to poachers. This skin could bring $10,000 in underground markets. To return such pelts to his evidence room, Kannan, an agent of India's Directorate of Wildlife Preservation, stuffs them in a bag* ***(bottom)*** *"lest they tempt others."*

Proof is negotiable *at a Bombay pet shop. To verify the health of export birds, buyers can purchase signed but blank health certificates—easily forged—like this one held before a cage of Alexandrine parakeets.*

Obtained by a bird dealer, the certificate awaits only the listing of the cargo—untested birds that may carry diseases.

Bribery and hidden shipments complicate attempts to control the huge pet-bird trade, some four and a half million birds annually. Many more are removed from the wild; perhaps one in ten survives the journey from treetop to wire cage.

been detected in legal quarantine periods. An outbreak of Newcastle disease—carried by exotic birds and fatal to domestic poultry—in California in 1971 cost 56 million dollars to control. U. S. Department of Agriculture officials say an outbreak of major proportions could cost a quarter of a billion dollars to eradicate.

An irreversible effect of illegal trade could be the extinction of animal species that are finding fewer and fewer places to hide. Of an estimated 13,200 species of mammals and birds known in the 17th century, more than 130 are gone forever and another 240 are considered endangered, together with many reptiles, amphibians, fishes, and invertebrates. Most losses and near losses can be traced to man's activities, either from hunting or habitat destruction.

"No imaginable consumption can threaten animals if they have sufficient habitat into which they can retreat," I was told by William Conway, director of the New York Zoological Society. "But at the rate the world's rain forests are disappearing—50 acres every minute—excessive trade can contribute to the downfall of some.

"The worst thing about the wildlife trade is that it provides things for people who do not need them. No one really needs a leopard coat. And certainly not a toucan."

WILDLIFE TRADE is probably as old as currency, and illegal wildlife trade must date to the first conservation laws. In the U. S., the Lacey Act of 1935 prohibited importation into this country of any wildlife acquired illegally in another country. The U. S. Endangered Species Conservation Act of 1969 banned U. S. import of any animals on the Endangered Species List. Other governments passed laws too, but enforcement was rare.

"Until recently, few of us knew one species from another," a U. S. customs officer told me candidly. "You just sort of glanced at the shipping papers that came with them and waved them on through."

The first serious effort to control all wildlife sales and plug the smuggling leaks took place in Washington, D. C., in 1973, when 80 nations met to draft the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The complex mechanism that evolved has been called the most remarkable trade pact ever devised. "It's like issuing passports for animals—dead or alive—that pass from one country to another," a Hong Kong customs official told me.

CITES divided wildlife into three categories, or appendixes:

Appendix I—dangerously threatened with extinction and therefore banned from any commercial trade, such as the rhinoceros and seven of the eight races of tigers.

Appendix II—potentially threatened, but

Stripped of their shells, *carcasses of endangered Pacific ridley sea turtles ride a conveyor at a processing plant that is legal in Mexico* ***(above)****. Many countries outlaw commerce in the 75-pound reptiles. The United States forbids import of any sea turtle products.*

The Mexican firm packages sea turtle meat for a company using the name Mixteca Brand ***(left)****. U. S. customs officers seized a shipment of 5,000 pounds when it appeared in Los Angeles incorrectly identified as river turtle, a type legal to import.*

commerce can take place if shipments are accompanied by authorizing documents from the country of export. The American alligator is listed on Appendix II, for example, and can be traded, while the U. S. crocodile is on Appendix I and cannot.

Appendix III—not considered endangered by the world at large, but listed by some countries where they originate, out of concern for their existence there. The scarlet macaw can be shipped from Panama, but Costa Rica bans its export because it is rare in that country.

Any nation that ratifies the treaty is expected to honor the three categories. "It puts the burden of detection on the importing countries," said a convention delegate. "If an item doesn't have the proper papers, don't let it in."

Drafted in 1973, put into effect in 1975, CITES underwent a sluggish start. In March 1979 the delegates met in San José, Costa Rica, and the embers of trade control were fanned into flame. Two years after San José, more than 60 nations have signed and ratified the treaty.

Enforcement worldwide has toughened, and smugglers and illegal traders are getting a taste of what it's like to be hunted. An organization called TRAFFIC (Trade Records Analysis of Fauna and Flora in Commerce), supported mostly by the World Wildlife Fund, now monitors the movement of animal products around the world. The information is supplied upon request to government, CITES officials, and conservationists. TRAFFIC offices now operate in London, Washington, and Nairobi; others are planned for Frankfurt and Tokyo.

"Before TRAFFIC there was no single reliable source of data about the amounts of animals and animal products being moved around the world," said Nicole Duplaix, director of the Washington office and one of the founders of the organization. "If the enforcement agencies around the world have been the arm of the law to stop smuggling, we have been the arm of documentation."

With war declared on animal smugglers, photographer Steve Raymer and I made an assessment of the battlegrounds. We visited areas where wildlife is captured, cities where it is collected by animal merchants for dispersal abroad, and the affluent countries where it is purchased.

To those concerned about wildlife trade, the good news is that stricter enforcement has curbed the activities of smugglers, perhaps cut them drastically. Some who once operated openly were driven underground by CITES, sometimes so deeply that we had to go there to assure ourselves that illegal trade existed.

The bad news: We were able to find it.

"EVERYBODY pick a tree!" Park warden Phil Snyder's whispered warning seemed to chase a swarm of butterflies up my back. Five of us on an antipoaching patrol peered around a clump of foliage into a clearing in central Kenya's Aberdare National Park. Less than 100 yards away, a black rhinoceros stood broadside to us, stamping his three-toed feet angrily, swinging his head quickly in one direction, then another. He sensed the presence of intruders but, with his poor eyesight and upwind position, could not locate us.

I had always thought the two horns growing out of a rhino's nose to be blunt. This fellow's scimitarlike weaponry, typical of the wild black rhino, looked capable of skewering a man like a barbecue spit. That unique protection is also becoming the animal's downfall. Wealthy North Yemenis will pay $6,000 for a *jambiyya*, the traditional dagger, when the handle is made of rhino horn (page 301). Many Easterners believe powdered rhino horn holds medicinal powers.

Demand for it has reduced the black rhino—once widespread throughout most of equatorial Africa—to scattered remnant populations totaling perhaps 15,000 to 25,000. More than 15,000 existed in Kenya

Custom competes with protection *of the hawksbill turtle. In Japan a bride's traditional hairpiece includes combs made of the sea creature's colorful shell. Scientists fear the annual harvest of perhaps half a million hawksbills could wipe them out. But Japan still imports the shells, thanks to a reservation clause in the CITES treaty: Nations can "take exception" to a ban on trade and continue commerce in that species.*

***A partnership for survival** has tamed these white rhinos, under close guard in Kenya's Meru National Park. Kenya acquired the rhinos from South Africa to augment its own black rhino population. Poachers make no distinction in their quest for the nose horn, falsely reputed to hold medicinal powers. Kills have dramatically trimmed the world's wild rhino population, spurring desperate educational programs and posters (**below**) by conservation groups intent on heading off the animal's extinction.*

alone in 1969, according to a study by zoologist A. K. K. "Kes" Hillman. Ten years later Kenya's total stood around 1,500 and was still falling.

Elsewhere, the Sumatran, Javan, and great Indian rhinos together probably number fewer than 2,000, and the white rhino, found mostly in South Africa, survives under close supervision. The trend suggests that this nearsighted thick-skinned juggernaut may be the next large mammal to disappear from the earth.

In Kenya the American-born warden Phil Snyder and his patrol were hunting the poachers who hunt the rhinos. We found none that day, and the rhino, not finding us, lost interest and trotted away.

"Without these patrols there would be no rhinos here within three weeks," said Snyder's assistant, Kamaw Hugangin.

Months later and thousands of miles away I was offered rhino horn in a pharmacy on Macao, the tiny Portuguese colony on the South China coast. The young clerks, grinning broadly, produced a whittled chunk of bonelike gray, at a price of $450 an ounce. Many Eastern men consider rhino horn an aphrodisiac, although there exists no evidence to support the belief. It consists of a substance called keratin, which is found on the human body as well. Scientifically, men with waning sexual powers could obtain the same results by eating hair trimmings and chewing their fingernails.

I WANDERED THROUGH alleys in crowded Bangkok until I heard a cacophony of bird sounds behind a high wall. Five dogs rushed the iron gate as I knocked, but polite attendants quieted them and let me in. Inside I found an ark of animals from the shrinking Thai rain forest—tree shrews, pythons thick as my thigh, a tumult of birds, terrified civet cats that spat from dark corners of their cages, slow-moving lorises with round eyes like goblins.

I asked the owner, a well-dressed woman in her 30s, if it would be possible for someone to buy clouded leopards and gibbons from her for shipment to the United States. (Both animals are banned from international commerce under the CITES Appendix I rating.) She looked at me carefully, then looked away. "It would be difficult," she said. "It is prohibited by law."

"Is it possible?"

"It would be difficult."

HE LOOKED every inch the successful Singapore businessman—flashy finger rings, gold digital watch, clothes made by the best Oriental tailors.

"I've made a great deal of money in the animal trade," he said. "But I'm getting out of the business. It's getting too difficult, too many regulations."

But he knew exactly how the illegal trading was done, especially with exotic birds from Australia, which bans their export. In

a Singapore hotel, he sketched maps tracing the feather trail through the Far East.

"A fishing boat is chartered and sailed to Bali, then to the east coast of Australia, outside the Great Barrier Reef," he said. "From there, twin-engine speedboats make a dash to shore and pick up perhaps 2,000 birds—roseate cockatoos, sulfur-crested cockatoos, and parakeets.

"The smugglers return to Indonesia and buy papers saying that that's where the birds are from. Then the birds are taken ashore under cover in Singapore and sold, mostly to European dealers. After expenses, such a trip can clear a million dollars."

So much for so few birds?

"Bird collectors in Europe and the United States will pay $12,000 for a pair of golden-shouldered parakeets," he said. "Brown parakeets and Naretha bluebonnet parakeets go for $8,000 to $10,000.

"Of course, there is the chance that the trip may make nothing. Each cage has a rope tied to it with a rock at the end. If a patrol boat chases them, the smugglers can dump the birds overboard."

MUCH OF THE illicit trade is carried on with the help of people assigned to protect the animals. I asked a young American biologist heading for the jungles of Colombia to contact me if he witnessed illegalities. His report weeks later included personal sighting of ocelot skins en route by canoe to a dealer in the nearest settlement, and Appendix I otter skins being sold to a government agent.

Bitter pill for rhino lovers: *Vanity and false beliefs may wipe out the rhinos. For their traditional daggers (**right**) Yemeni men prize handles carved from rhino horn; the value of this display at a market in Sana, North Yemen, exceeds $125,000.*

*In Kyoto, Japan, an apothecary offers rhino-horn chips and pieces as an aphrodisiac (**upper left**). No scientific evidence exists for that belief, nor for the claim that powdered rhino tablets (**left**) cure headaches, colds, and flu. The tablets were available in 1980 in China, but expected ratification of the CITES treaty should remove rhino horn from Chinese shelves.*

In Panama City a top officer in the department of natural resources admitted that illegal trade from neighboring nations passes through his country, but that he is powerless to stop it. "Some of the people doing it have political connections," he said.

The culprits are not always big operators. On Grand Cayman in the Caribbean, the saleswoman in a gift shop encouraged me to buy jewelry made from the shell of a green sea turtle. Even though this species is grown for market in a shore turtle farm here, all sea turtle products are banned from United States import. "It's very small, easy to hide in your suitcase," the saleswoman said, with a nonchalance that suggested long practice and past success.

Bird-loving Belgians flock each week to the Sunday market in Brussels' Grand' Place to ogle exotic species from the tropics. "Belgians are enthusiastic bird collectors," said a distinguished-looking gray-haired gentleman there, who added that he keeps a backyard aviary of some 50 birds. "Most of these birds are common waxbills and finches, but it is possible to buy others that are very rare, nearly extinct."

"How does one do that?"

"I know," he said with a smile and a wink, "but I cannot tell you."

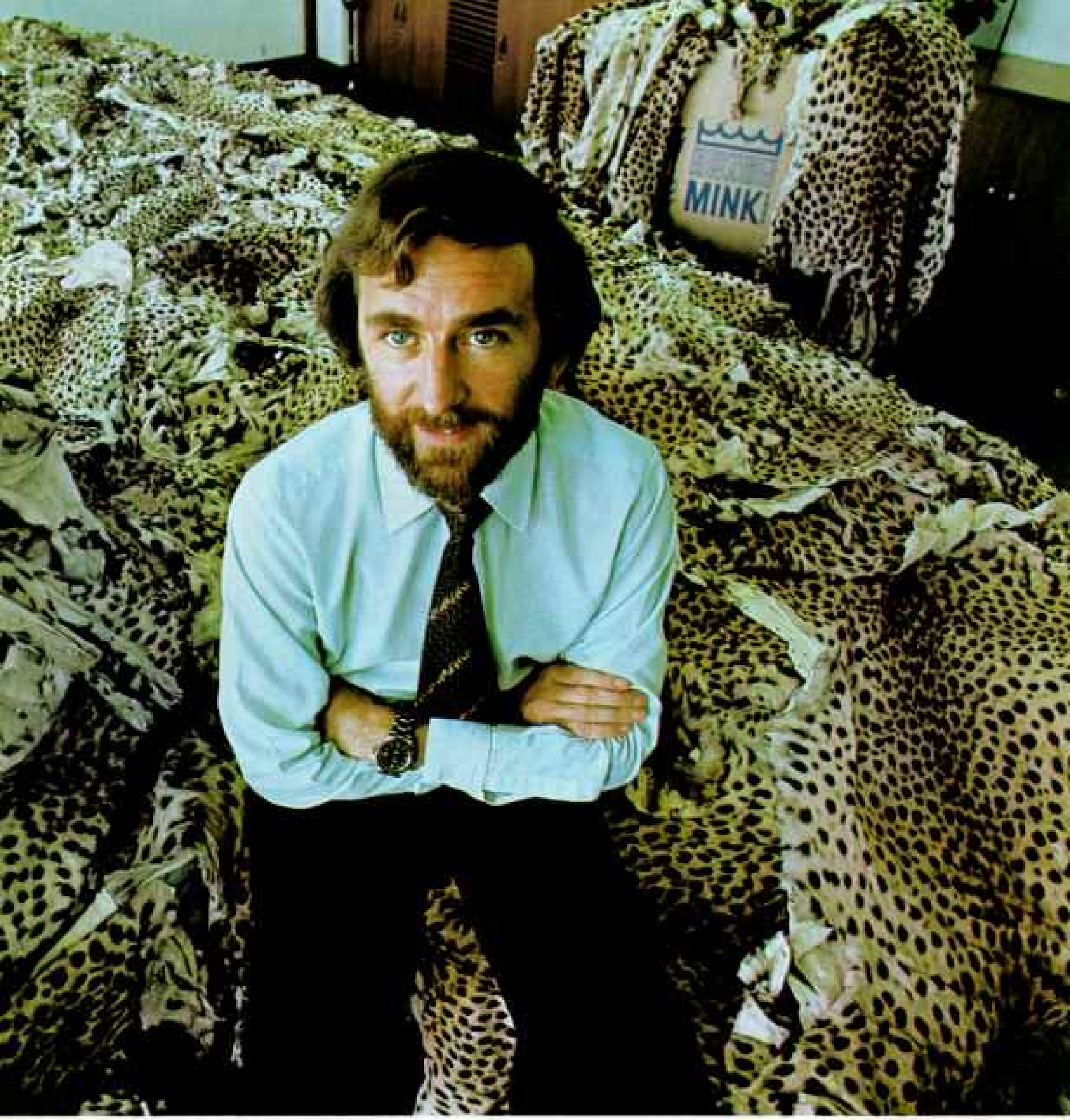
PERHAPS no single product is more synonymous with the illegal wildlife trade than elephant ivory. It touches all the major aspects of the problem—poaching, bribery, high profits, worldwide distribution, and an animal that finds it almost impossible to hide.

One of the world's precious commodities since biblical times, ivory sold for about $10 a kilogram (2.2 lbs.) during the first half of this century. The price shot to $100 a kilo in the mid-'70s before settling back to the present $74. With even a medium-size tusker carrying around some $1,300 on its upper jaw, elephants began dropping like flies all over Africa, usually outside the law.*

Although carved statuary, piano keys, and trinkets may be the ultimate use, much of today's new ivory is being held as a grisly investment, according to Au Ming Chi, chairman of the Hong Kong and Kowloon Ivory Manufacturers' Association. Many people around the world are buying raw tusks and hoarding them because they believe the elephant will become extinct and the price will soar.

Most African countries have limitations on their ivory exports, but official-looking documents can often be bought. After they are sold and resold in international markets, their origin becomes increasingly vague, until no one can say whether a carved figurine for sale in a Hong Kong ivory shop came

*See Oria Douglas-Hamilton's "Can They Survive?" in the November 1980 NATIONAL GEOGRAPHIC.



Poachers took a big bite *from the world's cheetah population when they amassed a shipment of 319 skins, intercepted at Hong Kong's Kai Tak Airport. The skins, packed in boxes marked "MINK," represent a 5 to 10 percent reduction in the total number of wild cheetahs. Hong Kong agent Chris Huxley, seated on the pile, intercepted them after receiving a tip that they would be arriving from Switzerland on a West German airline.*

from an elephant that was legally harvested, was poached with a poisoned arrow, or one that died of natural causes.

Joseph Kioko lives on the front lines of the poaching problem. The 35-year-old Kenyan is warden for the eastern portion of Kenya's Tsavo National Park. To protect the elephants and rhinos, he supervises 53 rangers, a thin force when spread over an area the size of Connecticut.

"We've found groups of as many as ten elephants, fallen close together," he told me

one morning as he made the day's patrol assignments at park headquarters. "You could tell they were just mowed down by poachers with automatic weapons."

The body count is not always in animals. Two park rangers and 20 poachers—most of them drought-poor Somalis from Kenya's neighbor to the east—have been killed in shootouts. "It's like a war," said Joe, who has been fired at while flying surveillance of his park in a light plane.

The problems encountered by Joe Kioko are universal. In 1979 two game wardens were killed and five seriously wounded in Thailand, where diminishing rain forests have long been a reservoir of birds, reptiles, and primates for research. "We have 24 wildlife sanctuaries, but only 215 guards," I was told by Pramote Saiwichian of the Wildlife Conservation Division. "We hope to hire and train more, but it all depends on the national budget."

The actual killing or capturing of the animals is usually the work of villagers, who then sell them to dealers. "You have to remember that many locals have always made their living by selling wildlife," said Angel Paucar, head of Ecuador's wildlife section. "For them, it is an economic necessity."

His solution: "We have declared large areas of our Amazon Basin as national parks. The Indians there will undergo training and become salaried as park guards. Instead of killing the animals, they will be paid to protect them . . . if we can get money to finance the project."

"There is a reluctance on the part of governments to spend money on wildlife, because they do not see the immediate economic return," a wildlife official in India told me. "They prefer to spend money on development schemes that bring in big cash."

Kenya banned all hunting in 1974 in hopes of rebuilding the game stocks that draw tourists and trophy hunters. The World Bank has lent them 17 million dollars for the project.

But a hunting ban does not necessarily amount to a trade ban. Ivory, rhino horn, and catskins have continued to leak out of Kenya, sometimes with the help of public officials. Kenya's harshest critics concede, though, that corruption there is decreasing.

PROPOSED NEW U. S. legislation would tighten the restrictions on ivory coming into the country. A 1980 bill for elephant protection would allow imports only from those nations that can prove they are practicing strict measures of elephant management. The bill passed the House of Representatives, where it originated, but died in the Senate. It is almost certain to be reintroduced, and possibly broadened to cover all endangered species.

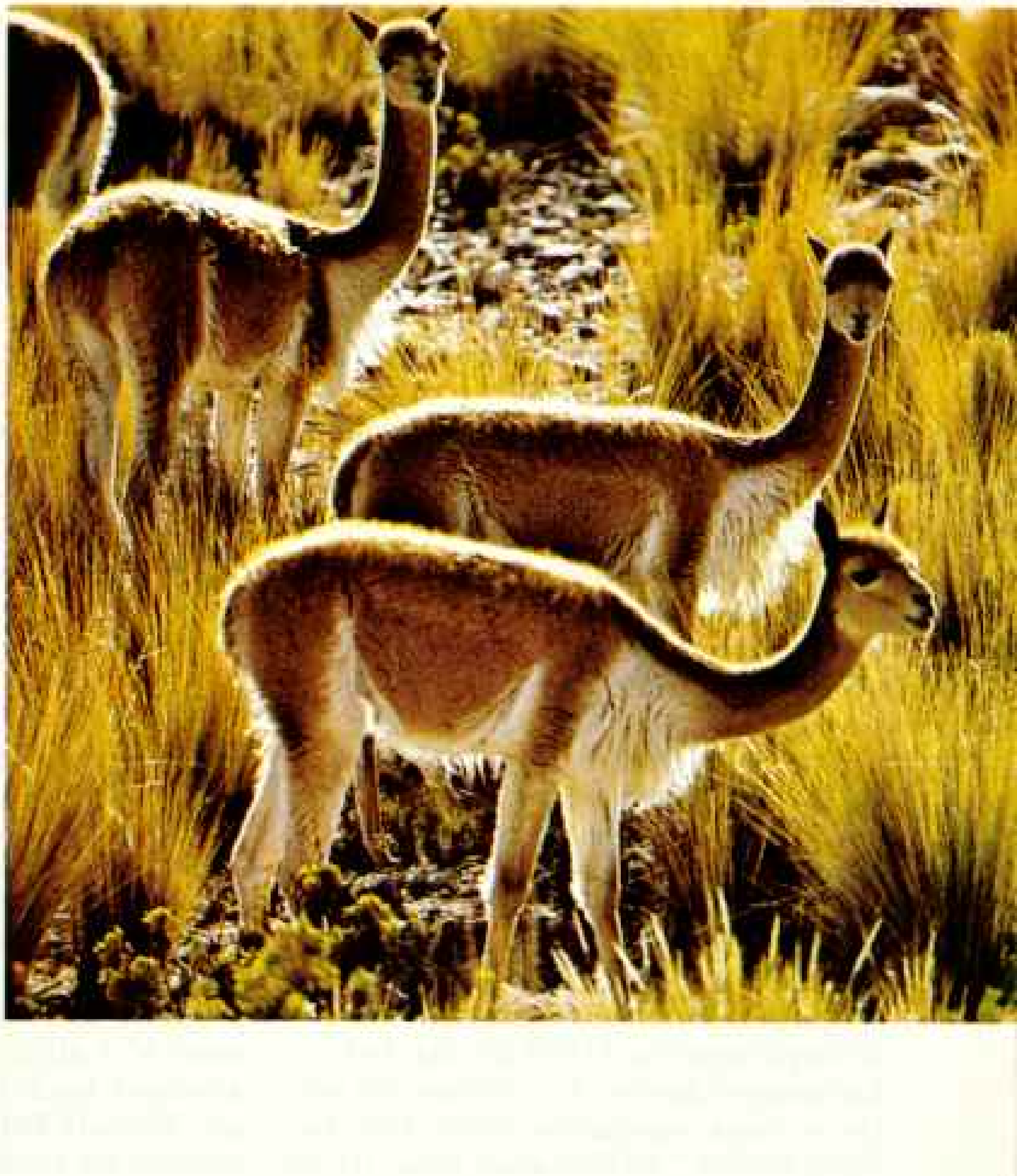
Strict though the measures may be for the African tusks, the United States has another problem to resolve with ivory produced

Fashion sets the pace *for the demise of many animals. In Japan, where spotted catskins remain chic, the owner of a fur boutique models a coat made from the fur of lynx* ***(left)****. Some countries, including the U. S., legally export lynx skins, but conservationists worry that legal outlets encourage illegal ones as well.*

In most developed countries public pressure has forced spotted-cat furs off shop displays and, often, off the streets. Major showrooms in Paris have agreed to stop creating coats made from endangered species. "We felt it would be shameful to continue to use them," said Christian Dior's Frédéric Castet ***(right)****, here designing a coat of dyed Persian lamb.*

A harvest by bullets *brought a storm of controversy to Peru, where skins of vicuñas shot by government hunters filled a warehouse; a wildlife ranger inspects the fur. In 1979 the Peruvian government asked for a change in CITES' strict regulation of trade involving that long-necked relative of the camel* ***(below)****. A herd in the Pampa Galeras Reserve was said to threaten its range with overgrazing; the government wanted to cull 5,000 bachelor males and sell their valuable fur. Despite a denial of the request, the killing of the animals began, outraging conservationists.*

Andean vicuñas had dwindled to 10,000 by 1965, with 80 percent of them in Peru. Under government protection the herd in Pampa Galeras had recovered, although the population figure is disputed. Public outcry somewhat limited the 1979 and 1980 harvest, but the furor raised a perplexing issue for the future: If nations protect and proliferate their endangered species, shouldn't they reap the benefits of their success?



within its own borders—the tusks of Alaskan walruses.

Most of the U. S. ivory-carving industry originated from scrimshaw—the etching of pictures on the teeth of sperm whales by early Yankee whalers. Carvers on the East and West Coasts and the Hawaiian Islands shifted to walrus tusks, then to elephant ivory when walrus kills were regulated. With interstate commerce in sperm whale teeth now banned in the U. S. and elephant-ivory imports reduced, traffic in walrus ivory has escalated. Although the walrus population has been creeping upward, so has the number of walrus kills—to more than 5,000 annually.

Under the U. S. Marine Mammal Protection Act, walrus hunting in Alaska is strictly limited. Walrus tusks may be sold only by native peoples who have worked them into "authentic handicrafts." In the seaside town of Lahaina on the Hawaiian island of Maui, I entered shop after shop displaying walrus ivory etched with seafaring scenes, for sale to tourists. Sailors in striped T-shirts hauled in a mainsail on one tusk. A clipper ship sailed across another piece, which sold for $775. The names of the artists did not sound native Alaskan.

I telephoned the artist who signed the clipper-ship tusk. Is the fresh ivory "worked as an authentic native handicraft" before he gets it from a local importer?

"Sometimes it just has the Eskimo's initials carved at one end," he admitted. "I've even gotten them with ball-point pen scribblings on them."

Wildlife laws are only as good as the officials who inspect shipments in and out of countries. In the United States, customs officers are attending seminars taught by animal experts, and visiting zoos and museums to see and identify exotic species. Tourists as well as big-time smugglers are feeling the new emphasis. I visited an "evidence room" in Honolulu, where hundreds of items seized from individual travelers were piled to the ceiling. They included leopard-skin coats, carved whales' teeth, and some 800 hawksbill and green sea turtle shells—all illegal according to CITES and the U. S. Endangered Species Act. "Please, tell people to check regulations before they buy things abroad," pleaded agent James Bartee of the U. S. Fish and Wildlife Service. "We don't like to take these things from them."

Customs and FWS officers make the first contact with wildlife shipments; the National Marine Fisheries Service and the Department of Agriculture may be called in to provide positive identification of the animals being shipped. If any question arises, the agencies refer shipments to outside experts.

I watched customs inspectors Randy Karavanich and Maryanne Noonan at Los Angeles International one day as they checked crates of monkeys imported for research. Everything seemed in order—clean cages, healthy animals, shipping documents.

"The papers say they came from Guatemala," said Randy. "But I've never seen a Guatemala permit before, so I wouldn't know if this one is false. We'd better have Roy take a look at it."

Roy Simpson, the Fish and Wildlife inspector on duty, is a quiet, bookish man, with an eye for detail. He peered at the monkeys and pored over a manual explaining trade requirements. "One man's name, and no other, should be on any shipment from Guatemala," he said. "It's missing from these papers."

The monkeys were confiscated, to be cared for at a nearby holding station while the case was being investigated. If the final decision went against the importers, the animals might later be given to a zoo.

Randy slapped seizure stickers on the cages, at the same time telling the occupants in mock seriousness, "All right, you guys are being seized. You have the right to remain silent. Anything you chatter may be used against you."

ADVISING MONKEYS of their rights is a laughing matter, but convicted smugglers are finding little humor in penalties they now receive in the United States. The emphasis changed in August 1979 with a presidential directive calling for more attention to illegal animal trade. A special wildife section committed to stricter enforcement was created within the Department of Justice. The new section's eight attorneys, headed by lawyer and wildlife expert Kenneth Berlin, aid U. S. attorneys in prosecuting cases at the designated ports

where wildlife shipments may enter—New York, Miami, New Orleans, Chicago, Los Angeles, San Francisco, Seattle, Honolulu—and several other cities along the U. S. borders.

In addition, special task forces are being set up around the nation to combine the efforts of Justice, Fish and Wildlife, Customs, National Marine Fisheries, and the Department of Agriculture. "We're committing the expertise of all these agencies to individual wildlife cases, instead of having each one conduct its own investigations," Berlin told me in Los Angeles.

It's working. A case investigated and prosecuted by the task force in that city resulted in a $10,000 fine for the company importing the wildlife, an 18-month jail sentence for the principal defendant, and shorter terms for two associates.

The most celebrated wildlife case so far took place in Philadelphia in 1979, where animal dealer Henry Molt was convicted for illegally importing reptiles into the United States from Fiji and Papua New Guinea. He was sentenced to 14 months in prison and prohibited from importing any reptiles for a three-year probation period. Molt is appealing the verdict.

There is action on the international front as well. "The battle against illegal wildlife trade has encouraged countries to set up the institutions for conservation they didn't have before," said Dr. Gerard Bertrand, who has traveled worldwide for FWS, exporting American conservation techniques. "And there's no question about what started it all—CITES."

This "most remarkable trade pact" has its weaknesses, admits Peter Sand, the high-energy Bavarian lawyer who heads the CITES Secretariat. "The treaty allows member nations to 'take exception' to some trade restrictions," he told me at CITES headquarters in Gland, Switzerland.

"France, Italy, West Germany, Japan, and Switzerland all take exception to the ban on saltwater crocodiles, for example, because they process the skins into leather goods. And since they make most of the world's handbags, shoes, belts, and other crocodile-skin products, their exceptions undermine the CITES attempt to protect the species."

Regulation alone probably cannot stop wildlife trade.

"You can't cut off trade completely when demand exists for the product," a French tanner of crocodile hides told me angrily. "You only drive it underground. The only answer to saving endangered species is to farm them."

MANAGING WILDLIFE to meet the demand for their products is inevitable, I heard from conservationists, animal dealers, tanners, bureaucrats, and illegal traders.

Management may include as large an operation as the great South African game reserves, where elephants, lions, and other trophy animals are carefully protected and regularly culled to prevent overcrowding. Such a controlled harvest can reap national income from hunting fees and tourism. In Papua New Guinea, crocodile ranching has become a national goal.

"The idea is to encourage villagers to capture the small wild crocs that suffer high mortality anyway and raise them to selling size," said Melvin Bolton, the United Nations' project manager. The U.N. has provided funds and technical assistance for the project. "It's not easy. These are people with traditions of hunting, not day-to-day ranching responsibilities."

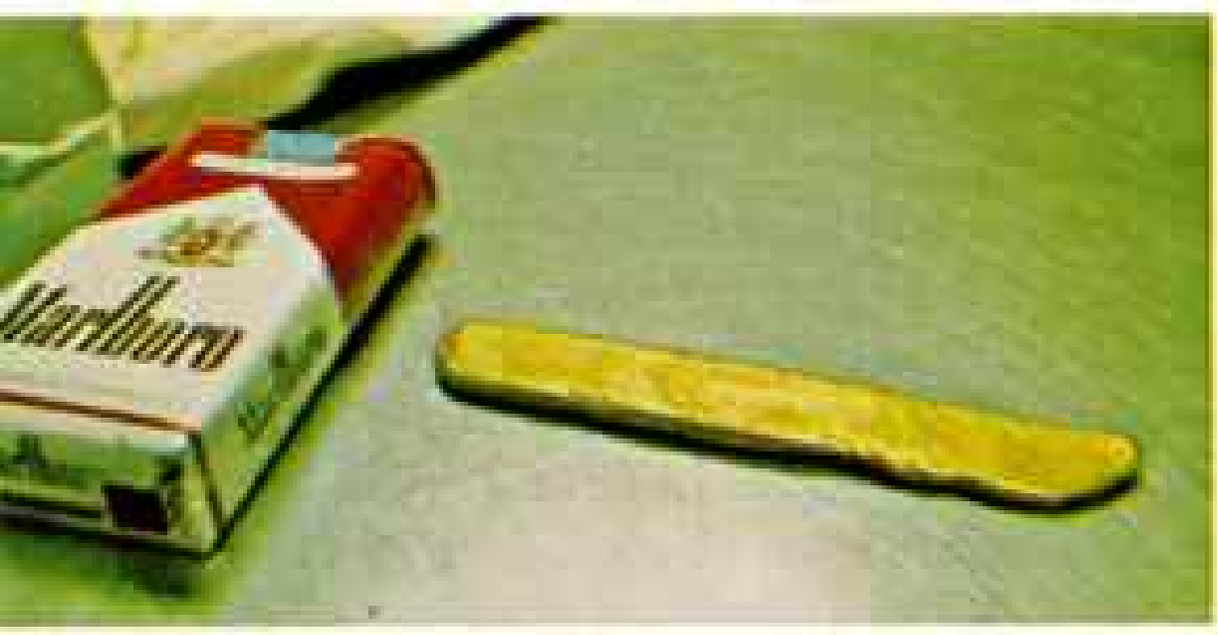
Villagers at Mamber, a collection of stilt-legged huts along the broad Sepik River in the northwest, are accepting the new life. Amid clouds of mosquitoes I walked with them to four croc pens enclosed by vertical log walls. Several sets of periscopic eyes peered from muddy pools.

It takes two years for a captured yearling croc fed on netted fish to attain a belly width of 15 inches, proper selling size. Mamber hoped to sell the first crop of 14 for about $150 apiece within a year.

"Eventually we'll sell 20 a year," said villager Moses Gawi. "We'll use the money for improvements to the village, such as a pump to bring a better water supply."

Two large ranching operations, both owned by Papuans and managed by Australians, are under way at Lae and Port Moresby. Both fatten their charges on offal from their own chicken-processing plants, which operate simultaneously. Croc-skin sales for

Gold-lined shipment *of ball pythons from Ghana* **(below)** *caught the attention of Los Angeles customs inspectors, who found 24-karat bars* **(bottom)** *sewn into the bag that held them. In a previous shipment, a similar bar was found in the belly of a reptile. The importer was charged with failure to declare the gold on his customs form and with cruelty to animals in the manner of shipping.*



these large-scale operations could number in the thousands annually.

An exception to the CITES ban on saltwater croc sales has been granted Papua New Guinea. The project is seen as a possible pilot. If crocs can be ranched, why not leopards, tigers, or cheetahs?

The problem is one of identification. Who can tell whether a saltwater crocodile skin was raised or poached? Conservationists argue that farming an endangered species creates a market for it and encourages poaching of the animals still running wild. Dealers claim the demand will always be there and might as well be accommodated legally. The world's first green sea turtle farm brought the argument to the courts.

CITES lists the green sea turtle as Appendix I but allows trade if it is born and raised in captivity. Cayman Turtle Farm on Grand Cayman in the Caribbean meets those requirements, said its manager, William Johnson, as we walked past concrete tanks filled flipper to flipper with turtles. Fed high-protein pellets, they reach growth of about 80 pounds within three years before being butchered.

The farm markets the shells as jewelry and wall hangings, the oil for cosmetics, meat for steaks, fatty calipee for soup, and flipper skin for leather goods.

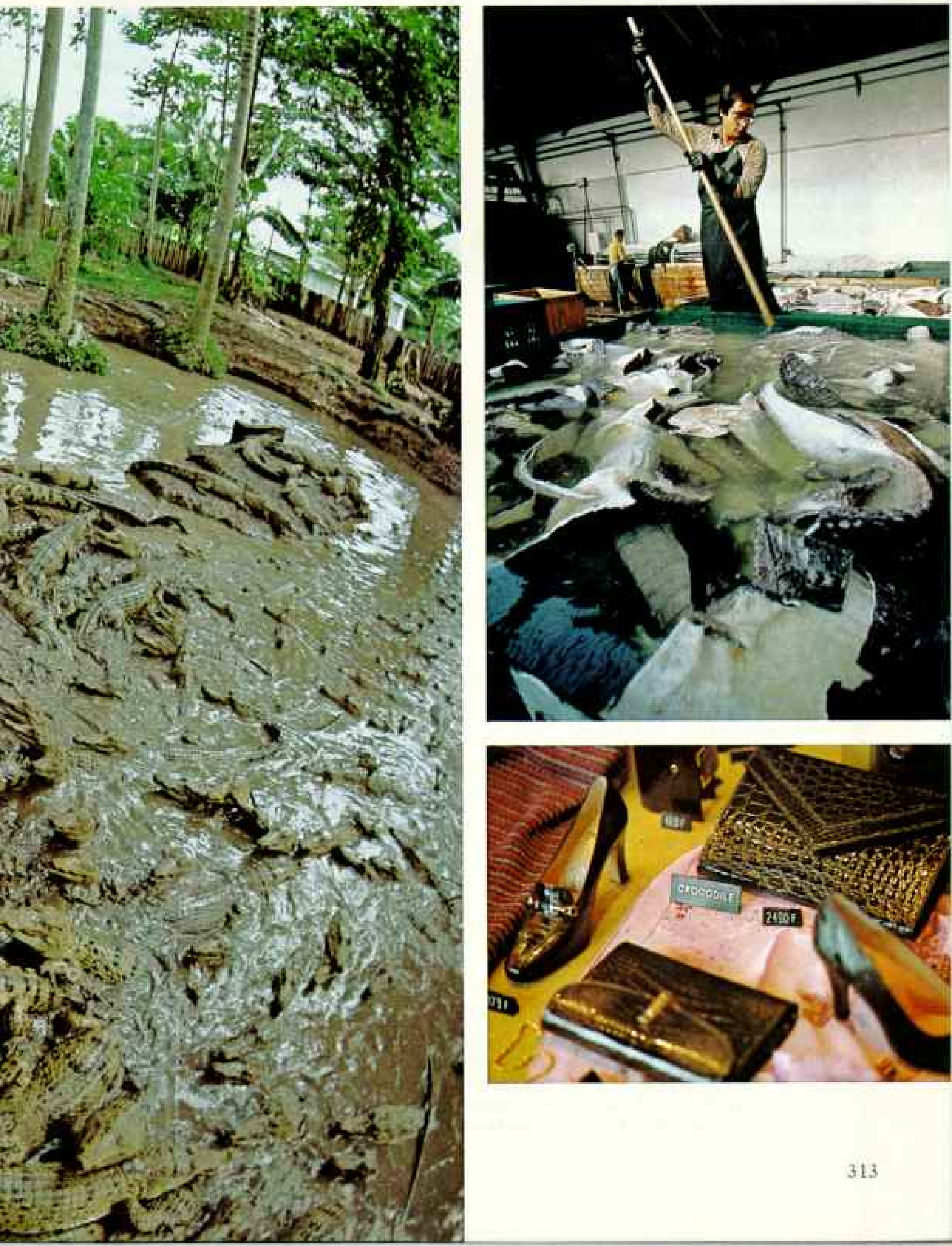
In the farm's early days, Mr. Johnson admitted, eggs were gathered in Suriname, from beaches said to be doomed to erosion. Now, he says, the entire stock comes from the breeding females.

Oval submarines with shells four feet across, they glide through the clear water of the large breeding pool with a smooth flipper motion that resembles flying. The largest weighs about 600 pounds. A sand beach lines one side of the pool, so the females can

Wildlife tycoon, *"Mr. Dang" of Bangkok annually sells nearly a million dollars' worth of pets from Asia. This rare albino python could bring $20,000 in Germany, Japan, or the United States, his major outlets. A portable telephone speeds sales, he says, and jets reduce animal deaths. "When we sent them by ship, we would lose maybe half," he told the author.*

Tangle of hungry crocs *rushes toward a keeper tossing chopped fish into a pen at Lake Murray, Papua New Guinea. Villagers are ranching crocodiles to reduce depletion of wild stock. Top-quality skins sell*

*for about $150, en route to tanneries in Europe. Many dealers say such ranching is the wave of the future. Conservationists worry that it encourages poaching. Near Fontainebleau, France, at the Gordon Choisy plant—largest processor of reptile skins—a worker stirs hides in hydrochloric acid to soften them (**below**). End product may be a $560 lady's purse (**bottom**) in a Paris boutique.*



lumber ashore to lay their eggs, which are gathered and artificially incubated.

In 1978 the U. S. Departments of the Interior and Commerce banned import of all sea turtle products into the United States regardless of origin. The agencies argued that sale of the products created a market that encouraged the poaching of turtles in the wild. They added that success of the Cayman farm might encourage the establishment of similar companies, whose start-up operations might also require collection of eggs from the wild.

The farm filed suit against the U. S. agencies to stop the embargo on their products, arguing that their operation met the requirements of the CITES treaty. As to depletion of wild turtles, they point out that hatching thousands of eggs annually adds to the sea turtle population.

The U. S. argument was upheld; the farm is appealing the decision.

ADEQUATE SPACE exists for both people and wildlife, in the opinion of most biologists, with the establishment of properly enforced game preserves. But no preserve is safe as long as there exists a demand for the creatures and their products, thus encouraging illicit traffic.

As human population pressures continue, many nondefenders of wildlife argue, "Who deserves the space more, people or animals?" Nalni D. Jayal, an Indian government conservationist, does not consider it a matter of choice. He sees wild animals as an important measuring stick for the state of the world. "The earth has developed a successful ecosystem, and the presence of all creatures in it is a sign that it is still healthy," he told me in New Delhi. "When we destroy any part of it, we destroy a bit of ourselves."

In his country, for example, the handbags made from glittering skins of the monitor lizard and the hooded cobra are popular tourist bargains. Why save these reptiles, one a throwback to the age of dinosaurs, both the stuff of nightmares? Because, Mr. Jayal said, they eat rodents, scourge of India's struggle to feed itself. Twenty percent of the annual food production is eaten by rats and mice, none of which are eaten by handbags.

OVER MONTHS of searching for illegal trade, I found the prey progressively more elusive. Traders and dealers told me they were going out of business or shifting their emphasis to legitimate animals. Time after time I traveled to locations where, I had been told, the trade was particularly heavy and blatant. Time after time it was gone, or forced deep into hiding when I arrived.

At best, the funnel of illegal wildlife became a sieve, in which the holes are slowly being plugged. A drip can empty a vessel, but the slower flow at least buys time for earth's endangered animals.

Can they be saved before time runs out? Or will they be sacrificed to doomsday choices such as whether people or animals deserve to live on the earth?

After I had heard the "people or animals" question posed a third time on as many continents, I decided to submit the idea to cold logic. I imagined a cosmic jury considering the evidence.

On the one hand, the case is argued for the animals, whose ancestors preceded man's on earth, and who for the most part maintained a system of checks and balances on their numbers.

On the other hand, the case of man is brought forth. A relatively helpless creature save for a marvelous brain, this comparatively recent addition brought the ability to articulate an appreciation of the world and developed the potential to ease pain and hardship for all its inhabitants. But man also brought killing for fun and for decoration—killing that began to upset nature's delicate balance.

The evidence is in. Who more deserves the shrinking space on earth, animals or people? As a member of the latter species, I am worried about the verdict. □

A taste for the exotic *cost an Asian bear its life; one paw serves as an advertisement for bear-paw soup in a Macao restaurant specializing in wildlife dishes. The demand for such luxury items creates a worldwide market that smuggling helps to fill. Can stricter enforcement save the animals before they run out of places to hide?*


USA

When the Space Shuttle Finally Flies

By RICK GORE

Photographs by JON SCHNEEBERGER

BOTH NATIONAL GEOGRAPHIC STAFF

Paintings by KEN DALLISON

THE SECOND SPACE AGE is about to begin. Space shuttle flight one will depart Cape Canaveral for low earth orbit as early as March 14. Its trip will be short—two and a third days. Astronauts John Young and Bob Crippen will take their flagship *Columbia* around the world 36 times to test its wings. Then a steep descent down onto the Mojave Desert. But at least three dozen space flights will follow, for tours of a week or more. *Columbia* will be joined by *Challenger*, *Discovery*, and *Atlantis*. By the late 1980s this fleet of orbiters could be making about 50 flights a year.

What is the space shuttle? Most people know that it sometimes rides piggyback on a Boeing 747. Many have heard about its main engines bursting into flame on the test stand, some of its protective tiles falling off, and the other expensive problems that have delayed *Columbia*'s maiden flight for more than two years. Yet ask someone how the shuttle is going to get to space, or better still what our nine-billion-dollar super machine will do up there, and the answer will likely be a stammer or a shrug. The space shuttle has come of age with an identity crisis.

Basically, the shuttle is a spacefaring cargo ship that can be used over and over again. Not only will it take satellites, military hardware, and people to space, but it will also bring them back. It will replace all other American satellite launching vehicles. If, once in orbit, a satellite fails, the shuttle can retrieve it for servicing. The shuttle will ferry telescopes, earth-scanning cameras, laboratories, and eventually construction equipment into orbit. It will move industry into space. Apollo's moon-landing program, Skylab, and the missions to the planets were the age of space exploration. The shuttle begins the age of space exploitation.

At times the shuttle also seems to be the beginning of the people's space program. "I'm convinced that by 1990 people will be going on the shuttle routinely—as on an airplane," says Robert Freitag, an advanced programs planner at the National Aeronautics and Space Administration.

For the first time women and minorities will be in the astronaut corps. My daughter could well grow up to help build a solar-power space structure as big as Manhattan Island that would convert solar energy to

Spaceborne at last? *After a two-year delay, the space shuttle is poised for launch this spring from Cape Canaveral. The reusable shuttle offers multiple options for the unique environment of space: astronomy, communications, biomedicine, defense, even manufacturing. The payload vehicle, the earth orbiter that looks like an aircraft mated to rockets and fuel tank (left), can ferry satellites and instruments to orbit and return to service them.*

Workhorse in space

*JAMMING terrestrial traffic, the orbiter "Columbia" creeps through Lancaster, California (**right**), after assembly in Palmdale. At NASA's Dryden Flight Research Center near Edwards, the orbiter was fastened atop a Boeing 747 for a journey to Cape Canaveral (**above**).*

In the giant building at left the "Columbia" was joined to its booster rockets and external tank. It will lift off from Launch Complex 39A, center, where Apollo astronauts began their journeys to the moon.

The many-faceted "Columbia" will launch like a missile, orbit like a spacecraft, and return to earth like an aircraft. Its wings will function from atmospheric reentry to landing—about thirty minutes.

KERBY SMITH (BELOW)

microwave energy and beam it to earth.

Already an unexpectedly high number of student and civic groups, corporations, private individuals, and foreign countries have bought "getaway specials" from NASA. These are canisters in which anyone anywhere can send experiments and inventions into space for as little as $3,000.

Even Hollywood is enthused. Director Steven Spielberg holds a getaway-special reservation but has no idea as yet what to do with it. *The China Syndrome* screenwriter, Mike Gray, told me that "the space shuttle is the set of the future." Still others see the shuttle as the first step toward colonies in space and human emigration from earth.

More immediately, astronauts riding the space shuttle will be deploying and servicing elaborate switching stations for telephones and television. Before the end of the century we should be able to make an inexpensive telephone call from a wristwatch telephone via satellite anywhere in the world. Less certain but potentially just as profitable is the prospect of building, with the shuttle's help, floating factories that take advantage of the unique ultralow gravity of space.

Finally, the shuttle will be a military

Automated flight *results from four computers that brief pilots by means of TV screens at center. Though pilots can take over in emergencies, an orbiter's flight is usually monitored by the two-man crew and a ground team of four. Scores of ground controllers monitored moon vehicles.*

machine. The Air Force has reserved 13 of its first 44 flights. A new surveillance system will go up. Our next war could be fought between satellites that hunt and destroy each other or even knock out missiles with lasers or high-energy death beams.

For a while the space shuttle will make only test flights. Not until 1982 will it fly its first regular mission, deploying a giant tracking and data-relay satellite. That gives us time to get to know this complex machine.

The shuttle that will spew fireballs and steam across the launchpad at Kennedy Space Center at Cape Canaveral has three main components: an orbiter, external tank, and two solid-rocket boosters, all bolted together. This ungainly configuration will stand 184 feet tall—about half the height of the Apollo lunar launch assembly.

The orbiter, which looks like a small, fat airliner, is the core of the system. It is what goes back and forth between earth and space. The orbiter features work and living quarters for as many as seven people and a 60-foot-long payload bay for stowing cargo. This bay could carry to space the weight equivalent of five adult African elephants.

However, the most obvious component of the shuttle will be the mammoth white bullet-shaped external tank. The external tank carries the enormous volume of liquid hydrogen and oxygen burned by the orbiter's main engines. In just eight minutes these three ultrahigh-performance engines will consume enough propellant to fill 18 backyard swimming pools.

If the orbiter itself had to carry all that liquid, it would be far too big. So instead the orbiter will ride on its fuel tank, and then, just before reaching orbit, it will drop the empty tank into the Indian Ocean.

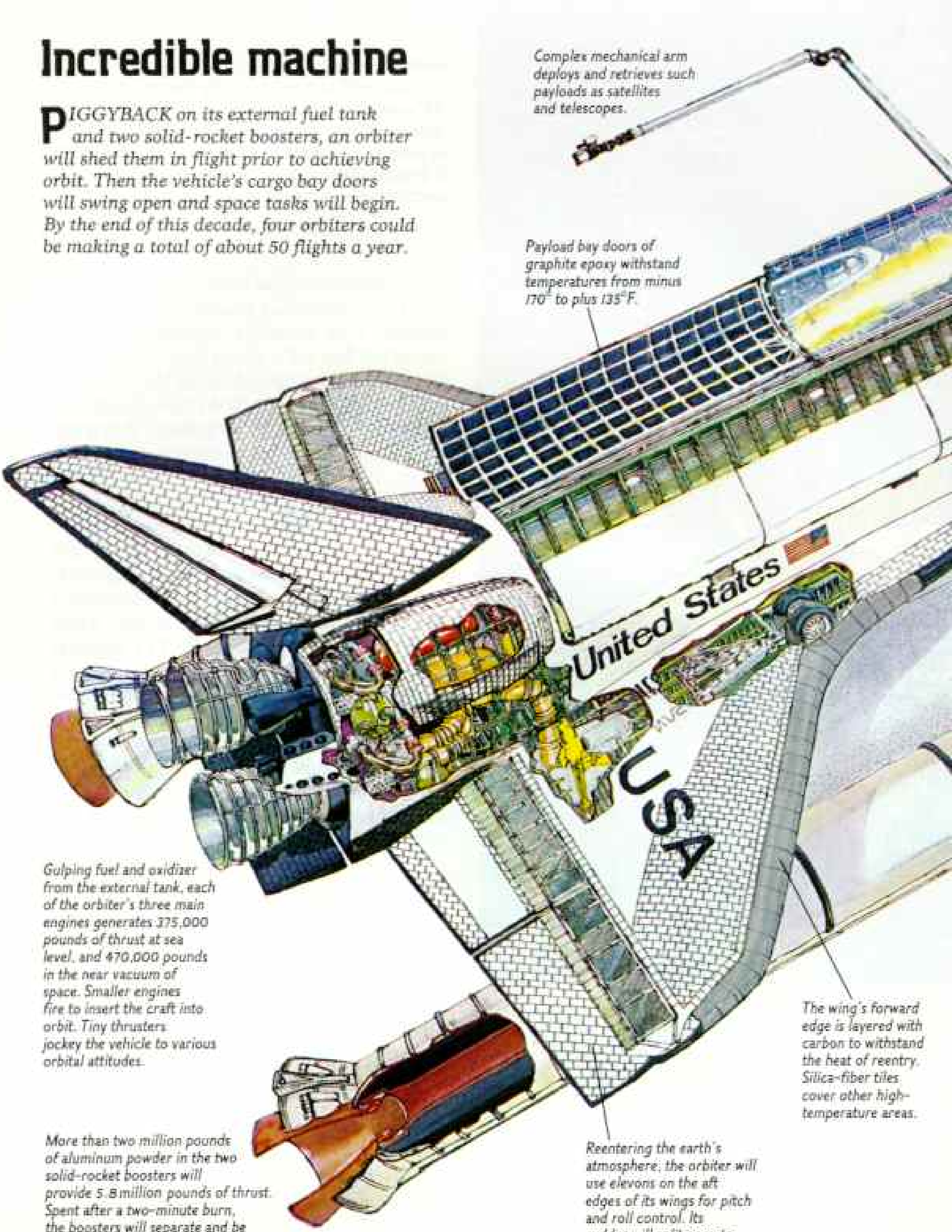
Riding Captive Flame Into Space

Unfortunately, on the ground the fuel in that tank weighs a million and a half pounds. As powerful as they are, the orbiter's main engines could scarcely budge this load. So a third component is needed, the solid-rocket boosters. Solid rockets, which burn a highly explosive aluminum powder, have long been used by the military. They have tremendous get-up-and-go. One I saw being test-fired in Utah looked as if it were spitting the sun out its tail as it sent a blinding holocaust across the desert.

No man has ridden solid rockets before, largely because they are hard to control. Once ignited, they are on for good. No second thoughts. *(Continued on page 327)*

Incredible machine

PIGGYBACK on its external fuel tank and two solid-rocket boosters, an orbiter will shed them in flight prior to achieving orbit. Then the vehicle's cargo bay doors will swing open and space tasks will begin. By the end of this decade, four orbiters could be making a total of about 50 flights a year.



Complex mechanical arm deploys and retrieves such payloads as satellites and telescopes.

Payload bay doors of graphite epoxy withstand temperatures from minus 170° to plus 135° F.

Gulping fuel and oxidizer from the external tank, each of the orbiter's three main engines generates 375,000 pounds of thrust at sea level, and 470,000 pounds in the near vacuum of space. Smaller engines fire to insert the craft into orbit. Tiny thrusters jockey the vehicle to various orbital attitudes.

The wing's forward edge is layered with carbon to withstand the heat of reentry. Silica-fiber tiles cover other high-temperature areas.

More than two million pounds of aluminum powder in the two solid-rocket boosters will provide 5.8 million pounds of thrust. Spent after a two-minute burn, the boosters will separate and be parachuted to earth for reuse.

Reentering the earth's atmosphere, the orbiter will use elevons on the aft edges of its wings for pitch and roll control. Its rudder will split open to function as a speed brake.

Radiator panels dissipate heat from electronics systems and from the crew cabin.

An orbiter can carry a maximum crew of seven — two pilots and as many as five mission and payload specialists.

Tipped by a lightning rod, the external tank contains 140,000 gallons of liquid oxygen in its forward bay and 380,000 gallons of liquid hydrogen aft.

A canister contains the three giant parachutes that will return the solid-rocket booster to earth after jettisoning.

An igniter, shown in silver, shoots a 20-foot tongue of flame into the forward solid-propellant segment. Within two-tenths of a second, ignition has spread throughout the 149-foot-long rocket.

Solid-rocket boosters, largest ever flown, have skins of half-inch steel.

Wandlike antennas conduct plasma-wave experiments.

Booms deploy magnetometers for measurements of earth's magnetic field.

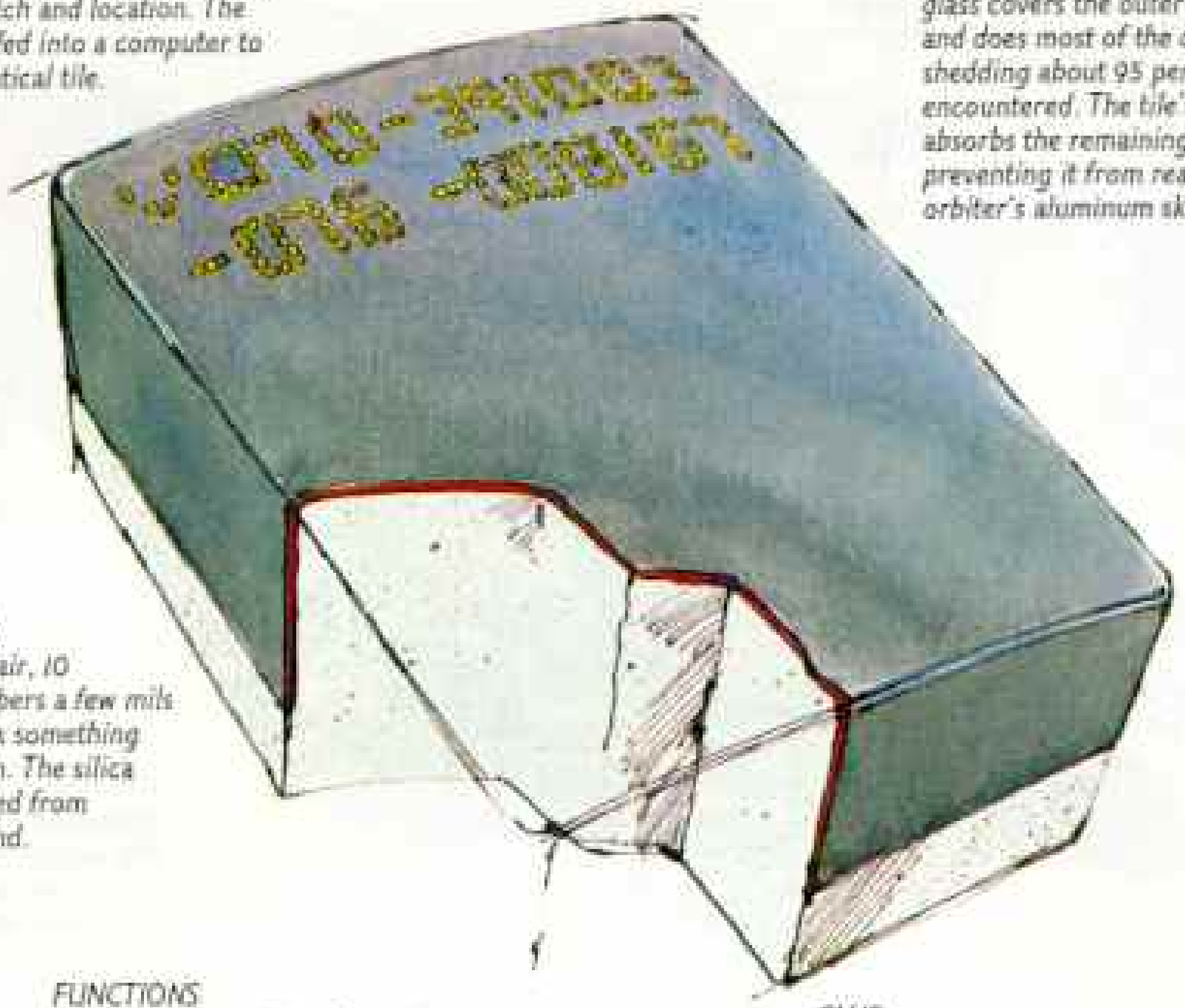
Cylindrical instrument gauges gamma rays.

A telescope measures ultraviolet radiation from cosmic sources.

Flying laboratory for diverse experiments, spacelab can take up an orbiter's entire cargo bay for a seven-day mission. Built by the European Space Agency (ESA), spacelab offers a pressurized module, forward, where scientist-astronauts can monitor the experiments that are performed by a motley of exposed instruments, aft. Possibilities abound in astronomy, earth science, and the manufacture of super-pure crystals and unique alloys.

IDENTIFICATION
Different for each tile, an identification number tells batch and location. The number can be fed into a computer to produce an identical tile.

COATING
Black-glazed coating of borosilicate glass covers the outer portion of a tile and does most of the cooling job, shedding about 95 percent of the heat encountered. The tile's interior absorbs the remaining 5 percent, preventing it from reaching the orbiter's aluminum skin.



COMPOSITION
Ninety percent air, 10 percent silica fibers a few mils thick, a tile feels something like plastic foam. The silica fibers are derived from high-quality sand.

FUNCTIONS
In addition to radiating heat, tiles establish the aerodynamic shape of the orbiter. During launch they will undergo severe acoustic vibration, many times greater than a thunderclap.

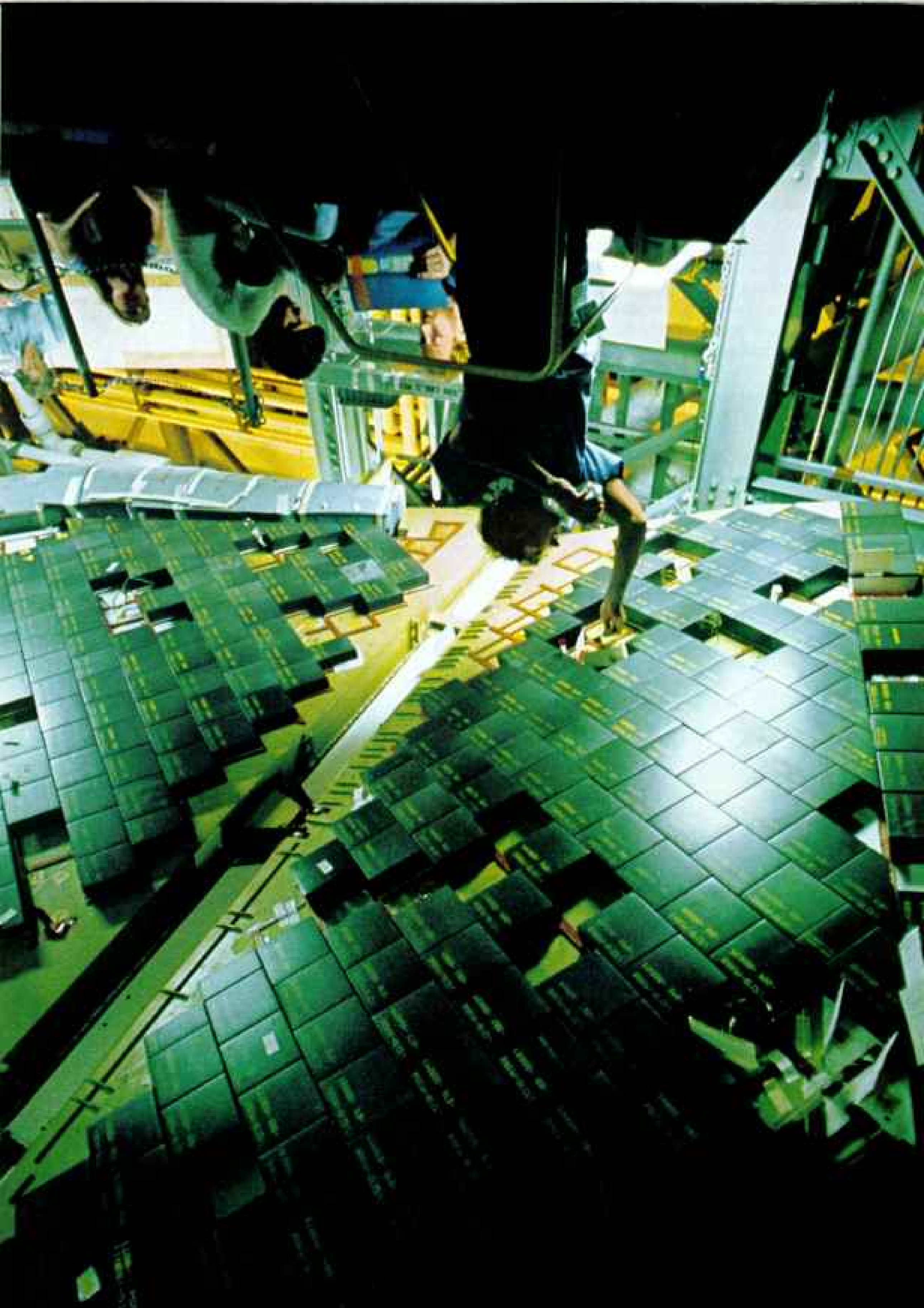
GLUE
Silicon-rubber glue, similar to common bathtub caulking, bonds a tile to a felt pad, not shown, that is in turn bonded to the orbiter's skin. The felt absorbs the stresses of airframe bending that could damage the rigid, brittle tiles.

Those incredible, troublesome tiles

LIKE AN UNFINISHED *jigsaw puzzle, heat-dissipating tiles line the underside of "Columbia"* (**right**). *Without them, the orbiter would burn up on reentering the earth's atmosphere. Approximately 34,000 tiles cover about 70 percent of the orbiter's surface.*

At a Lockheed Missiles and Space Company facility in Sunnyvale, California (**left**), *a technician exhibits surgeonlike concentration as he masks a tile before a ceramic coating is applied. The coating enables the tiles to withstand temperatures up to 2300°F.*

Computer-controlled machines cut the tiles; no two are exactly alike. Installation and testing difficulties made them one of the major elements in the shuttle program's delay.

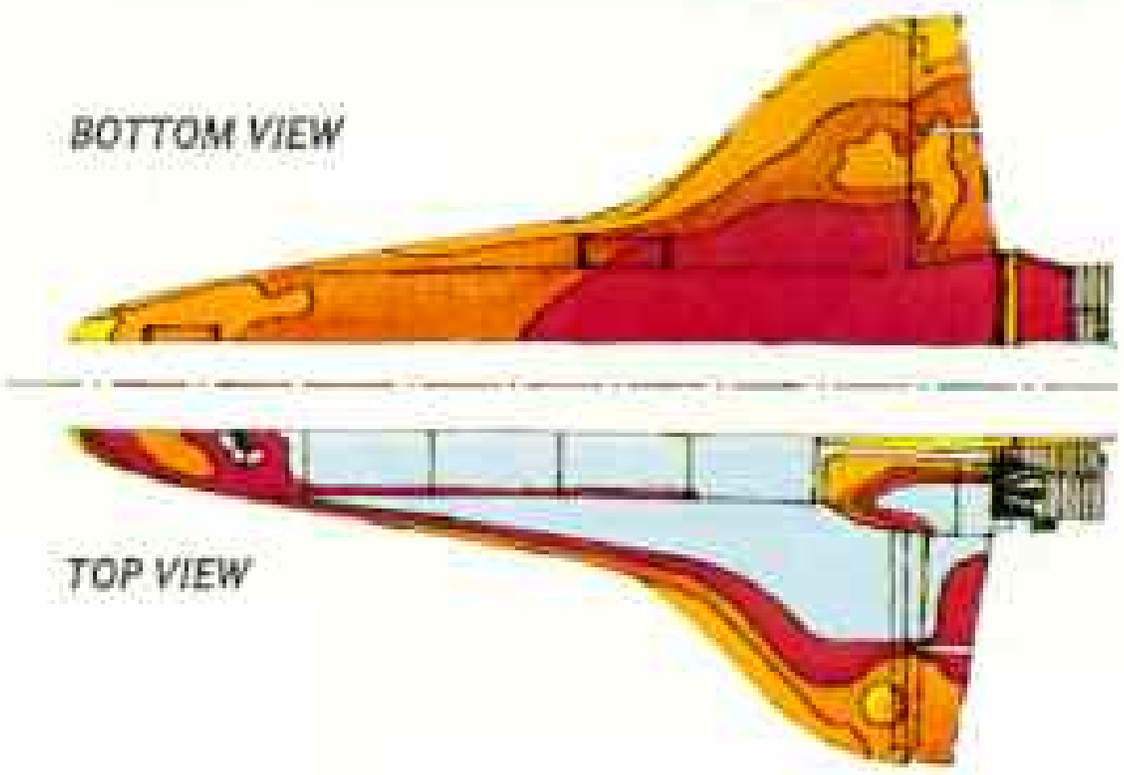


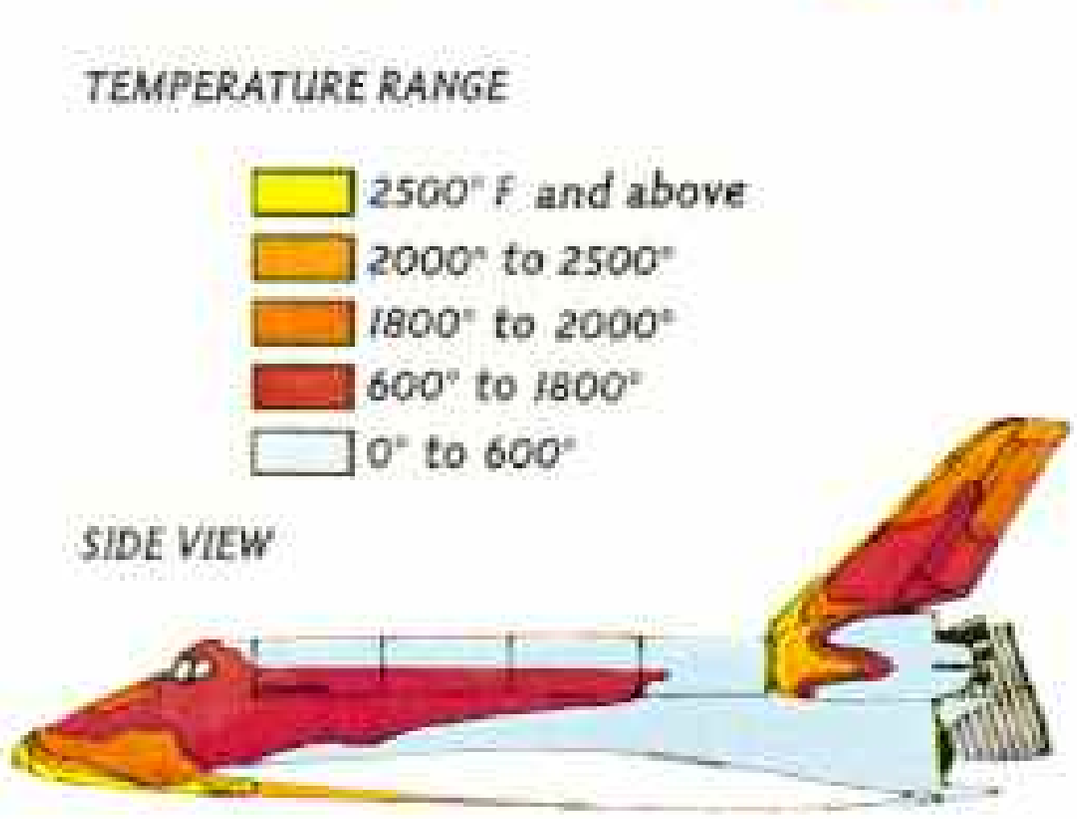
KERBY SMITH

Tile troubleshooting class *convenes underwater for astronaut Richard H. Truly (**above**) at NASA's Johnson Space Center in Houston. Problem: Fill the void left by a lost tile. Danger: In space the loss of tiles shielding critical areas, such as hydraulic lines, could threaten the orbiter itself.*

Experiencing reduced gravity, Truly uses a king-size caulking gun to fill a tile space with glue that contains an ablating substance. The patch would flake off gradually during reentry, thus shielding the orbiter.

*Zones of equal temperature, shown as a thermogram (**right**), dictate the type of protective material needed.*





*Relatively cool cargo bay doors are covered with fireproof felt. Tiles take over the middle range up to 2300°F. Heated in a kiln beyond this temperature, a cube releases interior heat so slowly that it can be held at the corners (**top**). Reinforced carbon protects the nose and wing edges where temperatures higher than 2500°F are expected.*

(Continued from page 321) No throttle back. That has been fine for launching warheads, but not for the subtleties of manned space flight.

On the shuttle the solid rockets are there just for the muscle. Two are bolted onto the external tank, and for two minutes they provide 5.3 million pounds of thrust. That is about what it would take to get 25 fully loaded 747s airborne. Once the solid fuel is exhausted, explosives fire the rockets away, to be recovered by a ship off Florida for reuse.

Finding the Orbital Flyway

So that is the system. One orbiter, one external tank, and two solid-rocket boosters, all taking off at the same moment. Two minutes after launch the solid rockets drop off. A few moments before reaching orbit, the orbiter sheds the external tank. Then it fires up two secondary engines, called the orbital maneuvering system (OMS), which put it in revolution around the earth.

During its orbital flight and later descent, these OMS engines and 44 smaller thrusters placed strategically along the spacecraft enable the orbiter to turn over or to straighten up, to change orbits or to rendezvous and dock. They also make the precise adjustments needed to take the orbiter out of orbit, to bank and swerve it safely through the intense heat of reentry.

In April of 1978, when I first saw the orbiter *Columbia* taking shape, there was still hope that it would fly the next year. In its huge hangar at the Rockwell Corporation Facility in Palmdale, California, the *Columbia* looked much like any large aircraft under construction. Its green-coated shell sat amid scaffolding, with men by the score crawling around the sides and in and out of cavities in the fuselage. Men welding. Men wiring and inspecting. Men scratching and often shaking their heads.

All these wires would later be hidden, but at this stage the *Columbia* was like a body with its skin off and its nerve ends showing. This nervous system is one of the hallmarks of the orbiter.

Nothing as big as the *Columbia* has ever been put into orbit, and nothing with wings has ever flown anywhere near the 17,500 miles an hour the orbiter must encounter. It is, nevertheless, the orbiter's brains as much

as its brawn that make it the most ambitious flying machine ever built.

From nine minutes before lift-off until just before touchdown, the shuttle flight will be almost totally automated. During critical phases of flight the orbiter's computers will perform some 325,000 operations a second. These computers are ten times faster than those controlling the Apollo spacecraft, with six times the memory.

The shuttle's computer system is called "quad-redundant." Astronaut Deke Slayton explained: "There are four computers, with a fifth as a backup. The four main computers all process the same information. All have to agree. If one disagrees with the other three, it is turned off. If one of the remaining three changes its mind, the majority wins again. If the last two can't agree, the backup computer is turned on. It decides. It can't be wrong."

This redundancy eliminates the need for the scores of mission controllers who kept tab on all the Apollo spacecraft systems and made crucial decisions for the astronauts.

"With the shuttle we are talking about four ground controllers manning a flight versus hundreds on a full-blown Apollo mission," said flight controller Pete Frank at the Johnson Space Center in Houston.

Instead of ground control, shuttle astronauts will rely largely on three television displays in the cockpit (pages 320-21). Two TV screens provide data on trajectory and guidance control. The third handles the orbiter's electrical, environmental, hydraulic, and many other systems.

If something goes wrong—say a heater in a hydrogen tank malfunctions and the pressure of the liquid hydrogen fuel subsequently drops—astronauts will hear a warning tone in their headsets and see a master alarm light flash on. A control-panel light indicating hydrogen pressure also turns on. The astronauts can then use a computer keyboard to call up details of the problem.

"It's a convenience," says astronaut Vance Brand. "This vehicle is so complicated. There's far too much data to monitor continuously. This system frees us in orbit for work on our most immediate tasks."

"Office" With an Awesome View

Except for the three TV screens and some 1,400 switches and circuit breakers, the orbiter cockpit looks much like that of any transport plane. Directly behind the cockpit, though, is a small area with still more control boards and a spectacular view out over the long unpressurized cargo bay. Here work the mission specialists, the people who actually carry out the business of a particular flight. They will be able to watch as they raise the orbiter's big remote manipulator arm, pick up a satellite stored in the bay, and plunk it overboard.

(The astronaut corps will be broken into two groups. Pilots fly the machine up and

MICHAEL LAMTON AND JON SCHNEEBERGER

Radiating confidence, *"Columbia's" commander John W. Young, 50, far left—a veteran of four spaceflights during the Apollo program—and pilot Robert L. Crippen, 43, will be aboard for the first flight. Their job is not without peril. Consequently the jetliner-like flight deck will carry ejection seats.*

Beneath the flight deck lie cramped living quarters, which will include three bunks, one toilet, an oven, and storage for 74 different types of food.

back. Mission specialists run the show once in orbit. Later, a third category, the payload specialists, will be added. These will be outside experts: A solar physicist, for instance, may be brought along on a solar astronomy mission.)

The orbiter cabin has two levels. Neither is spacious. Climbing onto the flight deck and into a cockpit seat was a feat of contortion. However, my way was impeded by bulky pilot-ejection seats that will be removed after the shuttle demonstrates several times that it can launch safely.

Beneath the flight deck are the Spartan living quarters, which include three seats, a galley, a washroom, space for either upright sleeping hammocks or berths, stowage, and an airlock exit into the payload bay. About ten people could stand shoulder to shoulder in these living quarters. The decor could be called modern metal file cabinet. As the *Columbia*'s first commander, John Young, put it, "A seven-day mission with six people is going to be pretty austere."

The interior of the orbiter may not represent a breakthrough in comfort, but its exterior has certainly pushed technology. One overriding problem in designing a shuttle was how to keep the spacecraft from burning like a meteorite when it reenters the atmosphere. Parts of the orbiter will register temperatures higher than 2500°F.

Earlier spacecraft had chemical heat shields that absorbed the heat, charred, and flaked off. But a shuttle orbiter may have to reenter the atmosphere 100 times or more. It must have a reusable heat shield.

The solution was to cover much of the orbiter's aluminum skin with tiles made from fibers of 99.7 percent pure silica glass. When they are that pure, silica fibers conduct virtually no heat.

The Stuff to Keep Things Cool

Engineer Ed Law pulled a small glowing cube of this white, plastic-foamlike material from a 2500°F kiln at the Lockheed Missiles and Space Company's Sunnyvale, California, plant. It had taken more than 30 minutes for the furnace to heat the cube cherry hot. Law picked the cube up by its corners and handed it to me.

"Be careful to touch only the points of the corners," he said. "A Japanese newsman nearly lost his fingerprints doing this."

When I took the cube, just a mild warmth radiated into my palms. Three minutes later the cube's 1700° interior still glowed. Yet I could touch the cube anywhere on its surface. The heat very near the surface had escaped into the air. That trapped within would take hours to work its way out through the ultrapure silica fibers.

Conversely, the brief intense heat generated by reentry will not be able to get through the orbiter's tiles: 90 percent of it will be reradiated into the atmosphere.

Some 34,000 of these tiles, coated with a

Feigning zero gravity, *scientist astronauts clamber around the innards of a spacelab mock-up at Marshall Space Flight Center, Huntsville, Alabama. From left foreground are Europeans Ulf Merbold, Claude Nicollier, and Wubbo Ockels. Americans Michael Lampton and Byron Lichtenberg are at rear. One European and one American will staff the initial spacelab mission.*

For the first time, astronaut ranks include women. A total of eight are training at Houston.

tough reflective sealer, cover the underside and those other parts of the orbiter that will be subjected to severe reentry heating. They look like the pieces of a great black jigsaw puzzle (pages 324-5).

Designing and putting that jigsaw puzzle together has been painstaking. The tiles have varying shapes and thicknesses. Many of them have to curve with the contours of the orbiter. A computer tailors and cuts each tile, which is then attached to the orbiter by hand, using a space-age glue that everyone publicly expects—and privately prays—will hold through the rigors of flight. If just one tile from a critical part of the orbiter falls off, the entire spacecraft could be severely damaged.

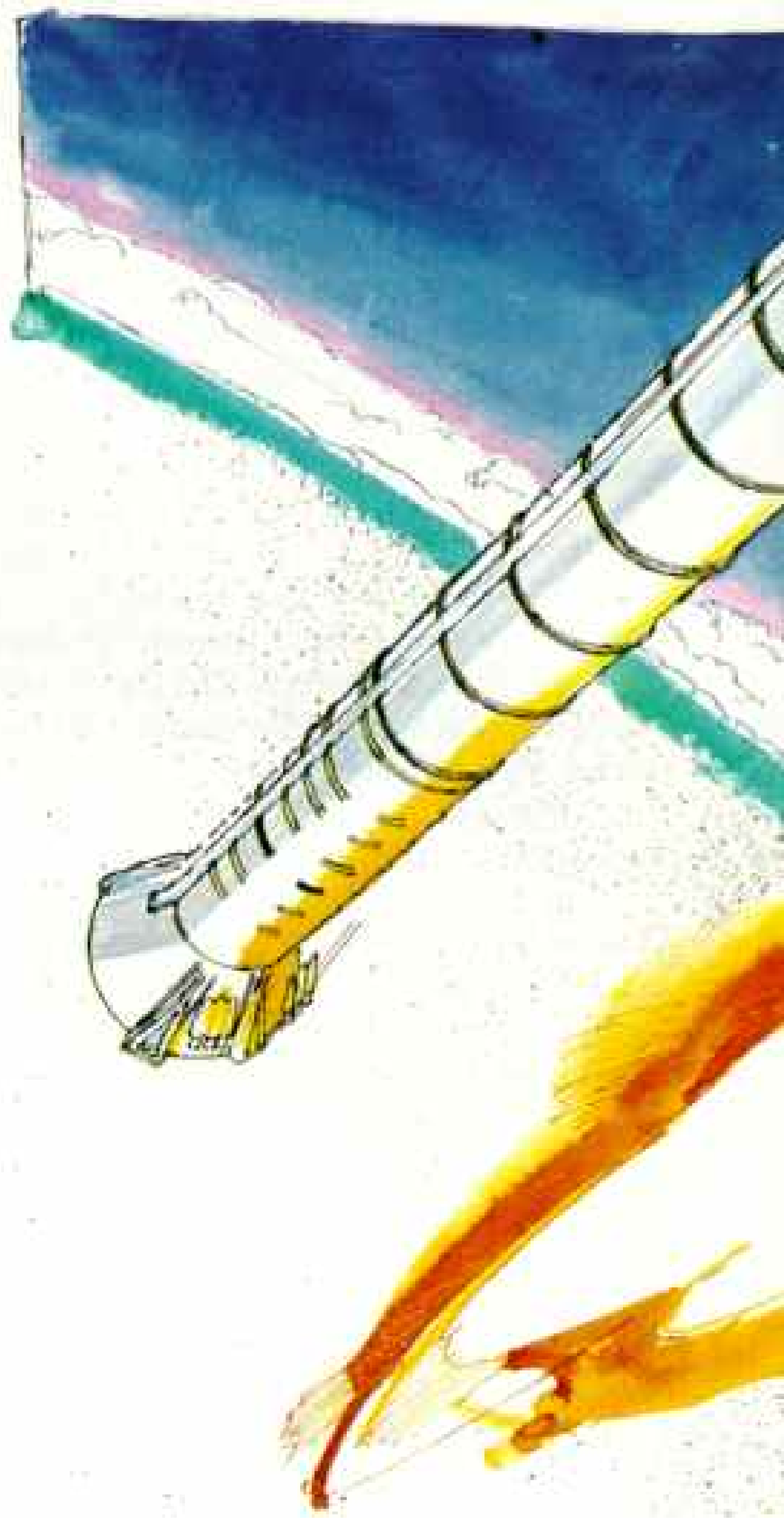
Rocket Engines: Nozzles and Pipes

The greatest challenge to the shuttle designers, however, has been the three big main engines on the orbiter. At full power these engines release as much energy as 23 Hoover Dams. Yet the engines weigh only 7,000 pounds each and, minus their nozzles, stand only five feet tall.

I am not sure what I expected to see at a factory that makes rocket-ship engines. Maybe lots of chrome and glitter. Certainly sparkling-clean assembly rooms. But a day at Rockwell's Rocketdyne plant in Los Angeles showed me that rocket making is a heavy, sometimes grimy, industry. It involves casting and welding thick chunks of metal, firing them in room-size furnaces, and dipping some of their components in great vats of electroplating chemicals. Under construction, these engines looked to me like glorified car motors with nozzles. Except for the intricate plumbing.

More than a thousand tiny tubes, for instance, run up and down the sides of the nozzles. During combustion these tubes siphon off the engine's frigid hydrogen fuel and use it to cool the nozzle enough to keep it from melting. More tubes then collect the hydrogen and feed it back to power two turbines that jump the pressures within the engine to nearly 700 times that of a typical household pressure cooker.

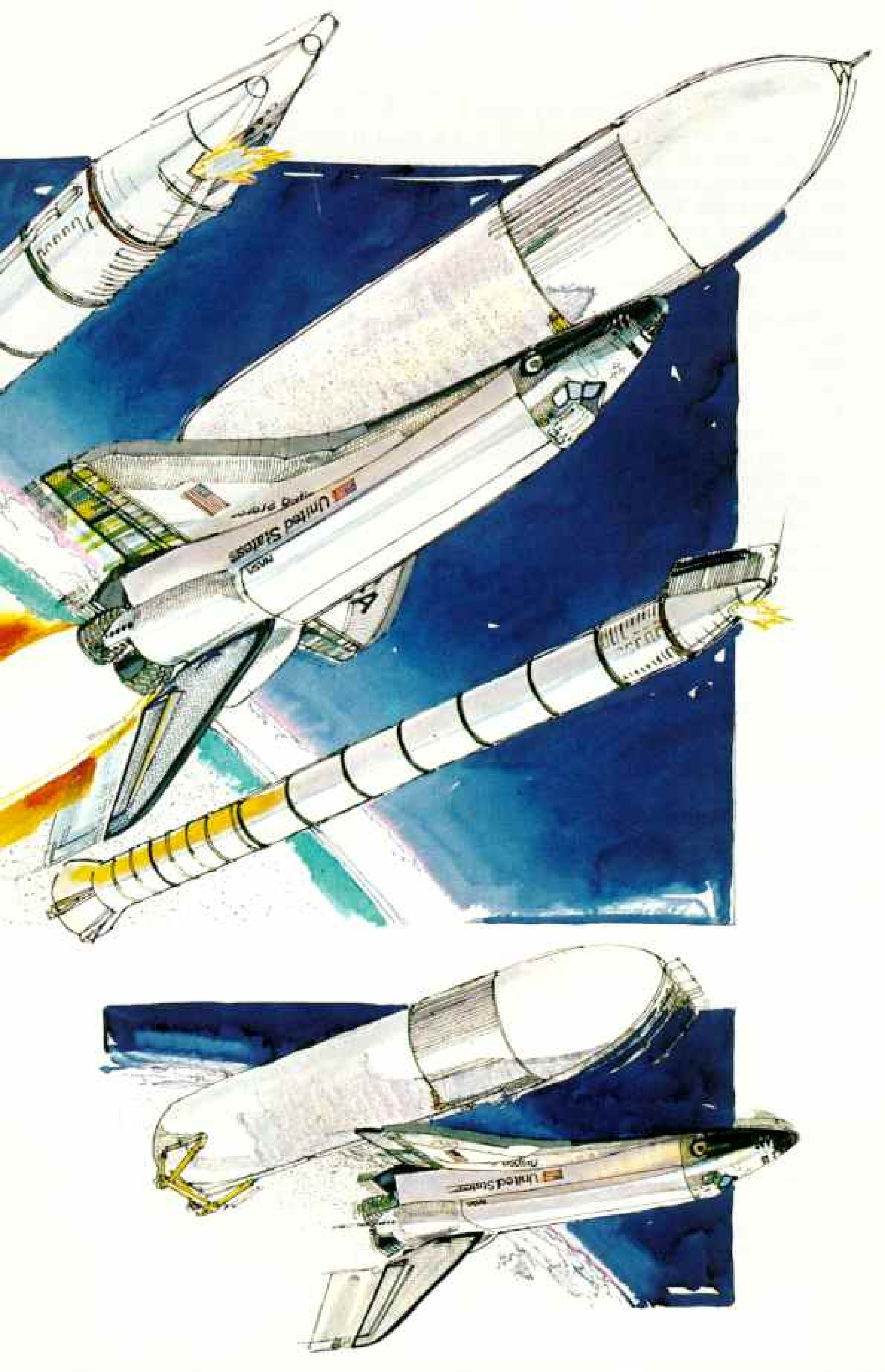
The engines need to burn hydrogen under those high pressures to get maximum thrust. Such pressures put unprecedented demands on rocket-engine technology. In test firings,



Rocketing into orbit

*LAUNCH PLUS two minutes. Fuel spent, the solid-rocket boosters are jettisoned 31 miles up (**above**). Explosive bolts pop the rockets free; small rocket motors then propel them outward.*

*About six minutes later at an altitude of 59 miles, the main engines are shut down and the external tank is jettisoned (**right**). Inverted flight facilitates separation. Smaller engines fire to maneuver "Columbia" into orbit.*


United States
United States

turbine blades have fluttered and cracked, bearings and rotating parts have broken down. Sometimes combustion has begun where nobody wanted it.

It has taken the Rocketdyne engineers about a year longer than anticipated to work out the problems. For a while the main engines received most of the blame for the shuttle's delays.

A Problem With Tiles

Then the thermal tiles proved much trickier to apply than expected. The *Columbia* had to be ferried from California atop a 747 with only a small number of its tiles in place. Enroute fake tiles, put on to protect parts of the craft from aerodynamic damage on the flight, fell off, ruining some of the real tiles. Later, thousands of tiles had to be removed and rebonded, giving the whole tile program an aura of fiasco. There were also delays in developing the computer programs that are used in the flight simulators that astronauts train in. That meant that even the astronauts could not have been ready on time.

One component that could have made the original date, however, is the huge external tank. "It's an 80,000-pound balloon," says one NASA engineer. "It's a big tin can," says another. Some tin can. The external tank is actually the backbone of the whole shuttle system. Both the solid rockets and the orbiter are bolted to it, and the overwhelming thrust these five engines produce at launch converges on the struts and beams of the external tank.

"In one spot the tank's shell may have to be membrane light and right next to it be able to withstand the equivalent of an enormous explosion," said Joseph Marcus of Martin Marietta, which runs NASA's Michoud assembly plant near New Orleans. "The tank also has to hold twenty times its weight in propellant, and keep it at hundreds of degrees below zero."

It takes more than half a mile of welds to put an external tank together. Once assembled, a tank is sprayed with foam insulation. Why insulate the tank? For one thing, the shuttle's odd shape will cause drag during its ascent, and parts of the tank will get quite hot. Since aluminum loses strength above 350°F, an unprotected tank might fall apart before it separates from the orbiter.

After separation the tank will reenter the atmosphere and disintegrate. Recovering it is not now economical, but eventually a small thruster, which would take the tank on into orbit, could be added. Bright aerospace-industry minds are dreaming up ways to use the discarded tanks. Perhaps several could be the core for a space station. Maybe the aluminum could be recovered to build ferries going from the shuttle's low earth orbit to construction sites higher up.

What happens for the time being when the external tank breaks up? The question is timely in light of NASA's problems with the falling debris from the dying Skylab.

"We target where the tank will land," says Porter Bridwell, one of NASA's external-tank program managers. "We have selected a site over the Indian Ocean at least 200 miles from land and with low density shipping. We have enough insulation to keep it intact down to 165,000 feet. The debris footprint will be 100 miles wide and 600 miles long."

How big will the pieces of this 80,000-pound balloon be?

"That's a good question," said Bridwell. "It's a magic art trying to predict that sort of thing. I just don't know."

Flight Transforms an Ugly Duckling

"I'm a test pilot, and this is the ultimate in test flying," Vance Brand, one of the eight astronauts being trained to fly the shuttle, said in his office at the Johnson Space Center. "I'm really excited about this vehicle. On the ground it may be stubby and look like an ugly duckling, but when it gets into the air, it's beautiful. It's a true air machine."

What will it be like to be in the cockpit of this ultimate flying machine? Brand and his seven colleagues helped me imagine being on space shuttle flight one.

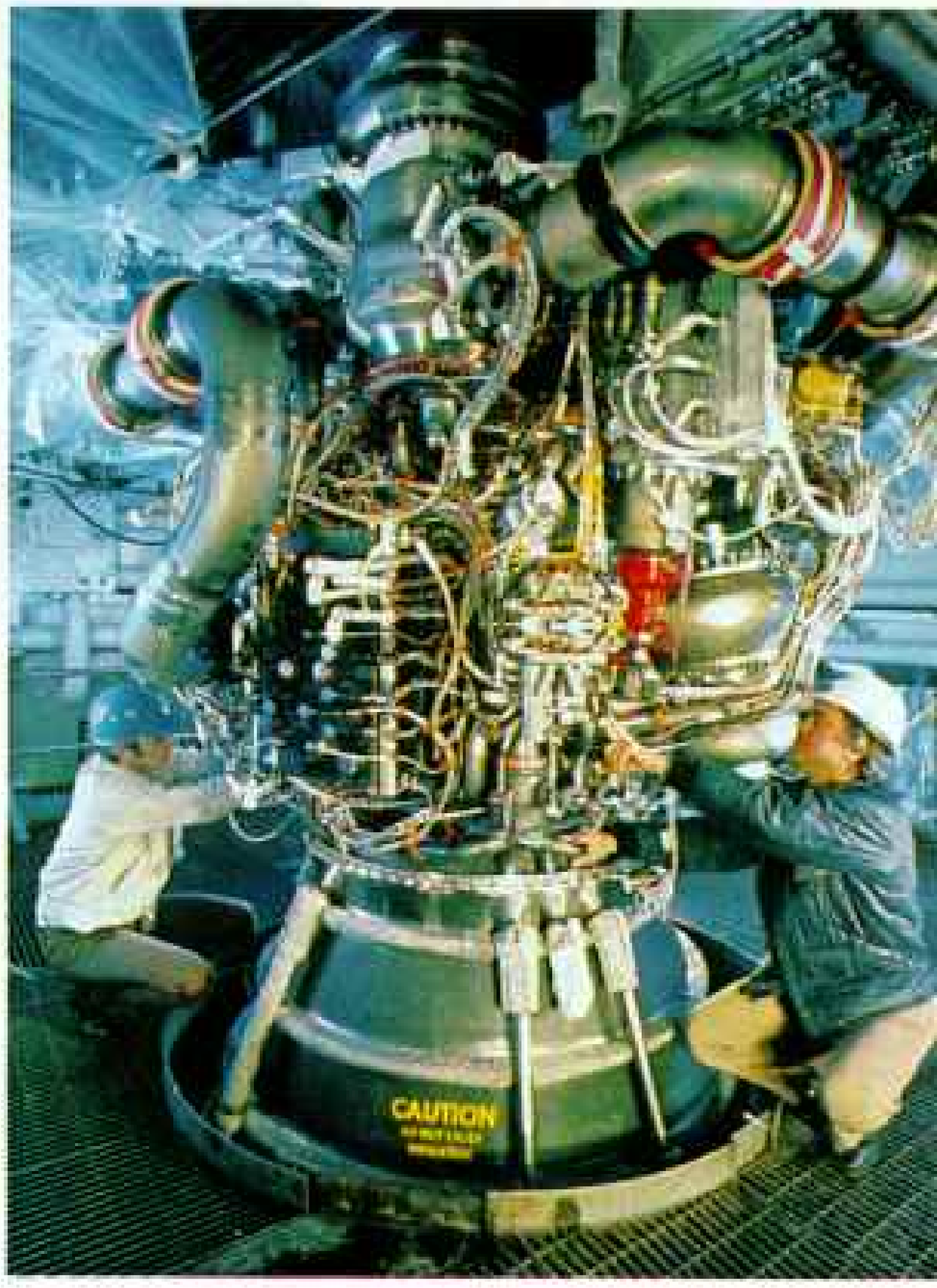
The feisty solid rockets make launch seem more like a lunge toward space. The astronauts are pressed hard against their seats, amid more roar and shaking than on any previous manned flight. Two rocky minutes after lift-off there is a bang and a lurch when explosive bolts blow the spent solid rockets away. Speed builds as fuel in the external tank is consumed and the shuttle lightens. Soon the computer pilots have to throttle back the engines to keep the orbiter from

An engine's growing pains

*HIGH-PERFORMANCE blend of complexity and sophistication, an orbiter's main engine (**center**) is rigged for a test firing at the National Space Technology Laboratories, Bay St. Louis, Mississippi. It is the most efficient rocket engine ever built.*

The development of such power put currently available materials to the test, and engine failures have played a significant role in the delay of the shuttle program.

*In Los Angeles a Rocketdyne engineer inspects tube alignment in the engine's main injector (**top**). Other engineers check impellers and rotors of a high-pressure fuel turbopump (**bottom**), whose shaft rotates at 35,000 rpm—twice that of a shaft in a conventional jet engine.*



exceeding the speeds its winged structure can withstand.

The astronauts are flying upside down now, riding the underside of the external tank. This will help the orbiter separate from the more massive tank with a minimum of thrust and of G-force discomfort. It also gives a stunning view of the blue, cloud-speckled earth. The sky has turned black. But there is little time to sightsee. All eyes must concentrate on the TV monitors that detail the health of the mission.

Suddenly the main engines shut off. Sixteen seconds later more explosives signal that the external tank has been separated. Excess fuel streams from the tank, and it spirals off. Now for a minute and three-quarters, while the tank moves safely away, the orbiter drifts. Astronaut Bob Crippen checks position, trajectory, and systems data to make sure the orbiter will indeed be able to reach orbit. (Otherwise, the crew could abort and fly once around the world and home onto a desert landing site in New Mexico.) Comdr. John Young then gives the autopilot the go-ahead. The OMS engines flare to life. One OMS burn takes the machine on up to orbital height. A second burn 35 minutes later makes its orbit circular.

Power to burn

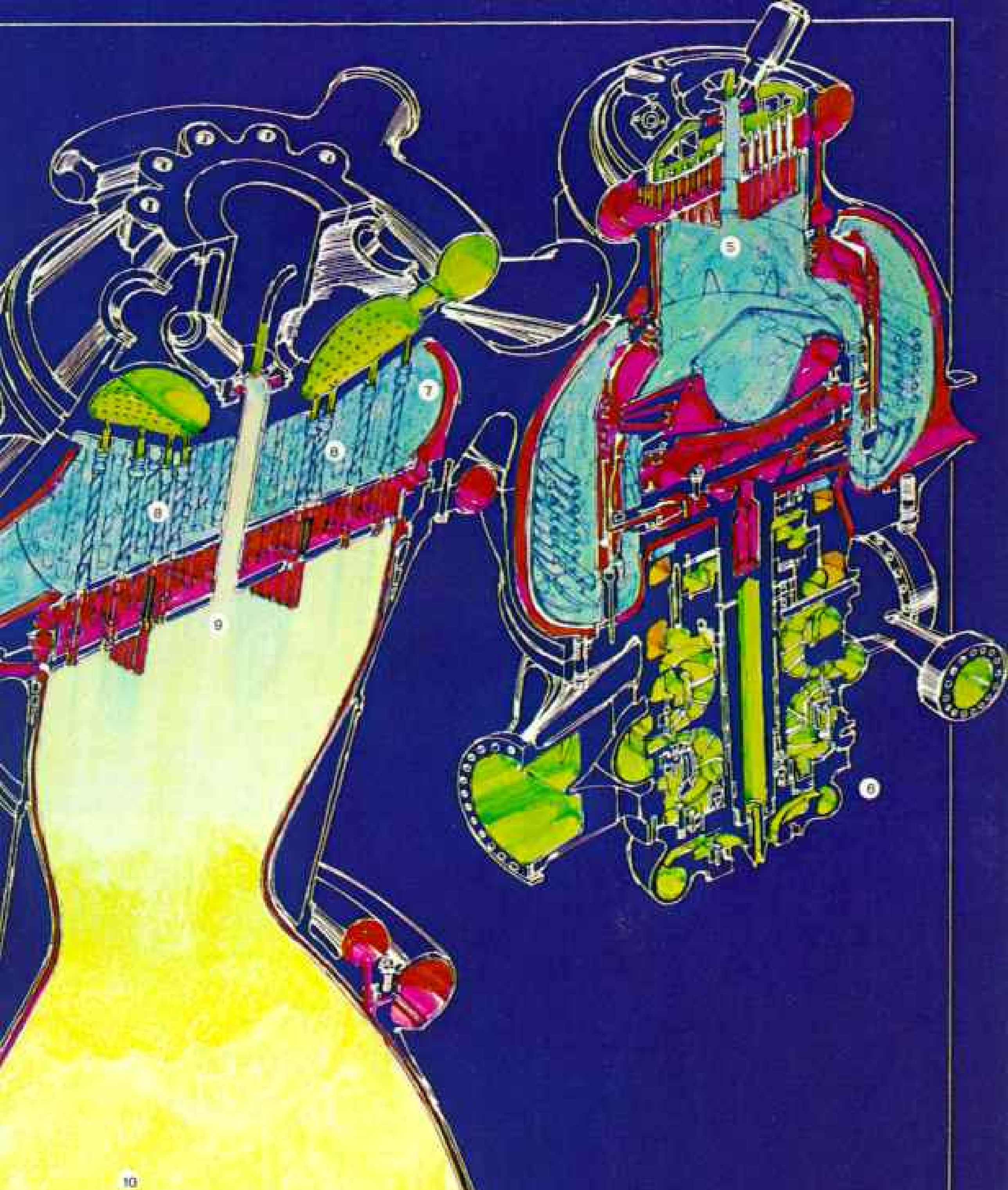
THUNDERING at launch for eight minutes, an orbiter's main engines generate more than enough power to light the state of New York. Their 12 fuel and oxygen turbopumps produce more than the horsepower needed to propel a battleship, with enough left over to drive seven nuclear submarines.

*A main engine (**right**) consists of a central rocket engine flanked by two smaller combustors that drive the turbopumps.*

*A spark igniter (**1**) flames a hydrogen-oxygen mixture in one combustor (**2**) to drive the turbines (**3**) and impellers (**4**) of the high-pressure hydrogen turbopump. Small as an oil drum but generating the power of 28 diesel locomotives, this pump compresses the hydrogen fuel to a pressure of 6,000 pounds per square inch.*

*Meanwhile, another combustor (**5**) powers the high-pressure oxygen turbopump (**6**). Exhaust gases from the combustors pass through manifolds (**7**) into the main injector (**8**), where tubes deliver the hot hydrogen gas and liquid oxygen to the main combustion chamber (**9**). Its temperature of 5500°F far exceeds the melting point of steel.*

*Liquid hydrogen at minus 423°F circulates in passages that surround the combustion chamber and main engine nozzle (**10**) to maintain metal temperature at a relatively cool 1000°F.*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World's strongest parachutes

HEAVIEST PARACHUTE PAYLOADS—80-ton solid-rocket boosters—return to earth for recovery and reuse, each borne by three enormous chutes (**left**) whose combined diameters exceed the length of a football field. Deployed at 6,600 feet with the rockets traveling at 225 miles an hour, the nylon chutes have many gaps (**above**) to cushion the shock of opening. After splashdown in the Atlantic Ocean, the rockets will float like buoys.

The main purpose of space shuttle flight one is to test out the spacecraft. So most of the next 55 hours in space will be spent making sure all systems are working. Almost immediately the crew will open the big silver doors of the cargo bay. "We keep the doors open for most of the flight," says Crippen. "Radiators inside the doors throw into space the considerable heat that builds up from all the electronics on board."

Later a critical test will be closing the doors again—a must if the crew wants to come home in one piece. The doors could warp from uneven solar heating. Their motors or the latches could fail. If difficulty arises, Crippen may have to don a space suit, go outside, and fix the problem.

On the second day in space the crew will rehearse their deorbit routine. Then they do it for real. Small reaction-control jets turn the orbiter around, engines first. Over the Indian Ocean, the OMS engines burn for two minutes to slow the orbiter slightly from its orbital speed, equivalent to about 25 times the speed of sound. The craft begins to drop and is turned nose up so that its tile-coated belly will absorb the reentry heat when it hits the atmosphere some 35 minutes later over Midway Island. By now the orbiter is banking and flying wide traverses to control its speed. The strain on the structure is tremendous, and NASA has only wind-tunnel data to say that the machine will not fall apart. Nevertheless, vouches astronaut Joe Engle, "We're going to be concentrating so hard there won't be time to be nervous."

Gradually the nose begins to drop. By the time it becomes visible from earth, the orbiter is diving ten times more steeply than a jetliner on its landing approach, and Commander Young is flying it manually. (The autopilot could let Young land with his hands folded, but NASA figures that a manned landing is safest for the first flight.) At about 1,800 feet over the Mojave Desert and a speed of 290 knots, Young lifts the nose and gently pulls out of the dive. At 270 knots he lowers the landing gear, and at 190 knots he touches down, puts on the brakes, and bounces to a stop on the wide-open dry lake bed at Edwards Air Force Base.

Four months later, *Columbia* will fly again. After four test flights, landing will be on the much narrower runway at Canaveral. The shuttle will be declared operational.

The bulk of the shuttle's work will have little to do with flying. So a person doesn't have to be a pilot to be an astronaut. Actually, in the future, "the best man for the job may be a woman." That's what the sign over Dr. Anna Fisher's desk in Houston reads. None of Dr. Fisher's new astronaut colleagues would bother to disagree. Initially, there was a lot of media attention, and some new space clothing had to be designed. Otherwise, neither Dr. Fisher, fellow physician Rhea Seddon, biochemist Shannon Lucid, electrical engineer Judith Resnik, physicist Sally Ride, geologist Kathryn Sullivan nor five more recently appointed women astronaut candidates have disrupted the previously masculine normalcy of Building Four, the astronaut headquarters at the Johnson Space Center.

Since 1978, 35 people have been added to the astronaut roster; 19 more are in training. These are divided into two groups: shuttle pilots and mission specialists—the people who will run the experiments and carry out the business of each shuttle flight.

When I visited Houston, the first 35 were in the middle of an intensive training program to gain background in fields as diverse as oceanography and solar physics. "It's been like taking a drink from a fire hose," said pilot Dan Brandenstein. "Like trying to absorb three years' worth of orbital mechanics in three hours." "It's an incredible experience," said Dr. George Nelson, a 30-year-old astronomer. "It's living out your fantasies."

Escape Hatches Are Portable

One of the early screening tests for the hundreds of astronaut applicants was a 15-minute stint in an inflatable canvas contraption called a "rescue ball." This tested for claustrophobia. If the shuttle has a problem in orbit that would keep it from coming home, each specialist could crawl into one of these balls. I tried it. It's like entering a collapsed pup tent. You sit cross-legged, zip yourself in, and inflate the ball. (Pilots have extravehicular space suits to escape in.)

Rescuers from a second shuttle would rendezvous with the disabled spacecraft, crawl through the hatch, pull the crew members out in their cocoons, and string each ball to a

tether. The pressurized balls have enough oxygen to keep their guests alive for three hours. But what if rescuers flubbed, or the ball came untethered? It would be quite a view through the peephole, as one drifted off to become a human satellite in a pod.

Bob Everline, one of the men in Houston who decide how to utilize the shuttle, says the first 40-some flights are sold out. "Through 1986 there's very little space left."

The first shuttle payload will be a series of environmental and earth-resources experiments on flight two. One experiment will evaluate whether orbiting radar can be used to make geological maps good enough for oil and mineral exploration. Another will measure ocean color, as a means of locating plankton or good fishing grounds. Other equipment will measure man-made carbon monoxide pollution in the atmosphere and study the structure of lightning from above.

Although flight four will carry up either a science pallet or a military satellite, the main business of the first four flights will be checking out the spacecraft.

Most of the satellites the shuttle carries up will be deployed with a spring, or if they must go to higher orbits, with secondary rockets called upper stages. A few satellites will simply be picked up and dropped overboard by the remote manipulator system (RMS), that skinny 50-foot-long arm with a clever claw. However, the arm's most important chore will be retrieving payloads from space. The shuttle will pull up within 35 feet of an object, the claw will grab it, and the arm will haul it in.

"Learning to use the RMS could be a career in itself," says astronaut Gordon Fullerton. "It's got a bunch of joints—shoulder, elbow, wrist, and grabber. All have to be coordinated. You operate it with two hand controls. It takes a lot of practice. You could bash a hole in your spacecraft with it, so you don't flail it around indiscriminately."

The arm will be tested on flight two, and one of its early assignments will come in October 1984, when it deploys—and about a year later retrieves—LDEF, the long-duration exposure facility. LDEF is a big, free-flying space ark with a menagerie of experiments and materials that scientists want to expose for long periods to the uncertainties of space. These materials range from novel composites that could be used in space construction in the 1990s, if they prove space-hardy, to substances that catch cosmic-ray particles and micrometeorites or that absorb interstellar gases.

LDEF experimenters will also send up spores and seeds, bring them back, and grow them to see, for one thing, whether future space agriculture might encounter unusual rates of mutation.

On the mission that carries up LDEF, the shuttle will also retrieve the solar maximum mission, a satellite that has been focusing telescopes and other instruments on the sun's surface during a period of maximum sunspot activity. This orbiting observatory will be the first to monitor solar flares outside the blurring, obscuring atmosphere.

A Chance to See Farther Into Space

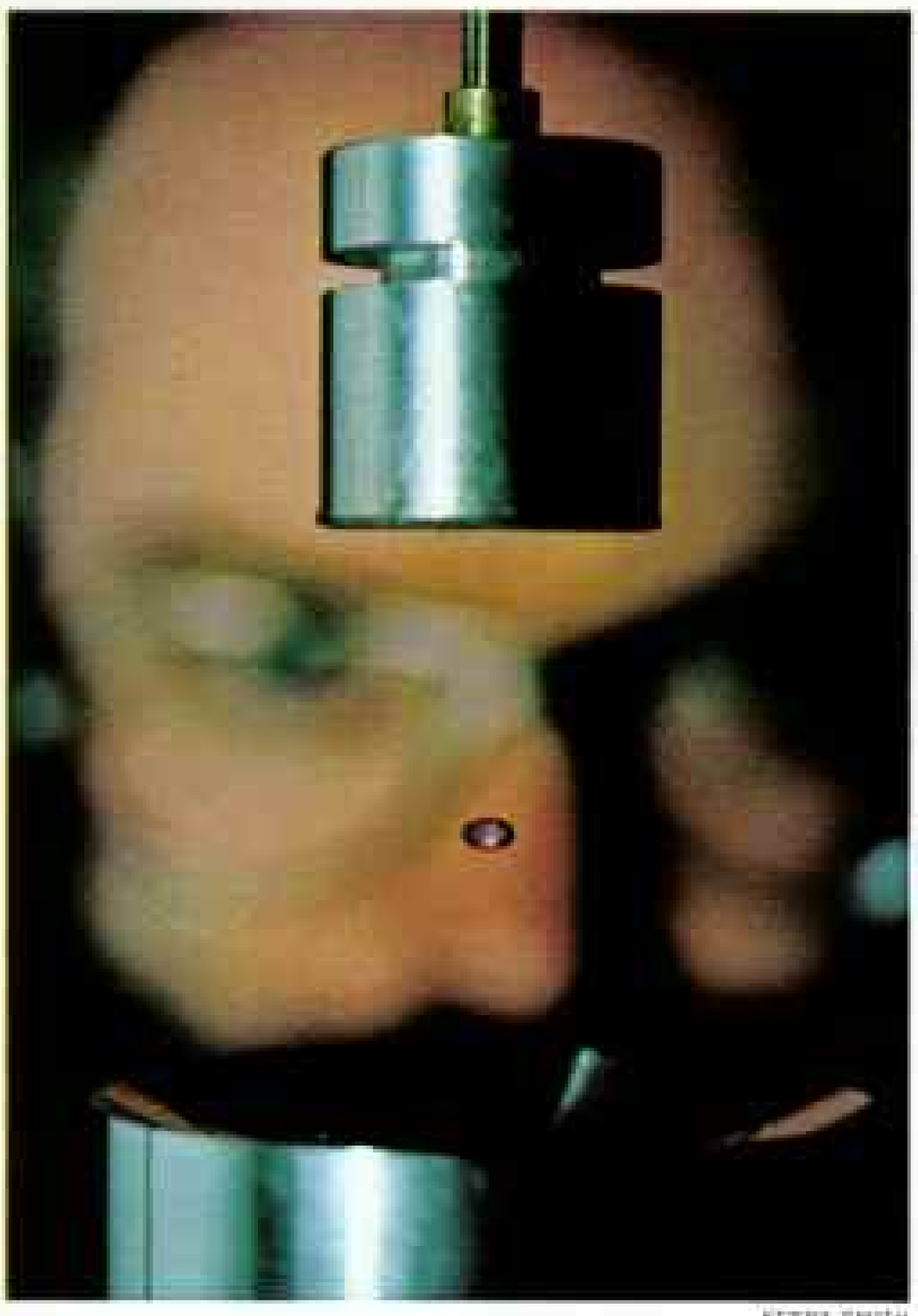
The atmosphere, which dims incoming light and makes the stars twinkle, has long frustrated astronomers. They are overjoyed with the new vision the space shuttle promises. In 1985 the shuttle will deploy the 45-foot-long space telescope, which will train five astronomical instruments on tantalizing regions of the universe. The space telescope will detect objects 50 times fainter than those seen by the best earthbound instruments. We will be able to see seven times deeper into space, and look at up to 350 times the volume of universe now visible.

Our knowledge of the universe should take off like a solid rocket as we zoom in on mysterious objects such as quasars and pulsars and locate black holes and perhaps the borders of the universe itself.

The shuttle will also take up infrared-measuring instruments that will study dense dust regions 17 trillion miles and farther away, where new suns may be forming. X-ray emissions from white dwarfs, black holes, and other collapsed stars across the universe will be detected much more easily. In one year of observation, astronomers expect to discover more than a million new sources of intense X-ray emissions.

The cream of the shuttle's scientific payloads, however, is called spacelab, which, when it flies, basically turns the cavernous payload bay of the orbiter into an all-purpose laboratory. Spacelab features a 23-foot-long habitable module, where people

can work in shirt sleeves. Spacelab also has five ten-foot-long pallets, which attach outside the module and carry experiments that can or should be exposed to open space. The module and all five pallets cannot fit all together in the orbiter bay, but spacelab is flexible. Depending on the mission, NASA can break the module in two and fly half of it with varying numbers of pallets. Spacelab will stay in the orbiter bay throughout its mission, which will typically be seven days.



KENNY SMITH

Defying gravity's tug, *high-intensity sound waves suspend a water droplet to simulate the reduced gravity of space. The technique could be used to confine molten materials for processing aloft without contamination—a sort of furnace without walls.*

Spacelab brings the first European accents to the U. S. manned space program. It was built by a consortium of companies in member countries of the fledgling European Space Agency. Moreover, a German, a Dutch, and a Swiss scientist are being trained as astronauts.

"Spacelab is very well known now in Germany, very popular," said a spokesman for ERNO, a West German firm that assembled the system. "We in Europe are convinced that space is going to be a good business."

Many of spacelab's experiments will focus on understanding earth's atmosphere and remote-sensing its environment. But the Germans are most intrigued by the prospect of using the nearly zero gravity of space to manufacture materials that cannot be made on earth. These include purer crystals for electronics components—and hence faster, smaller computers—along with better drugs and unheard-of alloys of metals that simply will not mix on earth. And so, among its trove of laboratory equipment, spacelab will have many furnaces for materials processing and incubators for biological experiments.

Rivals for the Northern Lights

There is disagreement and often pessimism in this country about the prospects for industrializing space, but the attitude I picked up in Europe was that zero gravity is such an unusual environment that it would be highly abnormal if the unexpected—and potentially very profitable—did not occur there.

Spacelab's most spectacular piece of equipment is being developed in Japan, another country that is eager to glean some of NASA's space know-how.

"We are going to send up a very big electron accelerator," explained Professor Tatsuzo Obayashi in Tokyo. "In one experiment we will eject some plasma gas into space and shoot a beam of electrons into it. We hope to produce artificial auroras borealis—perhaps over Tokyo or Washington."

A careful eye would be able to detect these auroras, which would be several miles long and sixty miles high. Spacelab sensors will see them in detail. The data they record will help verify our theories about how discharges of electrons from the magnetosphere cause natural auroras. Other spacelab accelerator experiments are basic physics: How do charged gases called plasmas and electron streams interact? The sun is a giant electron source, and the upper atmosphere is rich in plasmas. Spacelab experiments could help us understand how the sun's cycles affect our long-term climate.

Spacelab does have its drawbacks. A single spacelab flight costs 26 million dollars.

A superscope to eye the cosmos

*HIGH-FLYING maintenance man, an astronaut tethered to an orbiter climbs aboard a space telescope (**below**). The event, photographed in miniature at a California movie studio, is not likely to happen before 1986. But space-suited orbiter crew members at NASA's Huntsville facility practice the task underwater (**right**), to experience the weightlessness of space.*

Above the turbulence and haze that hamper terrestrial telescopes, the telescope—most powerful ever built for use in space—will increase man's view of the cosmos 350-fold, perhaps to the fringe of the visible universe to reveal the birth pangs of the first galaxies.

KERBY SMITH AND BRUCE PRICE (ABOVE); KERBY SMITH (RIGHT)

For rescue, have a ball

HUDDLED *like a yogi in a protective ball, an astronaut is rescued (***left***) from a disabled orbiter and carried by a space-suited astronaut to a sister ship. Astronaut Rhea Seddon, M.D., demonstrates the technique (***bottom***) in a mock-up of the "rescue ball" in Houston.*

Though a 15-minute confinement in the ball is one of the tests for prospective astronauts, NASA is still refining details of construction and procedure.

The ball will likely have three layers. From inside out: leakproof urethane-coated nylon, expansion-resistant polyester, and an insulating material to cope with temperatures from minus 160° to plus 250°F.

The rescuer wears a spacesuit and backpacks designed for extravehicular activity, including maneuvering in space. His left hand controls jets of compressed nitrogen at the corners of the backpack for propulsion.

RHEA SEDDON, M.D.

And so, for those who cannot afford this price tag, NASA administrator John Yardley came up with a low-cost alternative—the getaway special.

A getaway special is simply a canister, which can range from two and a half to ten cubic feet, and which NASA will fly standby when it has space available. Whatever is in the canister must take care of itself, with its own microprocessors, batteries, and controls. The shuttle crew will only flip a switch to turn the experiments on or off.

The getaway special is the obsession and almost a second career for an irrepressible Ogden, Utah, engineer named Gil Moore. Moore practically bounds around the country promoting the specials, pursuing civic groups, school boards, businesses—anyone who can raise the $3,000 to $10,000 getaway fare in order to give some kids in their town the chance to put an idea into space. So far more than 300 specials have been reserved.

From Solar Sails to Weightless Farms

Moore introduced me to dozens of students in northern Utah working on getaway projects. I heard a deluge of ideas. University of Utah students are planning to send up a solar sail, a membrane that would catch photons from the sun as a means of propelling a spacecraft. They were displeased that NASA had abandoned solar-sail research and want to demonstrate its feasibility.

Others want to determine whether spores or primitive bacteria can withstand cosmic rays. If so, perhaps life on earth could have been seeded from elsewhere. One high-school student has decided to try to make a light foam form of metals that might be used in space construction. Another simply wants to melt solders and see how they re-form in zero gravity. Several young biologists plan to see how duckweed and chlorella, rapidly reproducing primitive plants that have been discussed as future space foods, grow without gravity.

"I wouldn't be at all surprised if some of these kids came up with some important results," said Utah State professor Rex Megill. "They don't have the constraints of conventionality or peer review."

President Anwar Sadat has reserved four getaway specials for Egyptian students. The Japanese newspaper *Asahi Shimbun* ran a contest to solicit ideas for its special. In six weeks it received 17,000 suggestions.

Many businesses, too, look at the canisters as a cheap and secretive way to test out space-manufacturing concepts.

NASA, however, does have two regular first-class passengers. One is the communications industry. Even at 40 million dollars a launch, the space agency can hardly send satellites up fast enough to meet the booming worldwide telecommunications demand. The space shuttle should be able to put four satellites in orbit for the current price of one.

Building a New World in Earth Orbit

Not too far down the road are huge telecommunications platforms that would actually be constructed in space. These platforms would be able to carry 250,000 simultaneous telephone calls. On earth special receivers will let viewers tune in almost any TV station in the world. Platforms may make video phone calls commonplace.

Communications revenues from these platforms could run 40 to 80 billion dollars annually by the year 2010. Plans for building the huge structures are well under way.

At Rockwell International I saw ball-and-socket joints that will let remote manipulator arms snap the struts of a space structure together like poppet beads. General Dynamics engineers showed me an antenna that astronauts could unfurl in space as if they were springing open an automatic umbrella. McDonnell Douglas would like to have the platforms assembled by workers in shuttle-borne cherry pickers.

General Dynamics and Grumman are testing prototype machines that extrude triangular beams that can be space-welded into massive shapes. "I can produce a single beam 14 miles long if I want," said General Dynamics' Jack Hurt. These aluminum or composite beams are so light I could crinkle them in my hand. Yet in space they could support the weight of an aircraft carrier.

The Air Force is NASA's other regular customer. A separate shuttle launch facility is being constructed at Vandenberg Air Force Base in California, and a top-security flight-control center for exclusive military use has already been set up in Houston.

The military is the main driver right now

DE-ORBIT BURN
As "Columbia" travels backward and upside down at 15,200 knots, pilots fire the maneuvering engines to nudge the craft from a 150-mile-high orbit. Thrusters jockey the vehicle to a nose-high attitude for entry.

NASA (BOTH)

With a svelte tail cone *mounted to reduce aerodynamic drag, a test orbiter banks* ***(above)*** *during initial landing trials in late 1977 at NASA's Dryden Flight Research Center in California. Later the cone was removed to expose the engines to simulate an approach after reentry from space* ***(right)****. Here drag takes effect, and the orbiter descends at around 15,000 feet a minute—20 times faster than a jetliner. The rudder splits open to serve as a speed brake.*

Flight computers will control "Columbia" from reentry to the approach, when the crew will take over for a manual landing. Though automatic landings may later become routine, the crew will still have to lower the landing gear and man the brakes.

REENTRY
Heat from atmospheric friction turns "Columbia's" belly a bright orange. Angled 40 degrees to the airflow at an altitude of 50 miles, the vehicle banks to maintain course to the landing site.

APPROACH AND LANDING
Crossing over the dry lake bed runway at NASA Dryden at 52,000 feet and 650 knots, "Columbia" begins a left-hand approach and touches down at approximately 190 knots.

for advanced—and mostly top-secret—space programs. They will put into geosynchronous, or stationary, orbit 23,000 miles high, extremely sophisticated surveillance satellites, including antennas up to a thousand feet in diameter. They would also like to begin doing assembly work in low earth orbit by 1985—on what we do not know. By the early 1990s they will probably need a transfer vehicle to take men from the shuttle's orbit to the ultrahigh geosynchronous levels to assemble or service their equipment.

The Russians reportedly are also building a shuttle-type vehicle, one smaller than ours. They are establishing permanent space stations, and have been working on killer satellites that could destroy enemy spacecraft. With so much of the world's military and commercial communications going into orbit, space is a logical war front in the future.

Some Earthbound Hazards

Many shuttle advocates are worried that the system will be overly dominated by the military. However, there are other clouds in the space shuttle's future. One is pollution. At 50 flights a year, emissions from the solid rockets could decrease the ozone layer by as much as .25 percent, letting slightly more ultraviolet radiation reach earth. NASA claims the effects will be insignificant, and that later versions of the space shuttle

Flanked by two chase planes, the test orbiter "Enterprise" lands in a cloud

in the 1990s may well be pollution free.

Between the telecommunications industry and the military, NASA now foresees no trouble keeping all four orbiters, and a fifth one it hopes to build, busy indefinitely. In fact, it will most likely turn the management of the shuttle over to private industry in a few years.

The space program, however, is more than communications and military satellites. NASA's science payloads are just not getting much money any more. That means spacelab's future is unclear. Sadly, there are few new planetary missions planned. The agency does not even have the funds to fly a once-in-our-lifetime rendezvous with Halley's Comet in 1986.

Just where we are going in space and how fast will depend on NASA's budget. That depends in turn on politics and the national will. Perhaps if the Soviet Union does, indeed, develop a killer satellite, it will spur us more rapidly into space, just as Sputnik did two decades ago. The odds are that the shuttle era will evolve more gradually and that as profitable uses are demonstrated private enterprise will come in with capital.

In ten years the current shuttle surely will seem outdated. In 50 years we will probably look back on it as we do the covered wagons that took us to our first frontier. To me the real importance of the shuttle is that it is maintaining a frontier for us. This country cannot grow without one. □

of dust on the dry lake bed at NASA's Dryden Center.

Following the tracks of a different man

Thoreau

By WILLIAM HOWARTH

Photographs by FARRELL GREHAN

"*No truer American existed than Thoreau,*" *wrote his friend Ralph Waldo Emerson. Today readers the world over admire this Yankee for his tough-minded ideas and witty, eloquent prose. Born in Concord, Massachusetts, in 1817, Henry David Thoreau celebrated in his writings the virtues of a simple, independent life, every deed guided by strong convictions:* "*Rather than love, than money, than fame, give me truth.*"

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FIRST HE SAW TRACKS, curving gracefully across a snow-covered pond. Then he saw the fox. It moved slowly till he gave chase, then bounded over the drifts with a soft, catlike motion, as if it had no backbone. That night, January 30, 1841, he wrote in his *Journal:* "I tread in the tracks of the fox which has gone before me . . . with such a tiptoe of expectation as if I were on the trail of the Spirit itself which resides in these woods, and expected soon to catch it in its lair. . . .

"I know which way a mind wended this morning, what horizon it faced, by the setting of these tracks; whether it moved slowly or rapidly, by the greater or less intervals and distinctness, for the swiftest step leaves yet a lasting trace."

For years I have followed the tracks of Henry David Thoreau (1817-1862), the American writer and naturalist, looking for a trail to his ultimate lair. As a scholar I have studied his books, traced manuscripts in remote libraries, helped to launch a new Thoreau edition at Princeton University.

But as a tracker I have also sought what books and libraries could not supply: to see the world Thoreau described, to plot its boundaries, a map where I might glimpse the farther horizons of his mind and spirit.

A few years ago I lived in his hometown of Concord, Massachusetts, and explored its four quarters on foot or by canoe. Recently I returned to Concord and then followed his travels in North America, going north to Canada and Maine, east to Cape Cod, and west to the prairies of Illinois and Minnesota.

Some readers of *Walden*, Thoreau's most famous book, think of him as a hermit, a solitary crank who hated society and never strayed from his backyard. Others, remembering his essay "Civil Disobedience," see him as a radical dissenter, the man

A man thinking or working is always alone,

National Geographic, March 1981

let him be where he will.

Dawn and a light rain greet a visitor to Walden Pond. Here in Concord Thoreau built a house and lived alone for two years (1845-1847), absorbing the lessons of peace and solitude.

who went to jail (though only for a night) for refusing to pay his poll tax, as a protest against slavery and the Mexican War.

But the tracks I have followed were left by a different man. One of America's first backpacking tourists, he traveled widely and wrote several books, all expressing a firm social ethic: "In Wildness is the preservation of the World."

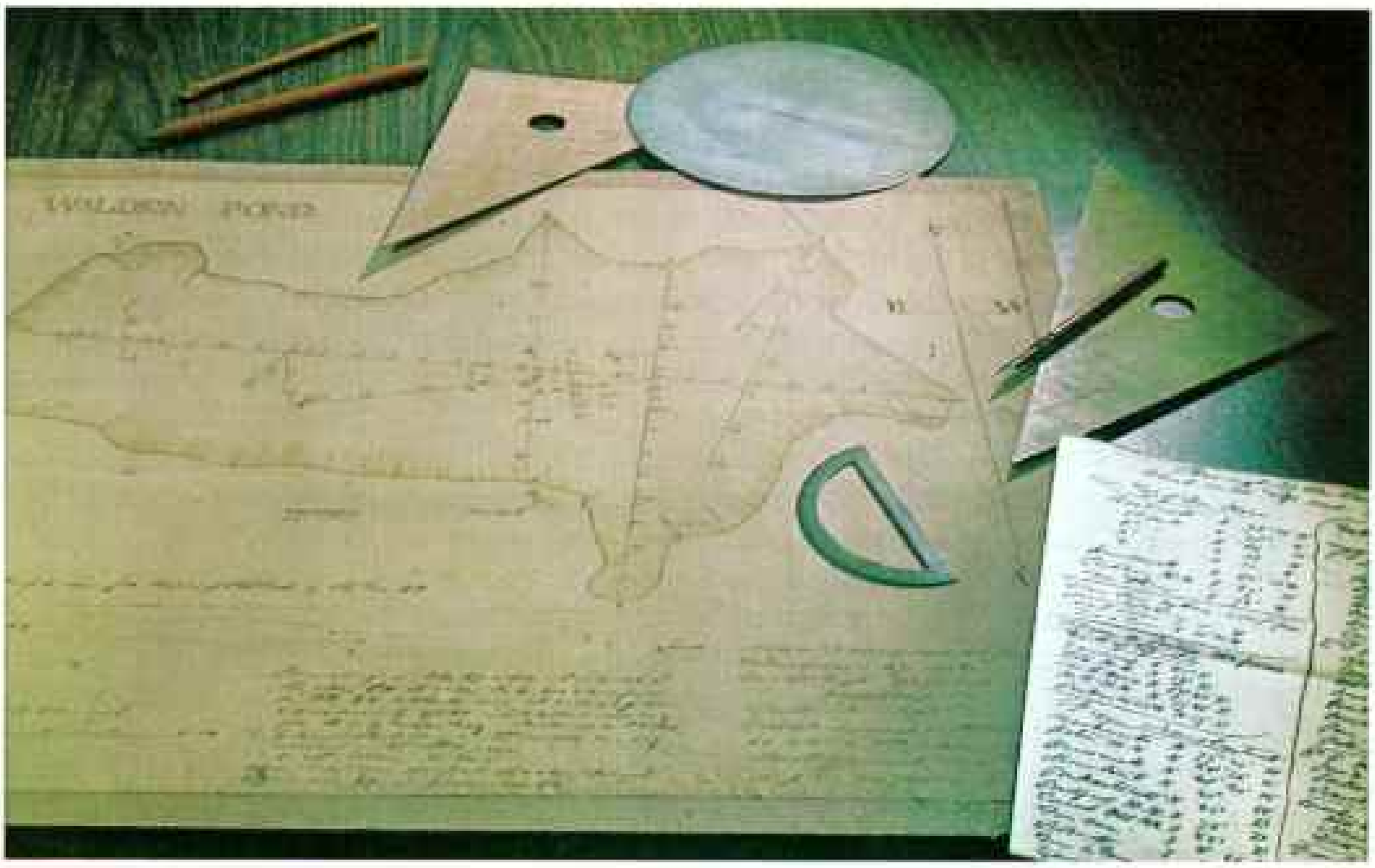
He called himself "a mystic, a transcendentalist, and a natural philosopher to boot," which meant he was a visionary who saw God in both man and nature, who believed that the earth and our minds are ever intertwined. One fellow transcendentalist was uneasy with Thoreau's tendency to act out his ideas. Ralph Waldo Emerson at first said going to jail was "in bad taste," but then soon praised his friend's integrity.

Thoreau rarely kept pace with his companions, for he heard the beat of a different drummer. After graduating from Harvard, he taught school in his early years, but his ambition was to become a professional writer. In this pursuit he chose to live an unconventional solitary life. He never married, never held a steady job. Mostly he boarded at home and helped in his father's graphite business. Because his writings earned little money, he supported himself with various skilled trades, chiefly surveying.

He was also a surveyor of forest paths, an inspector of snowstorms who spent his days listening to the wind, toeing a line between "two eternities, the past and future." His books toe that line as well. Today as I walk

A man of many talents *but few possessions, Thoreau helped his family make and sell pencils* ***(below)****; later he became a professional surveyor. With this trade he supported himself—and earned the free time for his true vocation, writing. Surveying tools and notes* ***(bottom)*** *frame his original map of Walden Pond, drawn in 1846. In a replica of the Walden house* ***(left)****, author Howarth attends to Thoreau's words: "I was rich, if not in money, in sunny hours and summer days, and spent them lavishly."*

NATIONAL GEOGRAPHIC PHOTOGRAPHER VICTOR R. BOSWELL, JR. (ABOVE AND BELOW)



in their landscapes, real and imaginary, I can still see the setting of his tracks.

South of Concord lies Walden Pond, a "deep green well" of 61 acres, with an irregular shoreline of coves and sandy beaches. Thoreau's earliest memories were of this pond, which he came to see as a mysterious place "made deep and pure for a symbol."

In 1845 he built a small house on its shore and lived there alone for two years. At Walden he wrote early versions of the only two books published during his life, *A Week on the Concord and Merrimack Rivers* (1849) and his masterpiece, *Walden* (1854).

Every aspect of Walden's scenery represented to him the human soul, that invisible presence men have called spirit, self, or personality. The pond was life eternal, "a perennial spring" forever brimming with fresh water from its hidden bottom. Like the soul, Walden had no "visible inlet or outlet except by the clouds and evaporation." Like man, it lay between earth and the heavens, reflecting their blue and green colors. The water was transparent, giving "an alabaster whiteness" to the body of a bather.

MOST VISITORS to Walden Pond today are bathers, and they do not come here seeking a holy place. On a hot Sunday 25,000 souls will jam the public beach, which stretches along the eastern shore. Swimming is restricted to this area, but people often spill over into Thoreau's cove on the northwest shore.

My companion at Walden Pond is Roland Robbins, the pick-and-shovel historian who excavated Thoreau's house site in 1945-46. We walk along the shoreline path, an ancient Indian footway that Thoreau said was "unwittingly trodden" by his contemporaries. Here and there are the unwitting effects of ours: eroded banks shored up by timbers, trees stripped of bark or snapped in two, broken glass and frequent traces of dog.

No house stands at Thoreau's cove, only some posts and chains that outline a 10-by-15-foot site. Nearby is a memorial, a pile of stones that slowly rises and falls like the pond's water level. Some pilgrims bring rocks to this cairn; others cart them away as souvenirs. Thieves have twice stolen a bronze plaque from the cairn.

Thoreau made his house plain and simple for a reason. His book describes how a troubled man, weary of village life and its "quiet desperation," found peace of mind by retiring to the pond and reducing his life to the minimum requirements of food, clothing, fuel, and shelter.

Building a house was his answer to the false economy of villagers, who wasted their lives getting a living but never learned how to live. Poverty was more efficient, for it liberated him from material burdens: "I would rather sit on a pumpkin and have it all to myself, than be crowded on a velvet cushion."

He built on a hillside, designing his house to take the sun: windows east and west, doorway at the south, a fireplace on the shaded north wall. Outside he built a woodshed and fire pit. And somewhere, a privy—which Roland Robbins has never located.

Thoreau took occupancy on July 4, 1845—Independence Day. He had built his house not as a hermitage but as a cheap, quiet place to live and write. The cost was $28.12½, or less than a year's rent in town, but he borrowed land and tools from friends, who also helped raise the main timbers. Later they often exchanged visits at one another's homes: "We belong to the community."

Two miles east of Walden, Roland Robbins has built a replica of Thoreau's house, open to visitors by appointment. The design follows Thoreau's specifications: post-and-beam frame, hand-hewn timbers, feather-edged boards, and square-headed nails throughout. Plastered and shingled from top to bottom, the house is cool in summer, easily heated in winter.

I can sense how well this place suits a writer's needs. The only sounds are complementary—rain dripping from leaves, a bird call in the forest. At Walden, Thoreau's main distractions were sunlight and chipmunks; he could think and work at his pace.

He went to the woods "to live deliberately. . . . to drive life into a corner, and reduce it to its lowest terms." The replica's furniture measures his purpose: a slant-top writing desk, a low cot, a table, and three chairs—"one for solitude, two for friendship, three for society."

His house required little care. He refused the gift of a doormat, rather than spare the time to shake it. "Our life is frittered away by

detail." Before leaving the replica and its furnishings, I take a broom and sweep the entire floor. Reaching into every corner, I am done—in two minutes flat.

AS THE SEASONS passed at Walden, Thoreau found in this pond a silent mentor. Villagers claimed it was bottomless, but he thought of the surface as a mirror: "It is earth's eye; looking into which the beholder measures the depth of his own nature." Winter brought the chance to measure the pond's depth, for he could stand on the ice and take exact soundings with a line and stone.

Of course Walden had a bottom, 102 feet deep, but in drawing a survey map, Thoreau discovered that two lines, connecting the points of greatest length and breadth, crossed exactly at the pond's greatest depth. On the surface Walden looked irregular and shapeless, but at its bottom lay hidden principles of symmetry and order. The same must be true of a man's character: "Perhaps we need only to know how his shores trend and his adjacent country or circumstances, to infer his depth and concealed bottom."

Thoreau finally left the pond because he had "more lives to live, and could not spare any more time for that one." He returned to Concord, carrying a message to his fellow countrymen: ". . . be a Columbus to whole new continents and worlds within you. . . . explore the private sea, the Atlantic and Pacific Ocean of one's being alone."

When I explore in Concord, three guides go with me: Thoreau's *Journal* (1837-61) and two modern Concordians, Mary Fenn and her daughter, Mary Gail, who have made a hobby of following Thoreau's trails in and around the town. As a surveyor Thoreau came to know Concord intimately, and he recorded this long courtship in 47 notebook volumes: "I have never got over my surprise that I should have been born into the most estimable place in all the world, and in the very nick of time, too."

The two Mary Fenns agree with me that the *Journal* may be Thoreau's greatest book. In its two million words he wrote about his daily tours of inspection, the afternoons—and sometimes nights—he went along the rivers or through the woods to odd corners of

VICTOR R. BOSWELL, JR.; CONCORD ANTIQUARIAN MUSEUM

PROTESTING AGAINST SLAVERY *was not enough. Often Thoreau sheltered fugitive slaves and helped them move along the Underground Railroad to the safety of Canada.*

One grateful escapee later gave him this earthenware statue of Uncle Tom and Little Eva, the characters made famous by Harriet Beecher Stowe.

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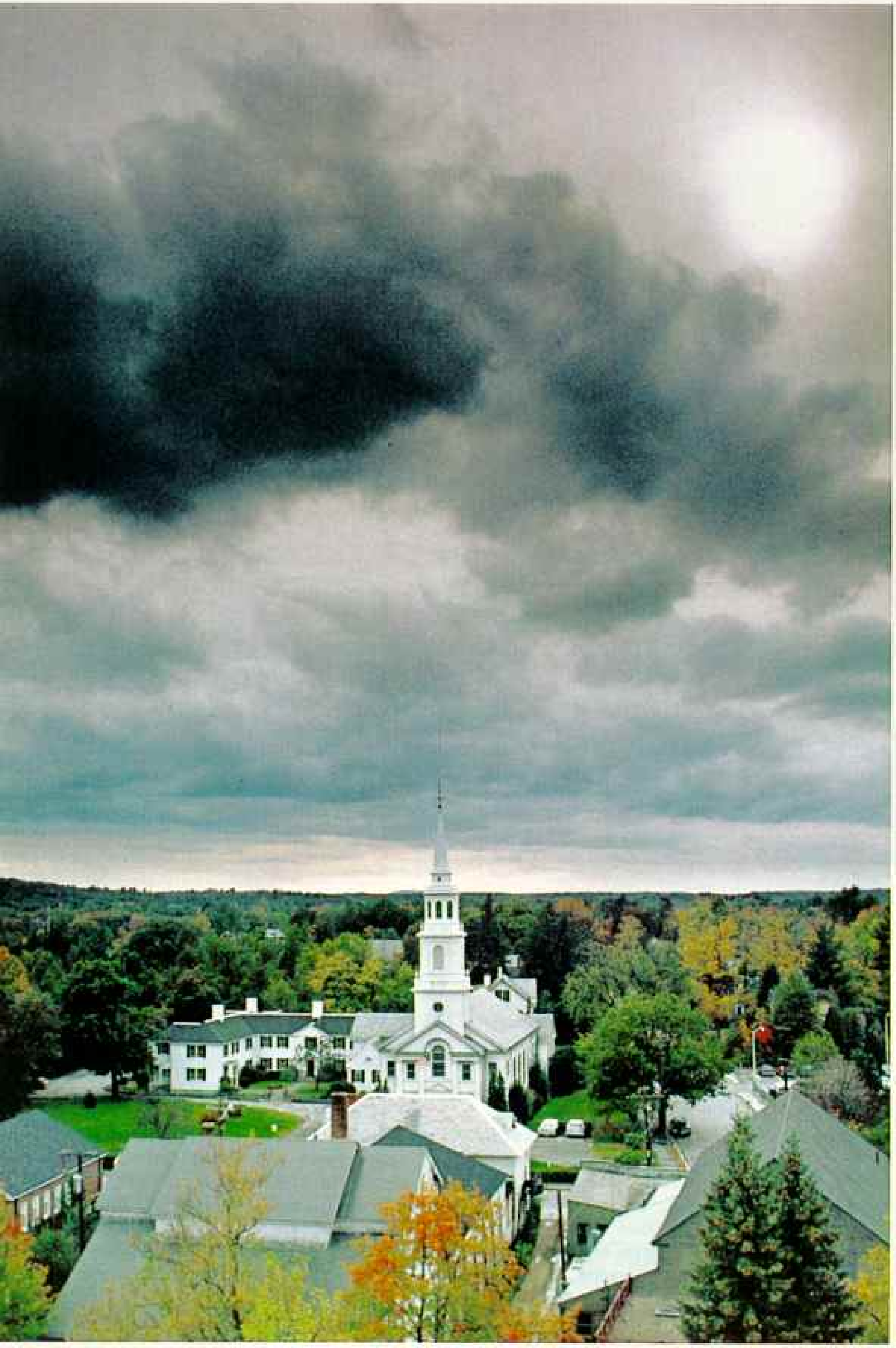
*"**We belong** to the community." Despite his reputation as a misfit, Thoreau often endorsed the values of democracy and society. Concord in his day (**above**) was a conservative village, yet it tolerated the many intellectuals—Emerson, Thoreau, Hawthorne—who settled there. Today minority voices still speak out at New England town meetings (**below**). Omit the clouds over Concord (**right**), Thoreau wrote, and "the landscape would be one glare of light without variety."*



Travels of Henry David Thoreau

As the age of discovery ended in North America, Thoreau urged his readers to "explore your own higher latitudes. . . . be a Columbus to whole new continents and worlds within you." He made the most of his own travels, going by foot or canoe when possible, studying maps and landmarks carefully, and then going home to write his memorable books about rivers, forests, shores, and mountains.

"Concord is the oldest inland town in New England, perhaps in the States, and the walker is peculiarly favored here."

town, looking for news to report. From the Fenns' rediscoveries I have learned the full significance of his remark, "I have travelled a good deal in Concord."

He dressed for his walks like a common laborer, the only college graduate in town to wear a muslin shirt, corduroy pants, and unpolished shoes with pegged soles. He carried a notched stick for measurements and a spyglass for birds. In his straw hat was a scaffold lining, where he could store plants. Humid "vapors" from his head made the hat a perfect "botany-box," he claimed.

In the *Journal* Thoreau recorded Concord's seasonal events, from spring floods to winter ice storms, and described obscure landmarks. He often walked with friends and their children, but more often he went alone. Some days he sat for hours, quiet and still, listening to the music of a swamp. In hot weather he bundled his clothing and splashed up shallow brooks, wearing only shirt and hat.

I TRAVEL in Concord a bit more sedately, often in company with my family and the Fenns, who have taught me and my wife, Bonnie, the names of ferns and wild flowers, mushrooms and trees. We in turn are now coaching our Jenny and Jeff. When the children excitedly bring us a plant, Bonnie identifies

"The scenery . . . is surprisingly grand. You are steadily advancing into an amphitheatre of mountains."

"The time must come when this coast will be a place of resort for those New-Englanders who really wish to visit the sea-side."

"... the country is virtually unmapped and unexplored, and there still waves the virgin forest of the New World."

it, and I supply a text from Thoreau's *Journal*. Rattlesnake plantain: "Is it not the prettiest leaf that paves the forest floor?" Buttonbush, its flower like a bursting nova: "as distinct and important as a star in the heavens viewed through 'optic glass.' This, too, deserves its Kepler and Galileo."

Thoreau lived in the age of Manifest Destiny, a popular doctrine that urged Americans to explore and settle their vast country, but he thought this one township was nearly big enough. To his active imagination, Concord was America on a reduced scale: The town had a sandy eastern plain, glaciated hills to the north, a river savanna down south, and western grasslands, part of them called "Texas." Seen in the proper light, these 26 square miles were an ample slice of Destiny, an inner continent to discover and explore: "The whole world is an America, a *New World*."

Yet Concord was never quite enough; a world clearly lay outside its boundaries, where Thoreau also traveled. Still he resisted the course of history, scoffing at Americans who headed west for gold: "Going to California. It is only three thousand miles nearer to hell." Except for one last journey, Thoreau sought his frontier in the East.

In 1839 he and his fellow schoolmaster, elder brother John, made a long camping trip. They headed down the Concord River to its

confluence with the Merrimack, up that stream for three days, and then by stage to the White Mountains in New Hampshire. After John died suddenly in 1842, Henry decided to write a book about their journey.

He wanted to write several books at once: a travel story, an elegy to the lost brother, a meditation on history, religion, and philosophy. The book that finally appeared, *A Week on the Concord and Merrimack Rivers*, was long, digressive, and anything but a best-seller. Thoreau paid for publication of 1,000 copies—and four years later he stacked most of them in his study: "I have now a library of nearly nine hundred volumes, over seven hundred of which I wrote myself."

The rivers' scenery today is not striking, but I can still see why the brothers' journey was a memorable idyll. They built a dory with oars and sails, packed a few supplies and some garden produce, and for two weeks left civilization behind. Following the rivers slowly, they stopped to swim and look for berries or Indian arrowheads. Thoreau's book moved at a leisurely pace, celebrating patience and the river's flow.

PATIENCE AND LEISURE are scarce commodities today. I cannot spare two weeks, only a few days driving along the riverbanks. Where the brothers camped and fell asleep to the sound of rain or lapping waves, I see today's usual roadside scenes: factory-outlet stores, truck farms, and shopping plazas. Thoreau was right: "The river is by far the most attractive highway."

He called the Concord a "dead" stream with a sluggish current. But he celebrated the Merrimack, which runs a lively, rippling course from mountains to sea, rushing through waterfalls so rapidly that the sun cannot "steal it back to heaven again" through evaporation.

By rowing against this current, the brothers were reversing the course of time. If John could not return from death, Henry's book would seal their friendship: "My Friend is not of some other race or family of men, but flesh of my flesh, bone of my bone. He is my real brother. . . . We do not live far apart."

The Concord remains a dead stream, absorbing the effluents of several towns, and the *(Continued on page 378)*

A PORTFOLIO

I have an appointment with spring. She comes to the window to wake me, and I go forth an hour or two earlier than usual.

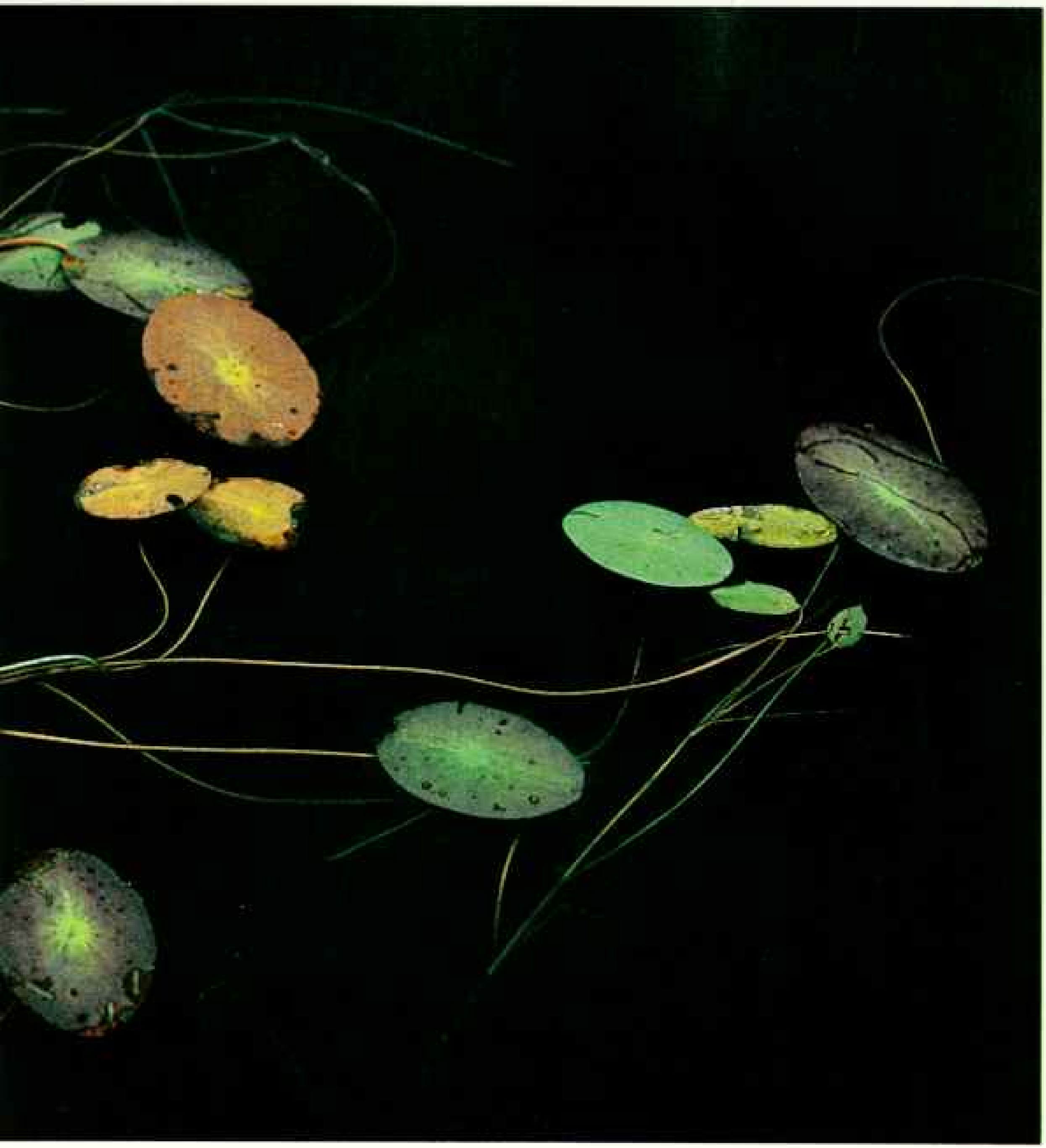
*Bloodroot (**above**) rises from last year's dead leaves to take the spring sun. As new leaves appear and thicken, a mighty beech tree (**right**) soars above their shade.*

Frogs are strange creatures. One would describe them as peculiarly wary and timid, another as equally bold

and imperturbable. All that is required in studying them is patience.

Emperor of the swamp, a bullfrog awaits its morning meal. "Motionless and indifferent as they appear, they are ready to leap upon their prey at any instant."

Some birds are poets and sing all summer. They are the true singers. Any man can write verses during the love season.

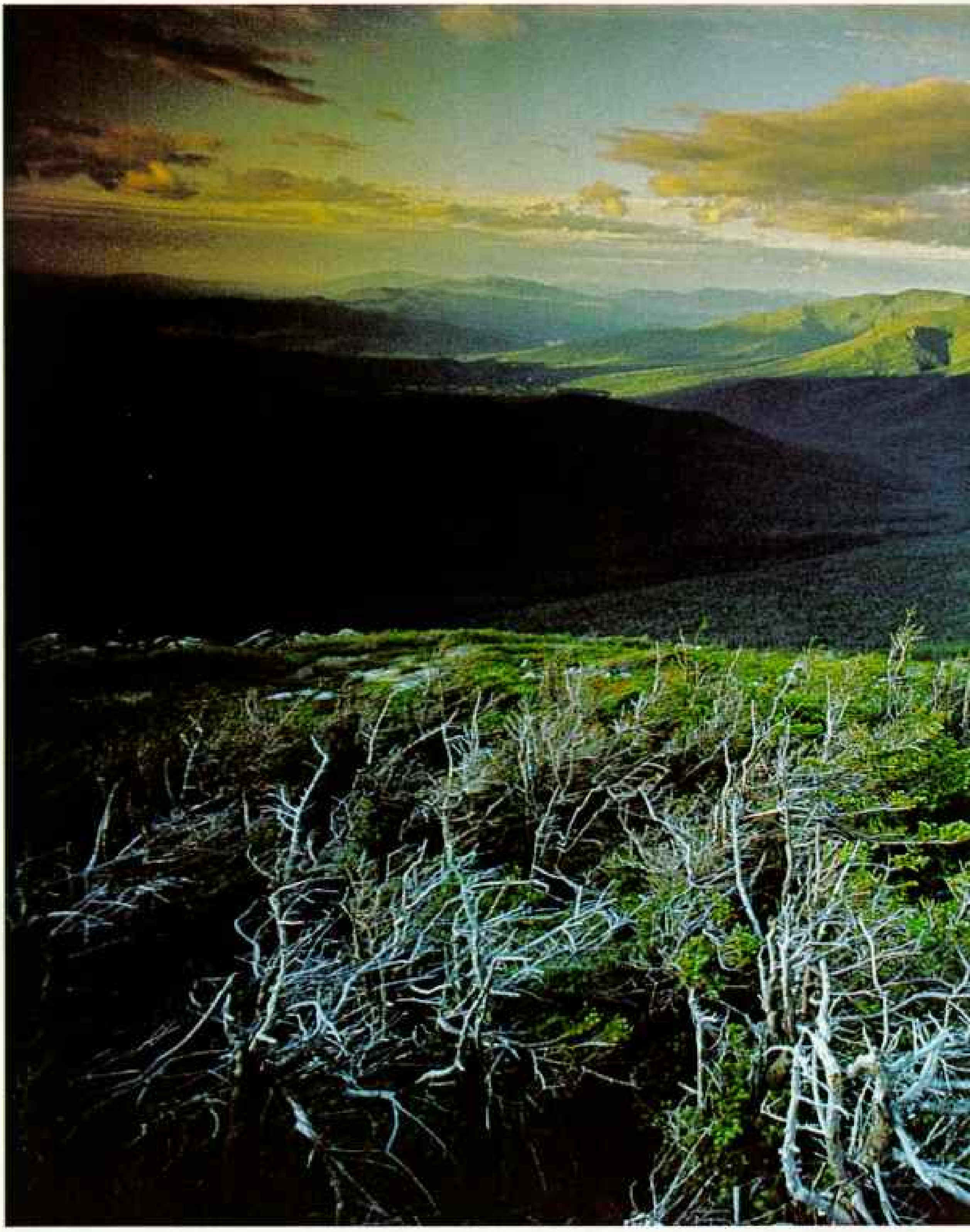


I have never met with a stream so suitable for boating and botanizing as the Concord, and fortunately nobody knows it.

Red-winged blackbird (**left**) *clings to a cattail perch in Great Meadows, a national wildlife refuge in Concord. Water lily pads* (**above**) *trail along the surface of the placid Concord River: "... out of that fertile slime springs this spotless purity!"*

It is remarkable that animals are often obviously, manifestly, related to the plants which they feed upon or live among...

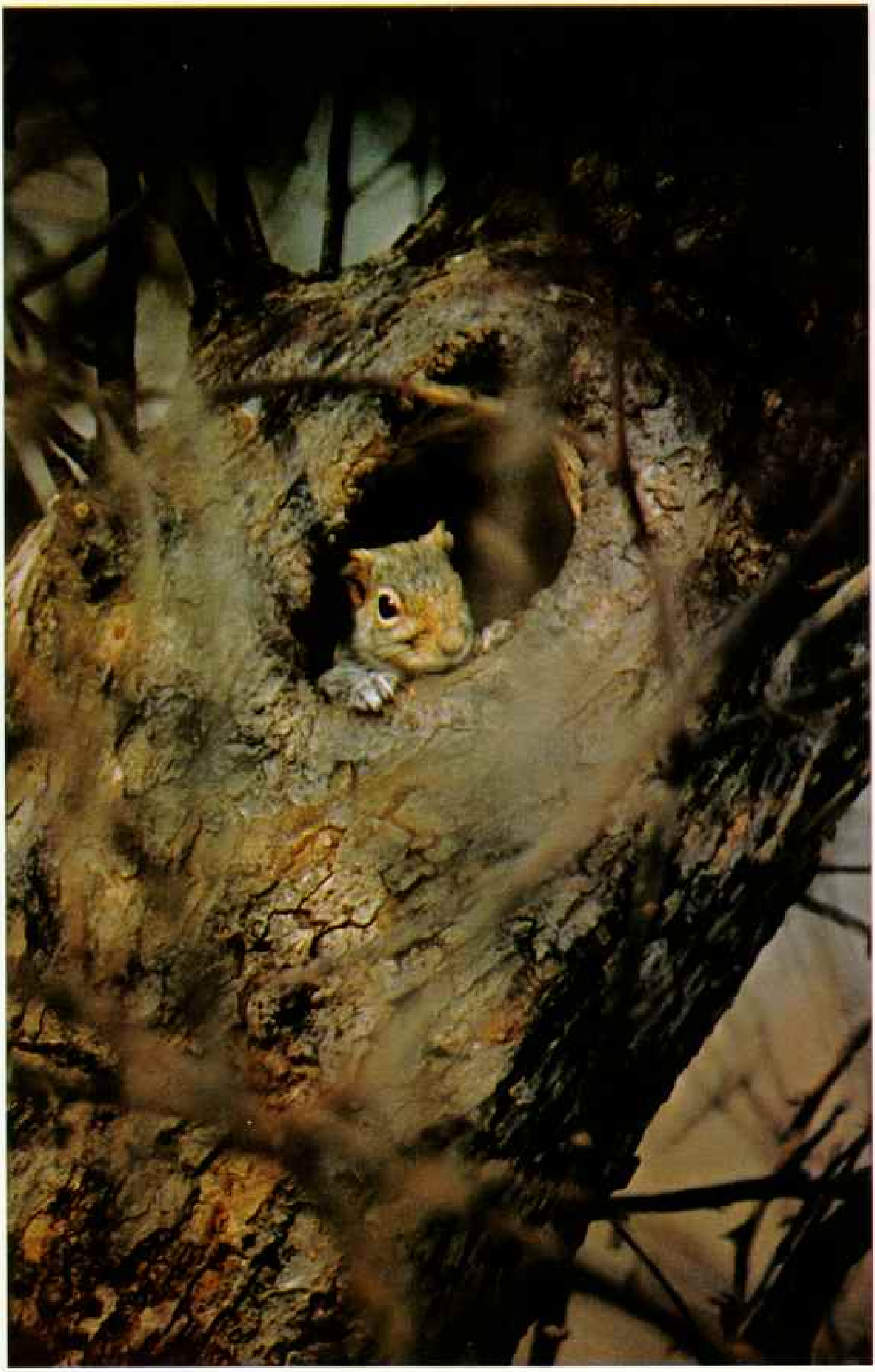
*Canada goose and goslings (**right**) strut on the grass near Sudbury River; cicadas (**above**) are in the adult stage of their 17-year life cycle.*



We could not judge correctly of distances on the mountain, but greatly exaggerated them. . . .

We no longer thought and reasoned as in the plain.

On the upper slopes of Mount Washington, in the White Mountain National Forest, the bones of dwarfed spruce gleam in late sun. Thoreau hoped this summit would remain public land, "if only to suggest that earth has higher uses than we put her to."



As the afternoons grow shorter, and the early evening drives us home to complete our chores, we are reminded of the shortness of life, and become more pensive, at least in this twilight of the year.

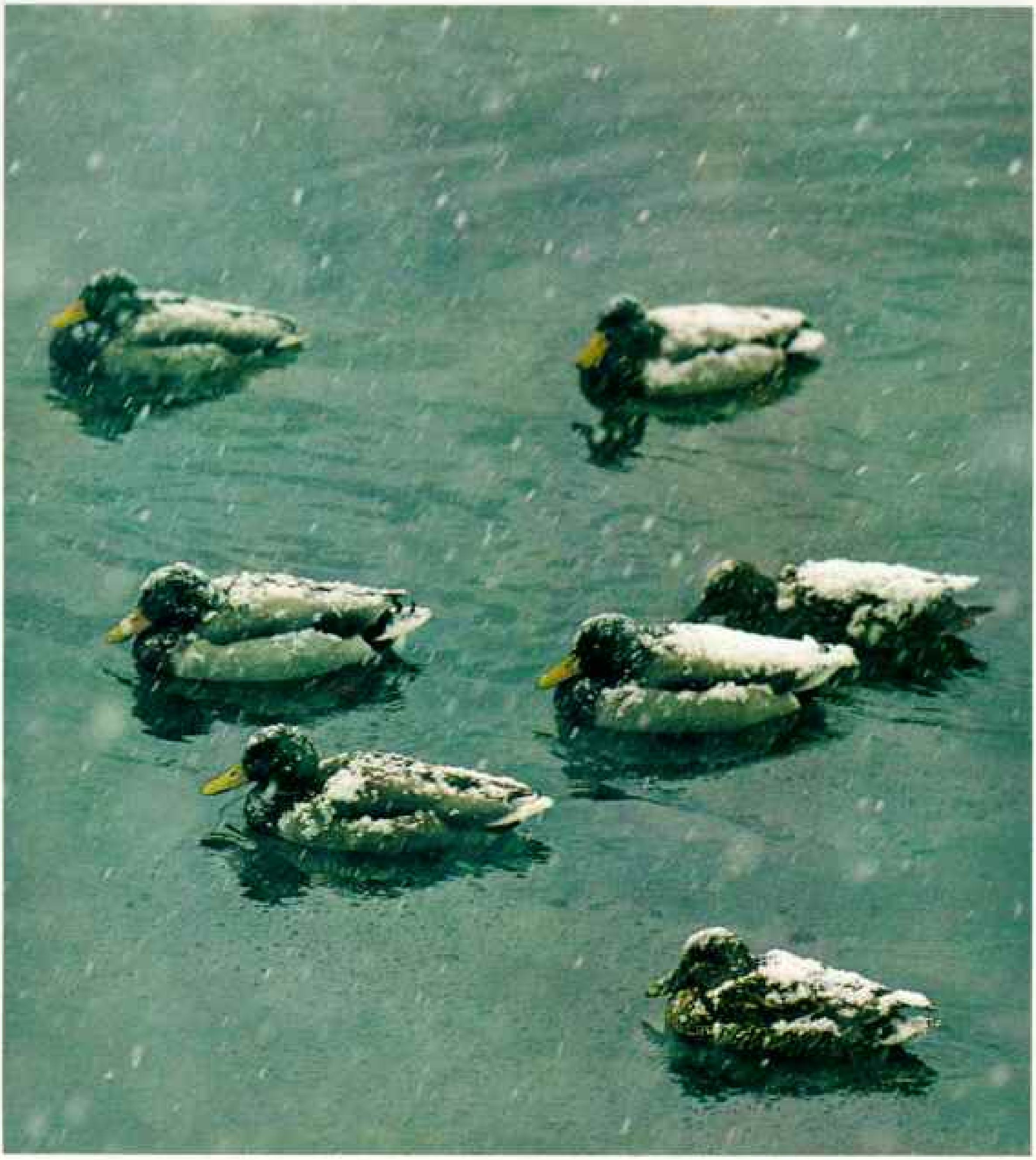
*The dying leaves of autumn were not a melancholy sight to Thoreau; he said they opened the forest and brought in more light, "warming . . . the spirits and imagination." So too with its creatures. As jewelweed (**right**) and white asters (**above right**) bloom and go to seed, they reproduce themselves; in storing food, the gray squirrel (**left**) buries the cones and nuts that yield new forests: ". . . for life will still prevail in spite of all accidents."*

How to live. How to get the most life. As if you were to teach the young hunter how to entrap his game. How to extract its honey from the flower of the world. That is my every-day business.

*In Quebec, mist rises above a stream (**far left**) or shrouds a pair of moose (**above**), which Thoreau described as "singularly grotesque and awkward." Yet in a common weed (**left**) he saw "A dandelion perfectly gone to seed, a complete globe, a system in itself."*

Winter, with its inwardness, is upon us.
A man is constrained to sit down, and to think.

Nature has its surprises; a snowfall may come to Concord before the leaves and ducks are quite ready. "We had not thought seriously of winter; we dwelt in fancied security yet." 375



Nature is full of genius, full of the divinity; so that not a snowflake escapes its fashioning hand.

National Geographic, March 1981

Nothing is cheap and coarse, neither dewdrops nor snowflakes.

*In learning that "the year is a circle," Thoreau came to see each moment in time as appropriate. Life abides even in the harsh and forbidding realm of a wintry mountain slope (**left**). After a late spring snow, alpine plants like diapensia (**above**) can reappear.*

(Continued from page 360) Merrimack is far less lively, with little of the traffic Thoreau saw. Now the stream is empty but for occasional canoes. I see one couple, headed north, and hope they are going as friends.

Near Rouses Point, New York, I cross what Thoreau called "the invisible barrier" between the United States and Canada. He passed here in 1850, heading for the St. Lawrence River Valley, and recounted this trip in *A Yankee in Canada*, one of several works published posthumously.

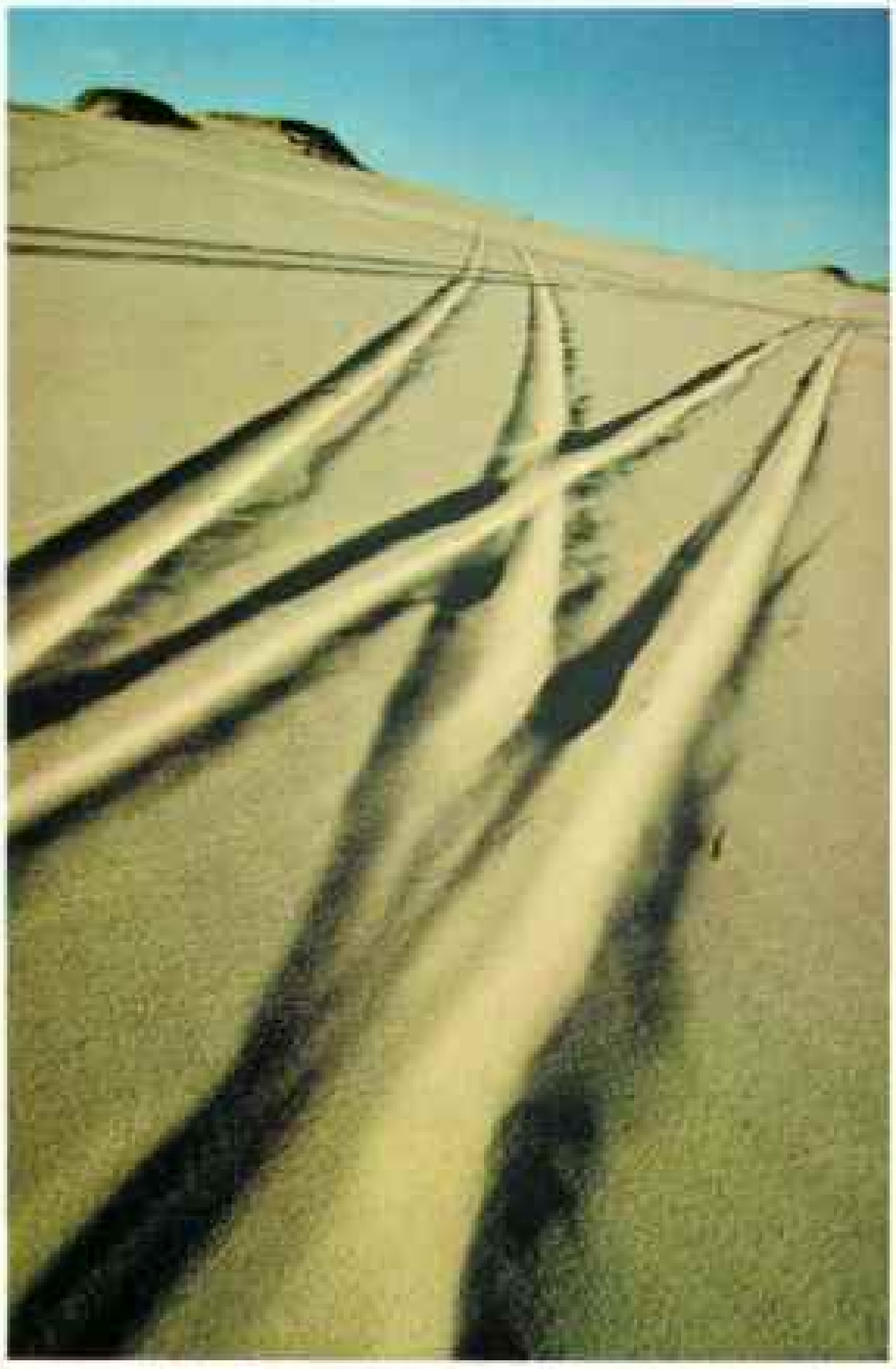
Much of this story had an irritable, rebellious tone, especially the segments describing Montreal and Quebec. Large cities were not congenial to his temper; moreover, these two were dominated by the Old World institutions of France and Britain.

Honoring Jacques Cartier, who explored the Montreal region in 1535, Thoreau climbed the hill of Mount Royal—now a public park—and found the Montreal panorama "considerably Americanized." Where Cartier saw a tiny Indian village set in the vast wilderness, Thoreau found a "stone-built city of white men." Today I can see little but a vast urban sprawl—skyscrapers and heavy traffic.

As for Quebec, Thoreau was critical of its military atmosphere: Everywhere he saw fortified walls and bristling cannon, British soldiers standing guard at the city gates. Britain had defeated France here only a century earlier, in a 20-minute battle on the Plains of Abraham.

Today Quebec's only uniformed sentries are at the Citadel, a fort that the British completed in 1850 as a defense against American attacks. According to its guides, the fort was indefensible. Thoreau had it right: "this is a ruin kept in remarkably good repair."

Here and there are posters praising Free Quebec, a still unattained goal of the province's French-speaking separatists. Thoreau might have sympathized with their cause. For him the New World was a place where "a government that does not understand you [should] let you alone."



Beach buggies *track the soft sand at Cape Cod. Here Thoreau hiked for miles along the great Atlantic beach: "... the solitude was that of the ocean and the desert combined."*

HIS MOOD softened as he left the cities and hiked along the St. Lawrence Valley. The provincial folk were more to his liking, and he found himself growing less inclined to scoff at their foreign ways. He suppressed his Yankee irreverence for Catholicism. These people worshiped at roadside shrines, not great cathedrals. Even though they believed Ste.-Anne-de-Beaupré was a place for miraculous cures, only a country chapel marked the spot: "I doubt if there are any more simple and unsophisticated Catholics anywhere."

Thoreau might be less generous today. A basilica now stands at Ste.-Anne, surrounded by restaurants, museums, and shops that sell miraculous water to busloads of pilgrims while loudspeakers intone prayers.

To his eyes Canada's sacred waters were the mighty cascades—especially those of the

Ste.-Anne du Nord River—that tumbled into the St. Lawrence. The falls of Ste.-Anne, seen at the northern end of his hike, provided a climax for his book.

This gorge was a natural cathedral, where three channels of water merged and thundered together into a "large circular basin." Here was an image of Canada's history, where three different peoples—Indian, French, British—had fought and merged into "what is called the Saxon current."

Today the falls of Ste.-Anne are still spectacular, but they do not resemble Thoreau's description. Now erosion has produced only a single broad stream that courses through the gorge, falling 213 feet before disappearing from sight.

LOOKING for his own country's origins, Thoreau made several trips to Cape Cod, "the bared and bended arm of Massachusetts," recording his impressions in *Cape Cod*. On his first trip he hiked backward into American history, from Eastham to Provincetown, where the Pilgrims encamped briefly in November 1620, and where lay the possibility of rediscovery and a new beginning: "A man may stand there and put all America behind him."

After two hours I am ready to put today's Provincetown behind me. The quiet village Thoreau saw, then mostly stacks of dried fish, has become a tourist resort. Shops on Commercial Street are dubbed Blue Poodle, Firehouse Leather, Spiritus Pizza. My stay here is briefer than his or the Pilgrims'.

I am reversing Thoreau's hike, going south to Eastham along the Cape Cod National Seashore. Sand erosion is an eternal problem here: In Thoreau's day the towns planted beach grass and prohibited grazing, lest cows eat "the cable by which the Cape is moored, and wellnigh set it adrift."

Plenty of traffic speeds by, none of it afoot. Thoreau saw a few horse carts; I am dodging beach buggies that rove this shore on bloated tires. Camper vans are allowed to park overnight for 72 hours, but a hiker with tent and bedroll may not. I feel this ruling excludes the very people who would see the beach as Thoreau did.

We live in a throwaway age. The trash on Cape Cod includes almost enough shirts and shoes to outfit an orphanage; aluminum cans, never rusting; and, everywhere, the unrotted carapace of civilization—plastic, in bags, bottles, and beer-can coolers.

In Thoreau's day Cape Cod was remote and sparsely populated. "It is a wild, rank place, and there is no flattery in it." Its people impressed Thoreau by their efforts to harvest this barren soil and the hostile sea. They learned to make do, or do without. Today fewer residents farm or fish, while tourists, wrapped in blankets against the chill wind, surf cast in comfort.

After spending a night at Wellfleet, I move to the dune tops, as Thoreau did, walking "the backbone of the Cape." On the bay side he saw desolate ponds and hollows; now they are dotted with tidy cottages.

At Eastham I meet James Roche, a ranger at Coast Guard Beach, who is digging in the sand. He has uncovered a bike rack, buried three feet down.

"Once we had a service road, a bathhouse, and a parking lot here." He points south, where nothing stands. "These improvements cut down the barrier dune, our main protection in bad storms. In February 1978 the ocean rolled in and swept away $160,000 worth of construction. It was bad planning, and worse luck." As Thoreau knew, the cape's massive sandbanks are fragile and unstable, and the ocean works them "as a cat plays with a mouse."

He also believed that Cape Cod was discovered by the Vikings, who were long forgotten when the Pilgrims arrived, seeking a promised land. Watching the waves eat up my own foot tracks, I can echo Thoreau's question: "If America was found and lost again once, as most of us believe, then why not twice?"

THE MAINE WOODS describes three canoe trips Thoreau took into "the virgin forest of the New World." His longest journey, made in 1857, followed an old logging route from the West Branch of the Penobscot River to its East Branch, 150 miles in a looping half circle. His companions were Joseph Polis, a Penobscot Indian guide, and Edward Hoar, a young amateur botanist from Concord.

In following Thoreau's route, I have assembled a roughly similar party. Warren

Elmer is a teacher of ecology from Vermont and veteran of many wilderness expeditions. Bob Peck and Steve Harbison are amateur naturalists, both from Philadelphia. Together we are undertaking a trip that had many surprises for Thoreau, some of them hazardous to life and limb.

A floatplane is our first hazard, as it bounces in the crosswinds north of Greenville, Maine. Below us is Moosehead Lake, rumpled in broad sheets, where Thoreau's party beat two days against the wind to reach North East Carry. The plane takes 25 minutes, passing over Mount Kineo, where Thoreau climbed to get a similar "glorious wild view."

On the quiet West Branch, we shove off into a perfect fall afternoon. Our aluminum canoes are less handsome than Thoreau's birchbark, but they handle better in winds or rapids. We glide forward, bows slurring the water in liquid ease. The woods close about us, and city life seems far away.

The plants Thoreau saw on the West Branch are unchanged: white and lavender asters, thickets of alder, spruce, and firs that "gave a peculiar, dark, and sombre look to the forest." His guide, Joe Polis, told him the Indian names for trees and demonstrated the many uses of wood, bark, or roots. Warren has equally strong feeling for trees. He tells me their names and habits, and which species yield the best fire for cooking.

Cold, steady winds are blowing on Chesuncook Lake; the hard work of paddling raises appetites sharply. Thoreau, a frugal eater, was annoyed with Joe Polis for insisting on regular meals. Warren also believes in refueling: "You don't want to push beyond your meals." The Indian preferred meat and bread to Thoreau's experiments with boiled lily bulbs, but together they drank hot checkerberry tea. Chesuncook village has more amenities today, including restaurant food and hot showers.

In 1857 Polis had called Umbazooksus Stream "a good place for moose," but Warren, who went through this open grassy marsh four years ago, accurately predicts that we will not see any. Beyond lies Mud Pond Carry, which divides the Penobscot and Allagash watersheds. Where Thoreau saw "a loosely paved gutter" we find a fast-running brook lined with stones.

Somehow, Thoreau and his botanist friend Hoar took a side path here and became lost in "an arbor-vitae wilderness of the grimmest character." Several hours later, Polis found the two exhausted men, muddy and fly-bitten, and led them to the shore of Chamberlain Lake. Carrying a canoe upside down, Bob and I can barely see ahead, but we follow Warren closely along the icy stream.

HAVING ENTERED the Allagash Wilderness Waterway, we camp on the lake at virtually the same place Thoreau's party stopped. Mount Katahdin rises 30 miles south. Thoreau went north from here to see the Allagash waters; so we fight head winds all the next day to reach his northernmost point on Eagle Lake, a crag locally called Thoreau Island.

We then reverse the trip, and after ten hours of hard work we camp again on Chamberlain Lake. The next morning our reward is an utterly placid day. Thoreau fought wind and waves going south, but we glide down the glassy lake in long straight pulls. Up on Katahdin it snowed last night, and the sun gleams on the peaks. Powerboats break the idyll now and then, but mostly we see canoes, making good time on the flat water. We pass into sunset, from Round Pond to Telos Lake, and loons make silhouettes against the red-gold surface. Ahead lie streams and rapids where Thoreau had the most anxious day of his trip.

Telos Cut, a channel dug by loggers in the 1840s, connects Telos and Webster Lakes; its swift tumbling descent and frequent bends looked to Thoreau like an "extremely rapid and rocky river." We decide to run our canoes through this stretch of what Joe Polis called "strong water."

Thoreau and Hoar portaged this canal, while Polis gamely paddled through in his usual fashion, standing up. Farther east, on the more rugged Webster Brook, the Indian drove his canoe as though he were "navigating a thunder-spout." He told Thoreau "it would be no joke to upset there."

At Telos Cut, Warren and I go first, followed by Steve and Bob. We slip our canoe in and begin to race forward. Streaked with froth, the water is moving much faster than

we are; it tumbles over rocks and crashes through chutes, the safe passages between rocks. At the first eddy we bail water and turn to watch the other boat descend. Steve and Bob come sliding down the bend, their orange life vests bright against the dark water. Steve wears his lucky Stetson, daring the river to knock it off. Bob rides the stern like a wary bantam.

Thoreau said Polis looked as though he were riding a nutshell "down an inclined and zigzag trough." The rocks here could easily split and hull our shells. Now Bob's boat shoves off first, we follow, and for half a minute all is well. I look down, stroke hard, look up—Bob and Steve are in the water, and their canoe has vanished!

Warren and I head for a chute on the right, but their submerged bow catches

overnight. Thoreau feared the worst: "it would be a desperate undertaking to find him; and where were they who could help?"

Our own situation is not desperate, but where will we find help? Across the stream a young female moose appears, sizes up our predicament, and fades into the woods.

Thoreau eventually found Hoar, and their trip went on without incident. Back at Telos Dam we find the dam keeper has gone for groceries, a hundred-mile trip. We wait a full day for his return, then use his two-way radio to call the floatplane, which brings new canoes and carries us to the East Branch of the Penobscot River.

Three days of perfect river travel follow, clear weather and a fast current taking us rapidly downstream. Thoreau complained of the numerous falls and pitches, which

White water ahead on Maine's Allagash Waterway, where Thoreau paddled in 1857.

ours. We dip, instantly swamp, and I am launched downstream—below the canoe, leading with my head. The water has crushing force, so cold we cannot feel the rocks slicing our ankles and shins.

Regaining our feet, we work for two hours to free the canoes, while the river pounds them against a rock. Finally rescued, both are too badly gashed for further travel.

Five miles east of us, at Indian Carry, Thoreau helped Polis with their canoe and lost sight of Hoar: "as if he had sunk into the earth." Hoar, thinking the others ahead, walked far downstream and was missing

have ominous names like Hulling Machine and Grindstone. Some we successfully run, regaining our honor.

As the East Branch opens into broad, placid stretches, we can feel the wilderness subsiding. Nearing home, Joe Polis talked of his investments and political connections. Thoreau sensed that this Indian, like the country they had traveled, was not quite what he had expected. On the other hand, I know that Warren is a city man who would rather stay in the woods, traveling with an ax and a good set of maps.

At the end of our adventure we are dirty,

unshaven, and out of food, but no one is eager to go home to airports and traffic jams. We all long for the freedom of Joe Polis, who said in passing to Thoreau: "It makes no difference to me where I am."

Throughout his life Thoreau hiked several mountain trails in New England. He wrote accounts of the trips in his *Journal* and *The Maine Woods*, often calling for public ownership of these "precious natural objects." Three of the peaks he climbed—Monadnock, Washington, and Katahdin—

A clear fall day *brings visitors to the Old Hill Burying Ground in Concord* (**right**). *At his simple grave in Sleepy Hollow Cemetery* (**above**) *fallen leaves are a silent epitaph for Thoreau, who died in 1862. In one of his last essays, "Autumnal Tints," he describes how leaves decay and bring forth new life: "They teach us how to die. One wonders if the time will ever come when men, with their boasted faith in immortality, will lie down as gracefully and as ripe. . . ."*

are now administered by federal and state agencies. Climbing these mountains with my family is a mixed experience, an introduction to the complex problems of modern wilderness management.

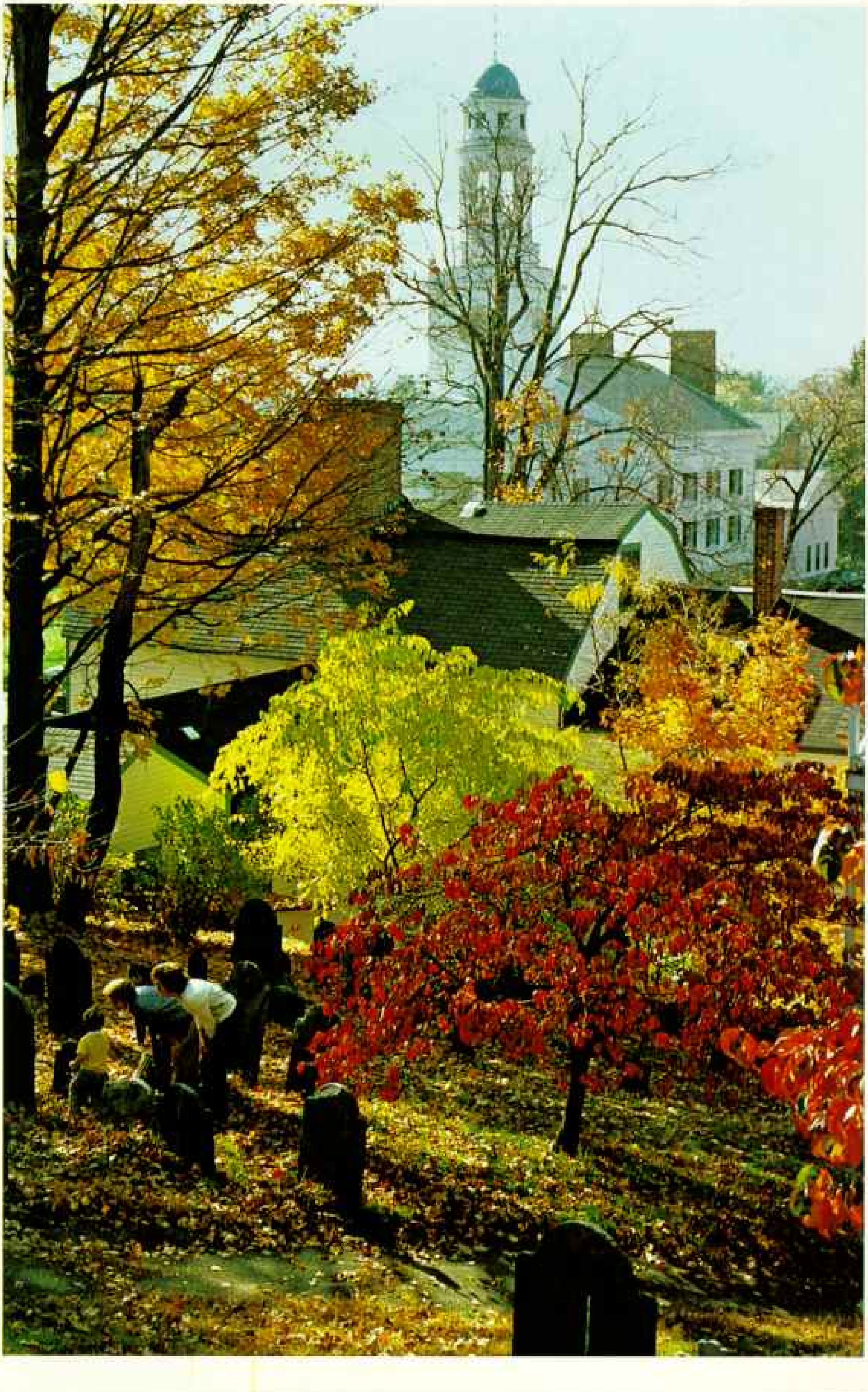
On Monadnock, in southern New Hampshire, my daughter, Jenny, can still locate Thoreau's camp of 1858 and 1860, "a sunken yard in a rocky plateau," where he placed his tent rafters between stone anchors. Her brother, Jeff, is dismayed, as Thoreau was, that many hikers continue to dump garbage at the summit and carve their initials on rocks. Monadnock is perhaps the most climbed mountain in the U. S.: 125,000 people each year, some hiking barefoot. Erosion on some trails is at a disaster level, exposing tree roots and turning paths into sluiceways.

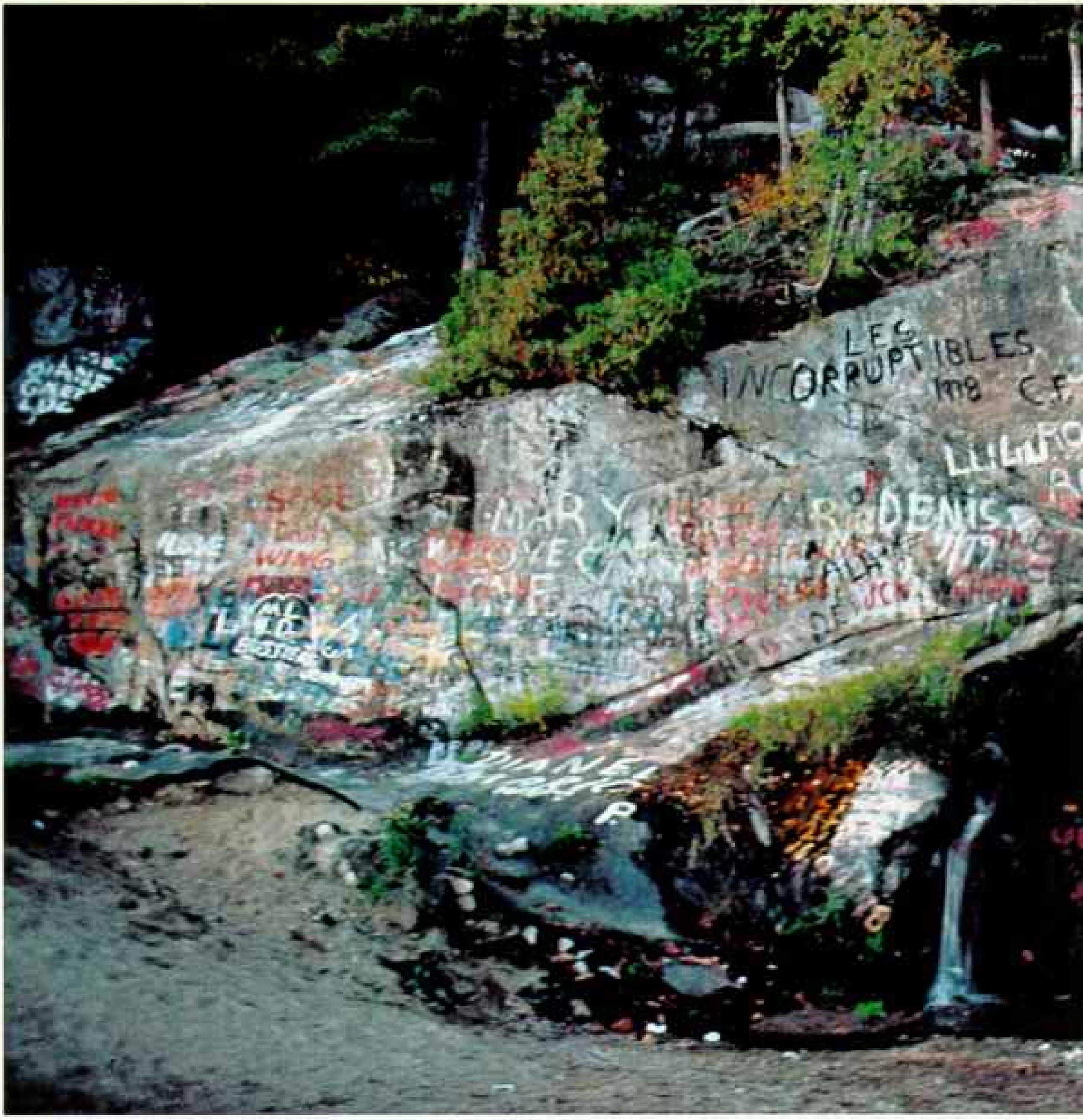
Rick Youst, a naturalist at the Monadnock Ecocenter, sounded discouraged: "Monadnock means 'mountain that stands alone' in Algonquian. It's the nearest big peak to greater Boston, where families need fresh air and cheap recreation. On fall weekends 3,000 hikers go up each day. A few stop to see our exhibits; the rest are out there beating the trails to death."

Mount Washington, lying farther north in New Hampshire, was private land when Thoreau climbed it in 1858, but today it stands in the White Mountain National Forest. Steps have been taken to help the many tourists who want to reach this summit. A toll road and cog railway, working opposite slopes, serve those who prefer to climb their mountains sitting down.

Hikers in Thoreau's mold, believing "it is far more independent to travel on foot," can follow his ascent and descent by using the system of trails and shelters maintained by the Appalachian Mountain Club and the U. S. Forest Service. The four of us opt to take the toll road up and a trail down, into Tuckerman Ravine where Thoreau camped. His party had a number of mishaps here, including a campfire that burned several acres of forest. The hikers today use portable stoves; open fires are forbidden.

At Baxter State Park in Maine, a Thoreauvian philosophy rules Mount Katahdin. The park's donor, Governor Percival Baxter, left strict deeds of trust, as park supervisor Buzz Caverly explains: "Wilderness was more important to the governor





The disease *is graffiti, and this waterfall in Quebec has no defense except its own beauty. As a pioneer conservationist Thoreau was outraged by similar signs of human destruction. On New Hampshire's Monadnock Mountain he saw names and drawings carved in the rock: "They are all of one trade,—stonecutters, defacers of mountain-tops. 'Charles & Lizzie!' Charles carried the sledge-hammer, and Lizzie the cold-chisel."*

than recreation, so we firmly restrict our number of visitors." The park has 200,000 acres of forest and mountains, but only 1,000 campers can stay overnight. Reservations are prepaid, facilities remain rustic. Daily use by cars is limited, and the same goes for mountain trails; when a parking lot is full, that trail is closed to hikers.

Up on Katahdin the effects of these policies are clear: The mountain seems uncrowded; I saw no sign of garbage or carved initials. Smaller groups of people also tend to help each other.

Our family party climbs the Abol Trail, a steep three-mile hike that follows a great landslide of loose stone and gravel. We start with empty canteens, expecting to fill them at streams. But they are dry. For months Maine has had almost no rain. We struggle over boulders, as big as automobiles, that Thoreau said were "the raw materials of a planet." Other hikers offer sips from their canteens, then encourage us to look for water on the upper plateau.

There we find deep, clear pools beneath the rocks and tall grass. People stop to rest and talk, sharing the day's adventure. Jenny and Jeff lend out their drinking cups; in a side pool Bonnie soaks her tired feet. Going on to the summit alone, I pass a sign that identifies this oasis: Thoreau Spring.

LATE IN LIFE Thoreau began several writing projects about natural history and American Indians, work now regarded as a unique blend of philosophy and pioneer ecology. He also continued to hold strong opinions, defending the abolitionist John

Brown after the 1859 Harpers Ferry raid.

At last, Thoreau turned westward. In May 1861 he began a 1,500-mile journey to Minnesota, where Americans had traveled "as into the future, with a spirit of enterprise and adventure." Though suffering from tuberculosis, he headed west in the same spirit, hoping to improve his declining health and gather field notes for future projects.

As I drive west from Chicago, the car radio crackles with news of voting fraud and poisoned fish, a litany of modern ills. But Thoreau read of worse news when his train rolled across Illinois, for the Civil War had begun. His notes avoided this subject, focusing instead on the great themes of his *Journal:* plants, animals, landforms, and how they compared to those of Concord.

Today I can see that many of Thoreau's principles remain intact. Some Americans are still trying the experiment he described in *Walden*. At Elizabeth, Illinois, my brother and his wife, David and Marian, have left city jobs to settle on a small farm. Like Thoreau, they are seeking more than a solitary way of life. David likes his neighbors, who are independent but always helpful. "With more room to breathe here, we feel closer to this community."

Near Galena, Illinois, Thoreau boarded a Mississippi River steamboat for Minneapolis, going upstream as in *A Week on the Concord and Merrimack Rivers*, but now seeking his own reconciliation with death.

His travel books on Canada and Cape Cod asked Americans to take a new look at their early history. North of McGregor, Iowa, I can stop at Effigy Mounds National Monument and study the Indian burial mounds. As a student of Indian culture Thoreau would have been fascinated, but his boat passed by here; the mounds were not surveyed until 1892.

On the Mississippi he found a new kind of wilderness, far different from Maine and the New England mountains but worthy of careful preservation. Today much of this area is the Upper Mississippi River Wild Life and Fish Refuge, which protects the river from human abuse.

Thoreau had left in Concord two large works in progress, for which he gathered data on this trip: "Wild Fruits" and "The Dispersion of Seeds." On one level they were almost scientific papers, using the new theories of Darwin to explain plant and animal distribution. On another level they gave a poetic explanation of his lifelong work as nature's reporter: "She knows that seeds have many other uses than to reproduce their kind. If every acorn of this year's crop is destroyed, or the pines bear no seed, never fear. She has more years to come."

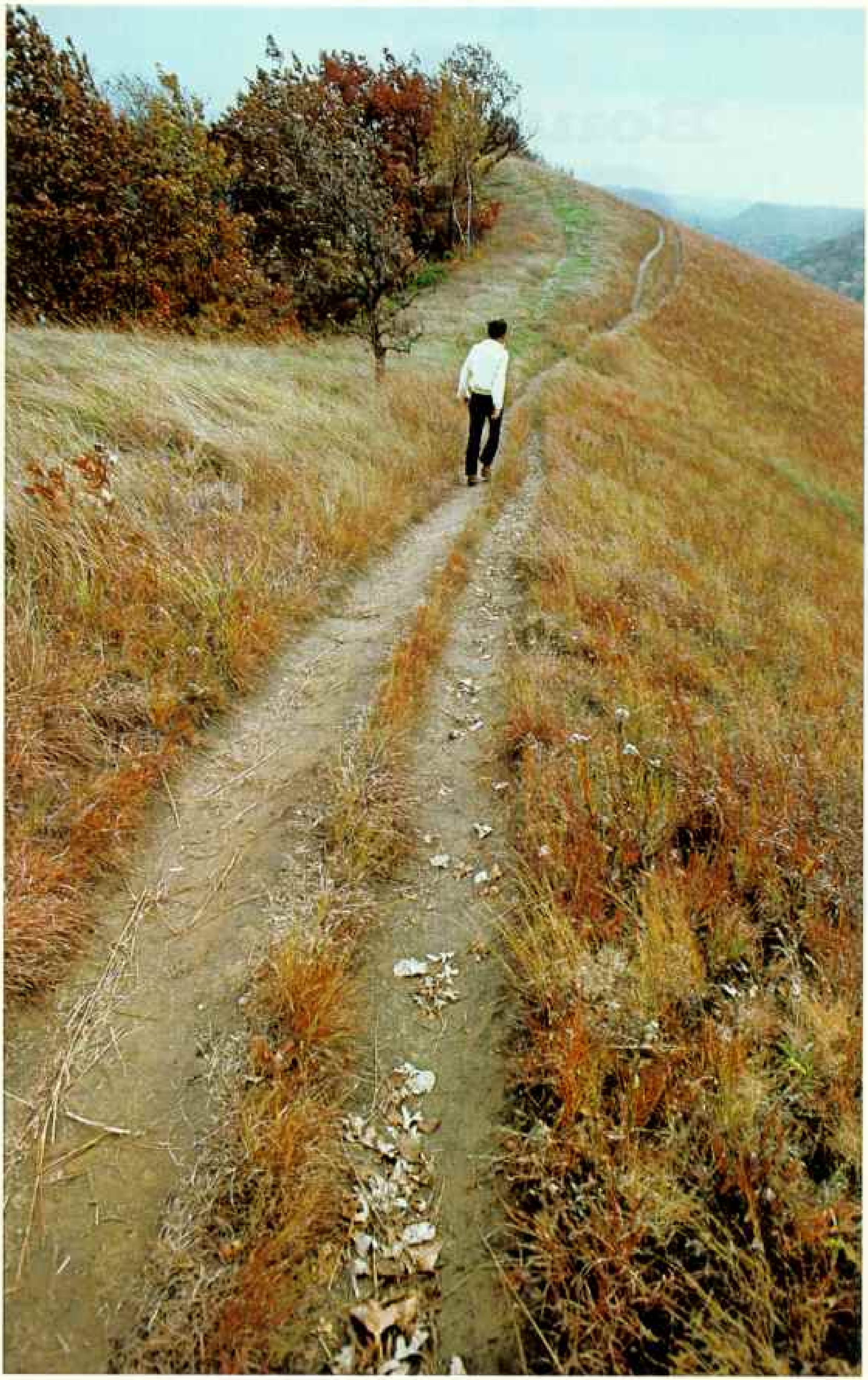
BUT HIS OWN YEARS were just about done. Before leaving Minnesota, he stopped at Red Wing and one day climbed Barn Bluff, a high, loaf-shaped mound overlooking the Mississippi. There he wrote a long letter to a friend in Concord, admitting at the end that he was "far from well." A year later he died in Concord of tuberculosis.

He was only 44 years old, and was little known as a writer or thinker. Yet today he has become a mentor for our times. His teachings were fundamental: Live simply, preserve the wilderness, and stay free in body and spirit.

Climbing down from Barn Bluff, I come across something odd, two paths that at first look like a vehicle track but then diverge, one side running higher than the other. I puzzle over this a few moments, and then dismiss it as a modern phenomenon. Hours later I find a short passage in Thoreau's notes: "The double path on bluff made by 2, one a little higher & fainter, ceasing near end of slope, like a regular 2 wheel track, 3 feet apart, the lower the deepest."

A small coincidence perhaps, but this double path has become to me a reminder of the Henry Thoreau I am still following: he on a higher and fainter track, I on the lower and deeper one. And someday, I may track that fox to his lair. □

On Barn Bluff *above the Mississippi River at Red Wing, Minnesota, author Howarth takes a walk along the double path Thoreau saw during his visit in 1861. Local historians believe the path may date from times when Indian tribes camped on the bluff.*



The Bonanza Bean Coffee

By ETHEL A. STARBIRD

NATIONAL GEOGRAPHIC SENIOR STAFF

Photographs by SAM ABELL

A wake-up cup *in the morning, a convivial cup during the day, coffee has worked its way to the marrow of civilized life. Around the world the delicate tree yields livelihood for 25 million people, like this young Indonesian harvesting from a bamboo ladder* ***(facing page)****. Worldwide, export earnings make coffee a leader in international trade.*

THE JAPANESE gentleman buried me up to the chin in a shallow grave and left me to compost in 13 tons of soggy ground coffee. Fermentation, induced by pineapple pulp, had heated my pool-size percolator (pages 390-91) to a barely tolerable 140°F.

For 2,000 yen ($9.50) and 30 minutes, I steamed in some $10,000 worth of the world's most popular beverage component, perhaps the best buy in today's Japan. Billed as an antidote for almost everything, this featured attraction at Nishiarai Kouso Sauna Center in suburban Tokyo merely left me limp. And somewhat immodestly clad in a dissolving paper bikini.

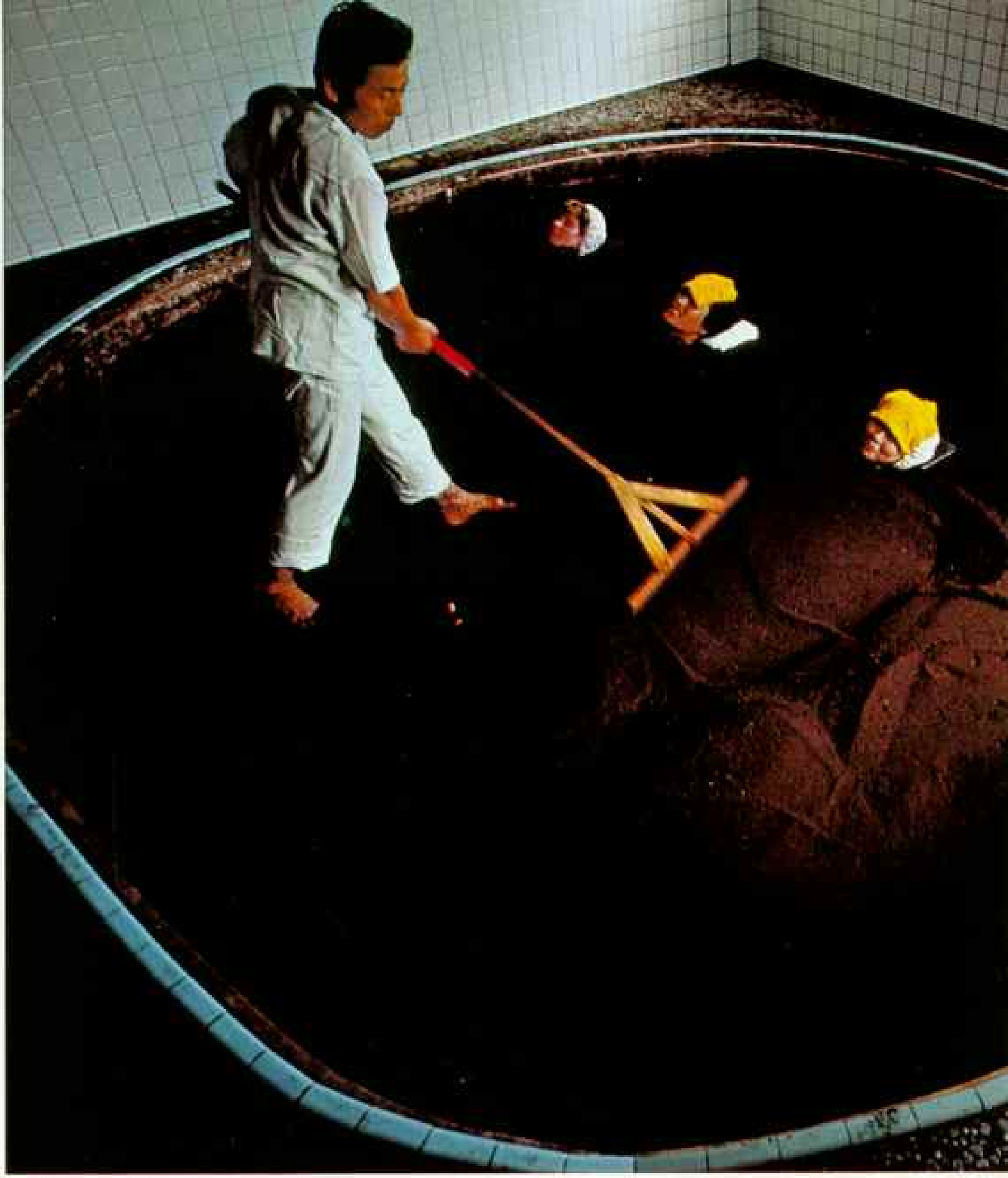
If the unique bath did little for me therapeutically, it surely showed how tastes have changed in this land of traditional tea drinkers. A generation ago few Japanese had sampled coffee by the cup, let alone by the tubful. Now Tokyo alone has some 16,000 coffeehouses; the nation, more than 100,000.

None I visited even remotely resembled Europe's "penny universities" of yesteryear, where scholars, philosophers, and politicians crowded into smoky dens to sip the brew for a penny or two. When an early English coffeehouse suggested customers ante up a little extra "to insure promptness" in service, the gratuity called the tip was born.

Japan's yen for coffee requires plenty of yen these days—the equivalent of $1.50 a serving. For those who find indoor prices too steep, platoons of curbside vending machines dispense coffee for about 50 cents a can, hot or cold according to the season.

Although new to Japan, coffee has been an eye-opener in other places since the ninth century, when, according to legend, an Ethiopian goatherd found his flock frolicking about after munching on coffee cherries. He sampled a few and was soon gamboling along with his goats.

From humble beginnings as both food and drink for

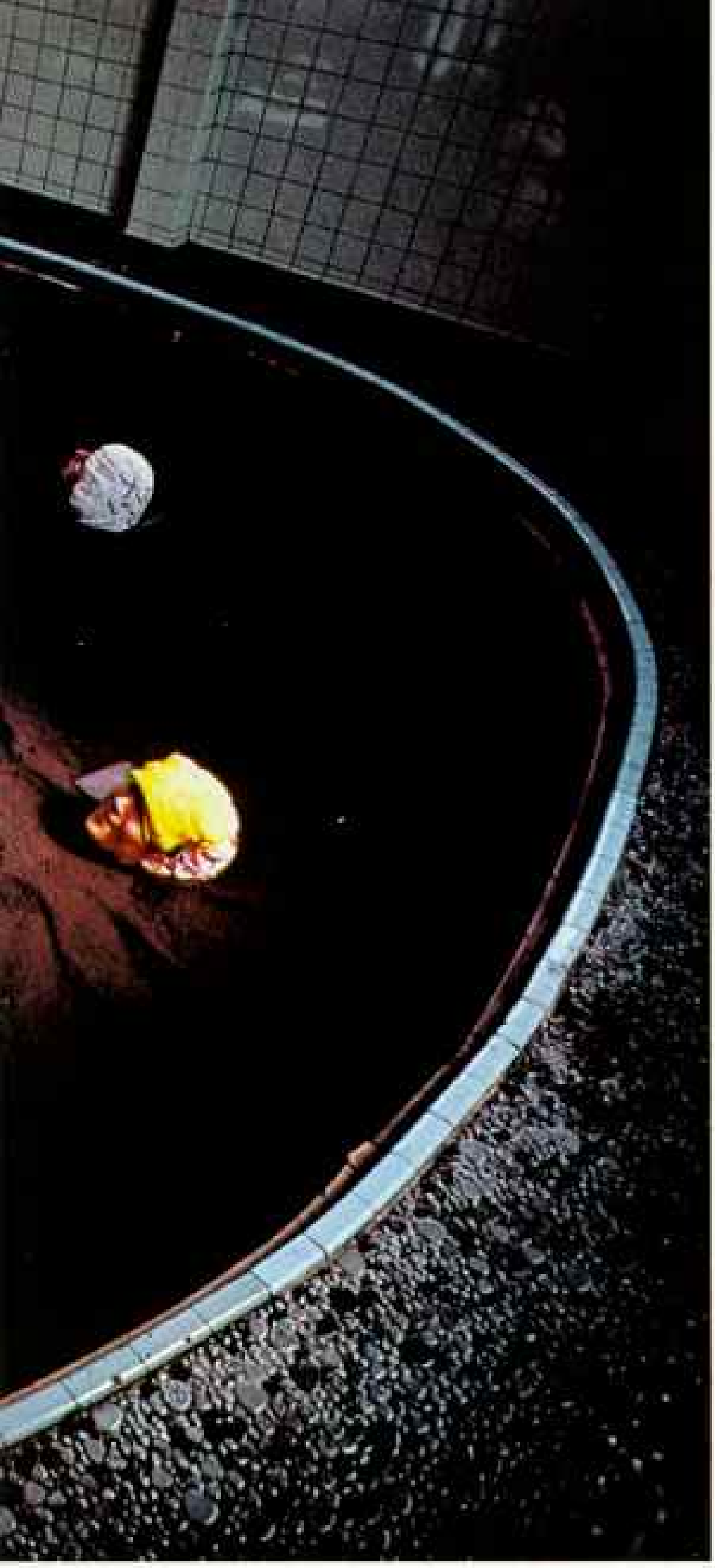


African tribesmen, coffee evolved into a global phenomenon of extravagant proportions. Among natural commodities in international trade, coffee usually ranks second only to petroleum in dollar value, accounting for 12 billion in 1979.

All 50 exporting countries—led by Brazil, Colombia, Indonesia, and the Ivory Coast—rely upon coffee as a major source of foreign exchange. Some 25 million people depend upon it for their livelihood. And uncounted millions down it by the potful.

This adds up to an amazing piece of action for a peanut-size bean whose sole purpose on this planet is to provide a virtually nutritionless beverage made mildly stimulating by the caffeine it contains—75 to 155 milligrams per cup. (Tea: 28 to 44 milligrams.)

Unlike Brazil, which grows a third of the world's supply—some five million tons last year—and drinks a third of what it raises, most producing nations consume coffee



Coffee break to remember: *In a Tokyo health spa, patrons in paper bikinis (**below**) bask in 13 tons of ground coffee (**left**) for alleged therapeutic benefits. The Japanese are turning from tea to coffee, which has three times as much of the natural stimulant caffeine. The U. S. Food and Drug Administration has recommended that caffeine used as an additive be removed from its "safe" list, until further test results determine its effect on health.*

sparingly: The bean brings more leaving home than staying there.

It's not their addiction to *cafezinhos*—demitasse doses heavily sweetened and darkly brewed—that gives Brazilians the jitters. Rather, it's the chilling thought of a killing frost, which, in 1975, damaged nearly half of the country's three billion coffee trees and sent retail prices into orbit.

Another such disaster loomed in June 1979, when I talked to Wolney Atalla, the world's largest coffee grower. Frost had again hit southern Brazil. "The loss of a single tree means the loss of income on that spot for the three to five years it takes to replace it. Multiply that by our 15 million trees, and you can appreciate our concern."

At Pirajuí, an hour's flight inland, the cold wave had already blackened large swatches of trees. Atalla's workers, bleary-eyed, toiled into their third sleepless night, burning oil-soaked sawdust and saltpeter to

smudge vulnerable areas with a warming smog. The Atallas, pioneers in this process, saw their efforts pay off in rescued trees.

The only major export country susceptible to frost, Brazil suspended all shipments pending assessment of damage. And uneasy importers, fearing a shortage, went on a buying spree. Inevitably, prices rose, even though Brazil's actual losses fell far below the first dire predictions.

Several international experts summed up coffee's swings in much the same way: "We have long periods of low prices, short periods of high ones. When highs occur, farmers rush in to plant. Once the tree begins bearing, it churns out beans without too much effort for the 12 to 30 years of its normal life. Overproduction follows; prices fall. Farmers tear up their plants and put in more stable crops. A disruption in coffee supplies starts the cycle all over again."

Producers and consumers agree that the only sensible solution is to limit output to

Promised land *of the coffee tree, the Andean uplands of central Colombia* ***(right)*** *offer ideal climate, slope, and soil for the globe-spanning African shrub. About eight months after the plant's short-lived flowers* ***(above)*** *fill the air with jasmine-like fragrance, Colombia's trees produce beans of world-famed quality.*

what the market can absorb, plus a standby reserve, and sell at prices reasonable to both sides. But what's reasonable?

Since 1963, 24 import and 44 export countries have cooperated through their London-based International Coffee Organization to stabilize the situation. By imposing a quota system, they can limit the outflow of beans from producing nations in times of oversupply. These controls, in force to sustain prices only until the market does so normally, have been applied twice: from 1963 to 1973 and again in October 1980.

Despite yo-yo conditions and a 100 percent increase in living costs in the United States over the past decade, coffee remains one of the least inflated prepared beverages: five cents a brew-it-yourself cup.

Coffee Craze Spread With Islam

Certainly the ingenious Arab who stirred up the first "bean broth" from the coffee cherry's agreeable seed had no way of knowing how his concoction would later stir the world. Launched about A.D. 1000 from Yemen, its popularity soon perked across all Arabia, keeping dervishes whirling through nightlong rituals and worshipers awake. For teetotal Muslims, it became an integral part of religious and secular life.

Battles over the brew began about 1500 when physicians sought exclusive distributorship and mullahs complained that outside imbibing was emptying their mosques. Despite frequent efforts to restrict its use, coffee collected devout disciples as Islam's influence pushed north and west.

Constantinople (now Istanbul) quickly acquired such a great thirst that Turkish law permitted a wife to divorce her husband for failing to keep the family *ibrik*, or pot, filled. Suing on such grounds should be easy these days. Never able to grow its own coffee, Turkey can no longer afford to import it from abroad.

Behind the landmark Blue Mosque in Istanbul, a middle-aged Turk who had traveled in the States stopped me to practice his English and his charm:

"You are from America, yes? I will show you around."

"All I'm looking for is a cup of real Turkish coffee."

"Ah, so sad. There is none. Something nice in leather, perhaps? Or maybe copper?"

"No thanks." I edged away.

He took my arm and guided me into a dark, cavelike café where, hidden from the eyes of less fortunate Turks glowering into their tea, we sipped small cups of bootleg brew—perhaps a bit milder but no less muddy than in better days.

The proprietor wasn't shy about his sources. "Mostly from my countrymen who work abroad. They bring in two kilos when they come home, for their own use of course. I buy what I can for 3,000 lira [$36] a kilo. Six times old price, but I do OK."

The bill convinced me: $1.50 for each three-ounce thimbleful.

"Government say Turks here no work hard any more. I say 'bah.' Take away our coffee and what they expect?"

Recognizing coffee as a hot item, visiting merchants of Venice carried their first cargo from Constantinople to Italy in 1615; by 1750 it could be found throughout most of western Europe. So, too, could that fraternal lodge of the Levant—the coffeehouse.

As the coffee craze rumbled across Europe, devout Catholics denounced it as the drink of infidels, and therefore sinful. Before committing himself, Pope Clement—so it's said—tried a cup and became an instant convert. He settled the matter by baptizing the brew to give it Christian status.

Germans grudgingly did without for a while when Prussia's King Frederick the Great banned the beverage to bolster sagging beer sales. In other places women agitated for prohibition, claiming coffee inhibited the virility of their mates.

By the late 1600s Britons became smitten with the bean, despite prices that reached the equivalent of $48 a pound—a record. Within a few years London was putting away more coffee than any other city in the world. (The economics of empire later caused a shift to colony-grown tea.)

Many of Europe's 18th-century literary and musical greats found coffee a pleasant prod to genius. Voltaire reportedly drank 50 cups a day; it's a wonder he got any work done. Balzac revved up on it before he wrote, and Talleyrand took time to pen his perfect formula: "black as the devil, hot as hell, pure as an angel, sweet as love." Johann Sebastian Bach composed an entire cantata poking fun

at those who sought to suppress the brew.

Along about the Bach era, the ever enterprising Dutch took a good look at the lucrative coffee trade, another at their colonies in the East Indies, and decided the two were made for each other. By the early 18th century Java was supplying the Netherlands with a steady flow of fine beans carried in the steamy holds of westbound sailing ships.

Fortunately, unroasted beans react little to lengthy storage if properly protected from strong odors, which they readily absorb. Once roasted, however, beans begin to deteriorate. Present-day purists put the peak flavor at no more than one month. Once coffee is ground and opened, they say, flavor declines after about ten days, even in refrigerated tight-lid containers.

Old Labels Have New Meanings

Beans labeled java and mocha (named for the former coffee capital of Yemen) still fetch premium prices in specialty shops and for use in better blends. More of both seem available than either source now provides.

A knowledgeable Belgian trader explained the discrepancy. "The bulk of today's commercial coffees falls into two basic categories. Robustas, hardy but a bit harsh, usually come from Africa or Asia and often end up in soluble form. Arabicas, largely from Latin America, are choicer, milder, of excellent cup quality. They're preferred for coffees where taste outranks convenience.

"The original javas and mochas—in fact, all important coffee at one time—were arabicas. But Mocha has practically gone out of business, and Java was forced long ago by mass destruction of its arabica plantings from leaf rust to substitute more disease-resistant robustas. Nowadays, some high-grade arabicas are called java and mocha even though they may be grown elsewhere."

When Indonesia, which includes Java, gained full autonomy in 1954, the Dutch departed, leaving behind a few large estates, now nationalized, and a good deal of native know-how in coffee culture. A returned Dutch exporter, A. M. Tijsseling, knows the market well. "Eighty-five percent of Indonesia's output comes from about 100,000 smallholders; some work only a few trees each. Methods are as primitive as they have always been—planting, picking, sorting, and processing, all done by hand."

Doyo Soeyono Kertosastro runs a more sophisticated operation on 860 acres of his private estate in Dampit-Malang.

Harvest was in full swing. Flocks of dainty little Javanese women perched in the treetops, picking away and twittering to each other like so many brown birds.

"Another native we have also picks with care," Doyo told me over a superb cup of coffee. "The *luak*, that's a small catlike animal, gorges after dark on the most ripe, the best of our crop. It digests the fruit and expels the beans, which our farm people collect, wash, and roast, a real delicacy.

"Something about the natural fermentation that occurs in the luak's stomach seems to make the difference. For Javanese, this is the best of all coffees—our *Kopi luak*."

He refilled my cup. "I'd like to try it sometime," I told him more out of politeness than conviction.

"You just did."

In the cherry reside the beans: *the two seeds at the heart of the coffee industry. On big plantations unripe green cherries are sometimes stripped along with the red and ripe. Most coffee, however, is grown on small farms, where several careful pickings garner the fruit at the peak of ripeness.*

Branches of the family tree founded by Java's pioneer plants finally reached the Americas in a saga of resettlement that reads more like fiction than fact.

A Java-born tree taken to the Netherlands in 1706 for botanical display spawned a descendant (most plants self-pollinate) that the Dutch presented eight years later to Louis XIV, King of France. Martinique's military governor, on leave in Paris, managed to nip off a slip and nurse it through a trouble-plagued return trip to the Caribbean on his own scant water ration.

Coffee reached French Guiana in 1722. By then, neighboring Dutch Guiana already had been in the bean business for about four years.

When differences between the Guianas developed, a neutral Portuguese envoy sent to negotiate a settlement negotiated himself into the affections of a French official's wife; she obligingly pilfered a few beans that he sneaked back to Brazil. Coffee was soon growing in suitable climates throughout equatorial Latin America.

The tropical Americas, which now enjoy a near monopoly on arabica coffees, have what it takes for peak production: rich soil, reliable rainfall, ideal altitudes between 3,000 and 6,000 feet.

Because the bean-bearing cherries cling along branches in tight formation and ripen at different rates, gathering them has always been done manually. And it still is in the highlands of Colombia and Central America where mechanization, even if possible, would create catastrophic unemployment.

Southern Brazil's much gentler slopes are less restrictive. Here, Wolney Atalla has already contoured some of his rolling acres to accommodate a mammoth of the modern age: *primeira colhedora de café do mundo*,

Bushwhacking *into the future, the world's first successful mechanical coffee picker* ***(top)*** *replaces 100 men on the Atalla plantation in Brazil. Before processing, cherries dry in the sun* ***(right)****.*

Though the machine may further coffee as an agribusiness in Brazil—already the world's top producer—it is expected to have little impact in the steep terrain of other Latin American coffee regions.

JACTO (ABOVE)

Pacific Ocean

Atlantic Ocean

CANADA 10

UNITED STATES 13

ICELAND 19

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28 APPROXIMATE CONSUMPTION LBS. PER CAPITA ANNUALLY

COFFEE PRODUCTION AREAS

EXPORT AND IMPORT

Countries with annual per capita coffee consumption under four pounds are not shown.

Upswings and downturns *keep dealers hopping at the Commodity Exchange in London, a center of world trading activity in coffee futures* ***(below)****. Historically, cycles of overproduction have been followed by low prices, subsequent production cuts, and a return to high prices. Adding to price instability are natural disasters.*

Freeze-dried fields *in Brazil, like these in São Paulo state after a 1979 cold spell, send chills through world coffee markets. Prices soared in 1975 after frost injured nearly half of Brazil's coffee trees. With much of its best coffee land south of the tropic zone, Brazil is the only major coffee producer to suffer frosts. Even so, it grows a third of the world crop.*

In a mutual effort to stabilize prices, producing and consuming nations have agreed upon a system of quotas and reserves. But stable or not, prices are seen as too low by many producers. Says one Brazilian grower: "The inflation rate in producing countries is rising faster than in the States. If coffee can't keep pace, supplies will dry up, and it won't take a frost to do it."

A world without coffee is hard to swallow. Finland, top per capita consumer (map, ***top left****), tucks away about five cups a day for every man, woman, and child. The United States averages less than half that much per person but outbuys everyone—some 1.2 million tons in 1979.*

the first successful coffee-picking machine.

Designed along the lines of a grape harvester, the machine straddles the tree rows like a platform on stilts, its rotors shaking off the cherries.

Field hands, paid by the bagful, tend to skip lightly loaded trees, leaving about 20 percent of the crop untouched. The colhedora isn't fussy; it can clean off 95 percent in a single sweep.

It's all still handwork high in Colombia's Andes, where Luis Gonzaga López of Chinchiná cultivates eight acres of coffee, about average among the country's 300,000 growers. With his nephew singing along the tree row beside me, I picked at top speed for more than an hour, collecting barely enough cherries to cover the bottom of my four-kilo waist basket. Meanwhile, my relaxed coworker had filled his to the brim without missing an eligible cherry—or a note in his nonstop serenade.

Safeguards Spawn Illegal Profits

As some protection against coffee's boom-or-bust cycles, farmers like Luis López may commit their entire crop to the National Federation of Coffee Growers of Colombia at a daily established price. To fund this subsidy program, the federation levies a 25 percent tax—in cash and actual coffee for its inventory reserve—on the exporters of outbound beans.

Most principal producing nations follow similar practices. But Colombia loses a lot in the process to smugglers.

Dr. Pedro Valencia, director of public relations for the federation, acknowledges the problem: "About 400,000 bags of contraband Colombian coffee reach the States every year; Miami warehouses are full of it. It's a free-access commodity to your country, so no one cares how it gets there. Returning ships bring back contraband cigarettes, which clear your country legally and enter mine illegally. So we lose both ways."

Smugglers ran far greater risk in Uganda during the tyrannical reign of deposed dictator Idi Amin. Compelled to deliver coffee to his corrupt regime for worthless currency or none at all, smallholders began sneaking their better beans into Kenya, which also prohibited such traffic. Those caught on the Uganda side were usually put to death,

Coffee's colonial tradition *thrived on the island of Java, where Indonesian workers here cull a day's harvest for rejects. Shortly*

after coffee as a drink reached 17th-century Europe from Arabia and Turkey, the Dutch made Java synonymous with coffee through their profitable plantations. Other European nations followed suit, planting coffee empires around the world.

How do you like your coffee? *Much of the world likes it quick, so a firm in Trieste, Italy, makes packets* (**above**) *for fast espresso. At a coffee center in Norway, cooks learn how to prepare it cafeteria style* (**top**). *Taste-wise wizards behind the scenes at the Jacobs Company in Bremen, Germany, sample brews* (**facing page**) *before prescribing their blend.*

while those across the border made a bundle as illegal middlemen.

While the intake of coffee may not be hazardous to health, its output can be, especially in tiny El Salvador, where 3 percent of the growers produce 60 percent of the crop. At the larger fincas one may be greeted by ferocious guard dogs and wary, armed employees. These coffee czars, most from the country's wealthiest families, have long been targets of terrorist threats, kidnappings, and sometimes murder.

Here, amid past volcanic convulsions, some farmers must rope themselves down their near-perpendicular *manzanas* to pick and prune their trees. And funiculars outperform man and mule in conveying the harvest from windswept ridgetops to deep-cleft chasms, where *beneficios* hull, dry, and bag the beans for export.

Coffee Fills National Coffers

Troubled as El Salvador may be, the country remains the coffee champion of Central America with a crop last year of about 150,000 tons, worth 532 million dollars to an economy almost totally dependent upon this one commodity.

Across the Atlantic in a like latitude, Ivory Coasters operate under more congenial conditions. Combined output of some 350,000 small growers makes them undisputed leaders in raising African robusta, a principal money-maker for nine of the continent's developing countries.

No one paid much attention to the commercial potential of robustas, first found growing wild in Zaire in 1898, until the 1950s. Since then, the Ivory Coast pick has grown to a quarter of a million tons a year, giving the country a sound economic base.

Mr. Gng N'Gorand Yobouet of coastal Aboisso is an average Ivory Coast landowner. Along with the customary two wives and a number of his 18 children, he works 16 acres of semicleared forest, growing a casual mix of marketable coffee, cocoa, bananas, manioc, kola nuts, and oil-bearing palms.

I followed him through half a mile of tangled undergrowth to the site of his scattered coffee trees. Towering above ready reach, all of them needed pruning.

"No, no. It would take away too many of my cherries. The government man says

they'll come back better on new branches. But not for two years. With so many mouths to feed, I cannot wait."

The government realized belatedly that old age and neglect of trees were killing off the crop. However, replacement and upgrading programs go slowly: Most farmers, like Gng, feel they cannot afford to lose what they have even for a more promising future.

Concocting a Quick Cup

The sudden surge in demand for Ivory Coast and other robustas stems from soaring sales of instant coffee. Introduced to an indifferent public in 1901 by a determined Japanese chemist, solubles refreshed some U. S. fighting forces during World War I but didn't win a lasting place in civilian larders for another two decades. Today 20 percent of all coffee is processed into spray- or freeze-dried form.

Which simply means dehydrating liquid coffee much as it comes from an ordinary pot into an extract of easily dissolved granules, pulverized to a powder or agglomerated into larger nuggets to resemble regular grinds.

Another act in the roaster's repertoire: eliminating most of coffee's kick. Unroasted beans are soaked in water to swell their cells, then submerged in a solvent that flushes out about 97 percent of their caffeine. Rinsed thoroughly, they reenter the pipeline to be roasted, ground, and packaged.

World's largest roaster, the massive Maxwell House plant in Hoboken, New Jersey, begins its production line across the Hudson River on Manhattan's Wall Street. Here experts like Tom Conroy, a 47-year veteran, decide what types and tonnage of beans to buy in order to maintain quality standards for more than a dozen company blends.

A gas-fired roasting machine filled the tasting room with a tantalizing aroma; polished cuspidors yawned around a revolving, cup-laden table.

"In the taster's trade, we smell, sip, and sense, but we don't swallow."

Tom began by "breaking"—stirring the coffee's surface froth to release all its fragrance. He then inhaled a spoonful with a squeal not unlike air escaping a punctured tire. After rolling it around on his tongue, he neatly bull's-eyed a cuspidor, gave the tabletop a slight turn, and took on the next cup.

"We classify coffee with such words as smooth, acidy, Rioy, winy, sharp, pungent, or neutral. Some, like acidy, may sound

"*Mad Dog in a Coffee House,*" *by Thomas Rowlandson, satirizes an English coffeehouse of around 1800. Coffeehouses swept Europe in the 17th century as havens of temperance and wit. In London they served as forums for emerging political consciousness. At the time of this caricature, however, they were in decline, having spawned the English private club.*

negative but are actually favorable traits.

"Identifying a batch and where it's from isn't too difficult: This is a Brazil from northern São Paulo state."

The United States might never have acquired the coffee habit if rebellious colonists hadn't resisted Britain's tax on tea, dumping a load into Boston's harbor and refusing to buy any more from Tory sources. By the time the Revolution ended, coffee had preempted tea as an American table mainstay.

Our forebears took their coffee seriously, steadily, but not with any frills. They simply poured loose coffee, crudely milled, into water, sometimes added eggshells to settle the grounds, and boiled the whole mess to the blackness of a bat cave. Not gourmet, perhaps, but it warmed and fortified many a frontiersman, and such coffee still satisfies some cookout chefs.

Like others, I have long sought the ideal recipe: filter, drip, or perk; beans and blends from this place or that; roasts that range from light brown to something short of soot.

I managed to figure out that the world's annual bean production could make 3,644,000,000 cubic feet of liquid coffee, a volume equal to the Mississippi's outflow for an hour and a half. But I have yet to figure out how to brew that perfect cup. □

ANTONIO SANTOS COLLECTION

A Sumatran Journey

By HARVEY ARDEN

Photographs by
DAVID ALAN HARVEY

BOTH NATIONAL GEOGRAPHIC STAFF

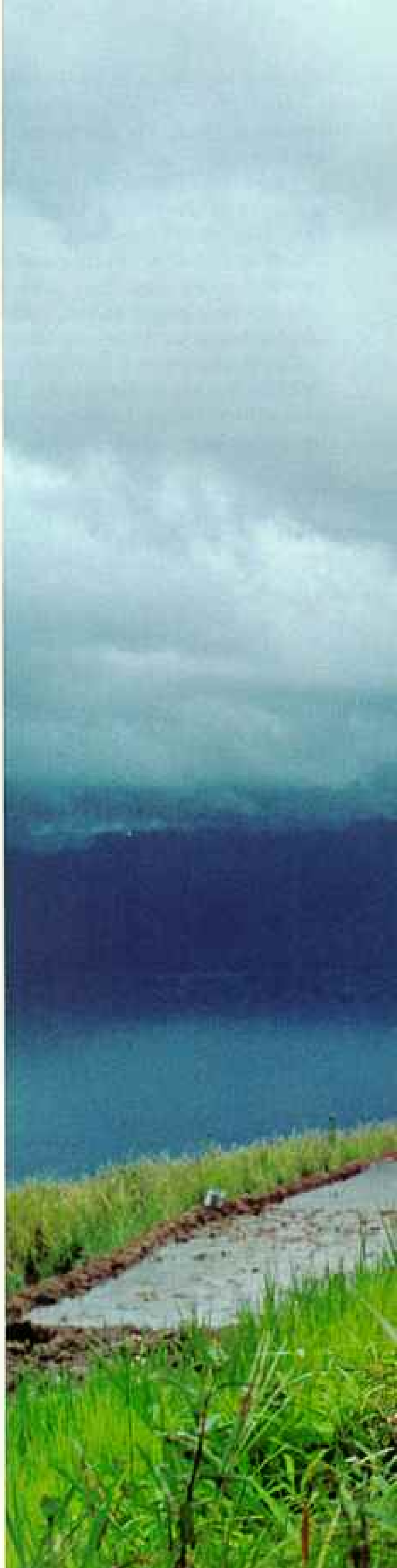
SUMATRA TAUGHT ME many things, but perhaps the most useful was the humbling concept of *jam karet*—rubber time. It has nothing to do with rubber trees, though that vast Indonesian island taps more than its share of them. No, jam karet has to do with filtering frustration out of daily events, and accepting what must be.

I was introduced to it on the journey from Telukbetung, Sumatra's southern port, to Palembang in the interior—a scheduled nine-hour trip by rail.

The train, a vintage affair, chugged and wheezed through the logged-over countryside, repeatedly hissing to a stop for no seeming reason. As it paused for ten, twenty, thirty minutes, the heat grew oppressive.

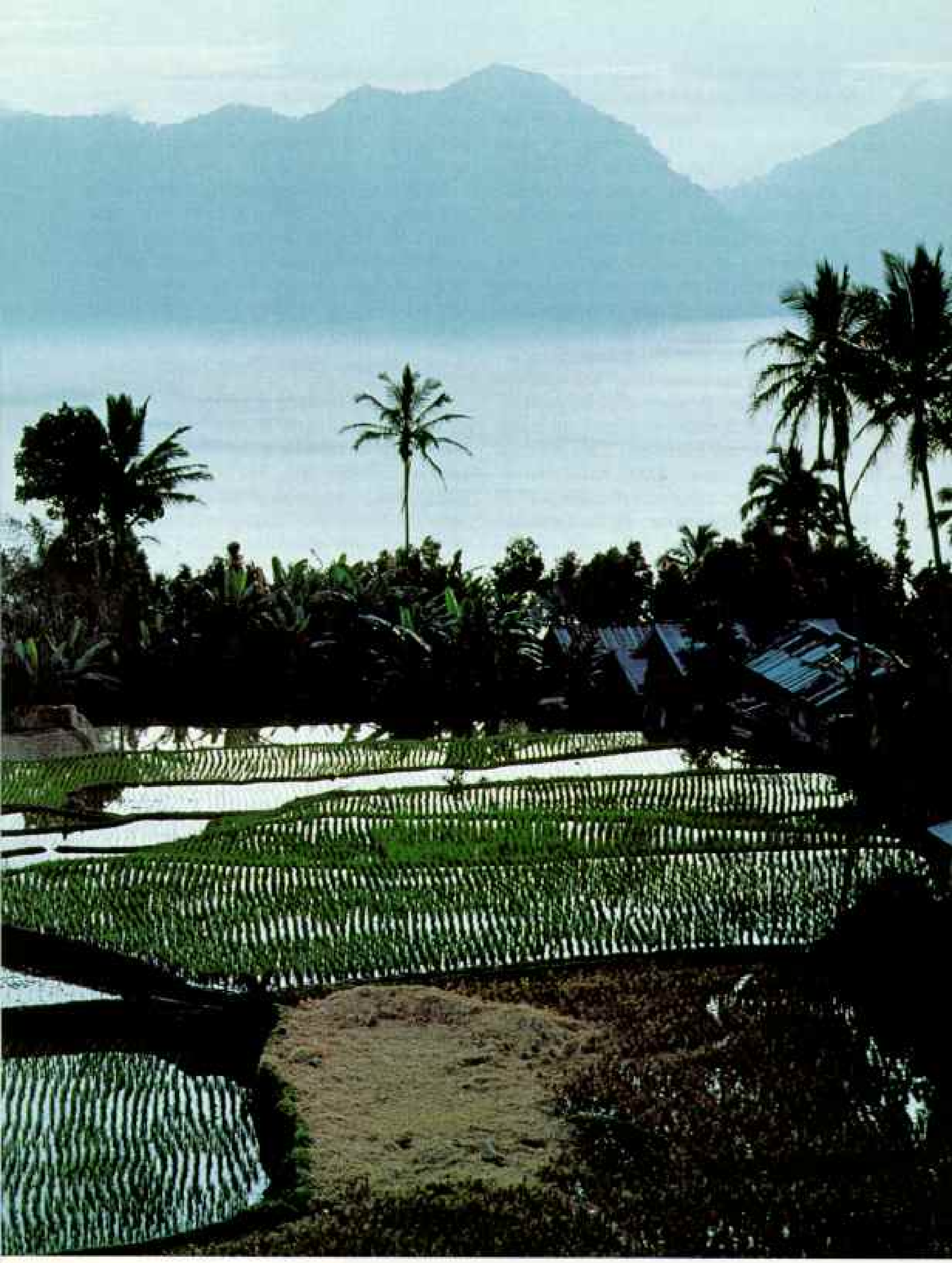
Exploring the breezeless cars, I found hundreds of *transmigrasi*—landless poor from overcrowded Indonesian islands—being resettled in Sumatra's open spaces (Java has 1,100 persons per square mile, Sumatra a mere 90). This voluntary program aims at transplanting an astonishing 2.5 million people during the current five-year plan alone.

These transmigrasi were crammed together with all their worldly goods—pots and pans, bedding, bicycles, sacks of rice, crates of squawking chickens. But they seemed not to mind the long delays; most stared



At home in an ancient volcano, *a rice farmer eyes a storm above Lake Toba, cupped in a crater on Indonesia's Sumatra. His upland home rises high and cool above jungles and swamps of the world's sixth largest island.*

Paddies shingle the shore *of Lake Maninjau, another crater lake in Sumatra's thousand-mile-long Bukit Barisan—"parade of mountains." Visited by Marco Polo,*



sought by Columbus as one of the fabled East Indies, Sumatra has seen explorers and exploiters come and go in quest of its pepper, rubber, coffee, and mineral riches.

out the windows with unexpectant eyes.

"Why hurry?" asked a father cradling two children. "We waited months before they let us go. When we get off the train, we wait some more. They take us into the jungle, give us seeds, a buffalo, some tools to cut trees and build houses. It will be years before we have a real home. So why hurry?"

Chastened, I returned to my seat and waited out the further delays without complaint. Rubber time—a useful concept in a land where impatience is futile.

The train pulled into Palembang long after dark. "Only six hours late," the conductor said, smiling. "Beware of pickpockets."

I learned much more, of course, in many weeks of exploring Sumatra. This western bastion of Indonesia's 3,000 habitable islands sprawls like a dozing crocodile just 60 miles south of Singapore, its half-opened mouth pointing toward Java and its tail toward India (map, page 413).

Bisected by the Equator, the California-size island is a place of wild and improbable extremes—29 volcanoes, 13 of them active; a thousand-mile-long tidal swamp; vast rain forests roamed by elephants, rhinoceroses, tigers, and orangutans; and exotic flora including the rare rafflesia—the world's largest flower—more than a yard across.

It's a place, as well, of incredible natural wealth, producing 50 percent of Indonesia's exports—including 23 percent of the world's rubber, a tenth of its tin (mostly from the offshore islands of Bangka and Billiton), plus huge harvests of coffee, tea, pepper, palm oil, and other cash crops. It is also a barely tapped storehouse of gold, copper, and other mineral wealth.

Here, too, lie the biggest oil and gas fields in Southeast Asia. When Japan invaded the Dutch East Indies in 1942, Sumatra was a prime objective—not only for its natural riches, but also because of its strategic position on the Strait of Malacca, chief shipping lane between China and India.

Texans Leave Their Brand

"You from Texas or America?"

The question came from a smiling youth who hopped unbidden into my open-back taxi in Telukbetung. He was the first of many Sumatrans who would suddenly materialize beside me, eager to practice English—a highly esteemed second tongue in Indonesia. The stereotype Texas oilman who helped pioneer Sumatra's oil industry had obviously been branded deep on his consciousness.

I had envisioned Telukbetung as a sleepy South Seas port. Instead, I found a noisy, roiling city, fuming with traffic, vivid with flowers and pastel architecture, redolent of odors—most noticeably that of the durian, a spiky-husked, melon-size fruit that smells like rotting meat but tastes (if you can get it past your nose) like sour custard spiked with sweet almond liqueur.

Humanity in transit: *A father and his children peer from a train (**left**) taking them from crowded Java to resettlement in Sumatra's wide-open spaces.*

*Other "transmigrasi," or landless migrants, cram a ferry (**right**), provisioned only with patience and their few worldly goods. Each family will receive subsistence supplies under a voluntary program designed to transplant 2.5 million Indonesians within a five-year period.*

When it pours, *it keeps on pouring in a land left wringing wet by more than a hundred inches of rain a year. The infamous Sumatran squalls sweep in from the Strait of Malacca to batter—and bless—the fecund landscape.*

Vendors hawked shoes, unripe mangoes, herbal remedies. A loudspeaker blared the muezzin's call to prayer. Lurid posters bally-hooed the latest blood-and-sex movie epics from India, Japan, Italy, and the U. S.

The jungle I had expected has long since been driven far back by logging, plantations, and transmigrasi settlements—some started as far back as the 1930s by the Dutch, who ruled these islands for 320 years before Indonesia declared independence in 1945.

At a pepper plantation I plucked a cluster of peppers—still green—from a tall thin tree. Saronged women nearby raked ripe black peppercorns out to dry on woven mats. The trees' abundance along Sumatra's littoral gave it the name Pepper Coast.

Sumatra, of course, was one of the East Indies Columbus sailed westward to find. By the late 1200s, Arab and converted Indian traders brought Islam to Sumatra, whence it spread to Java and neighboring lands. Europeans arrived later—the Portuguese staking their first claim in the area in 1511. On their heels came the British and Dutch, aware that a single cargo of pepper could earn a princely fortune.

Signs of Old Eruption Remain

On a hillside above Telukbetung's harbor, I pondered a large iron buoy weighing at least a ton. Now a road marker, it was tossed up here—nearly a mile from the sea—by a catastrophic tsunami from Krakatoa's eruption in 1883.

Where that volcanic isle once stood in the Sunda Strait between Sumatra and Java now looms a smoldering black cone named Anak Krakatau—"son of Krakatoa." A Sundanese boatman named Sinestro had shown it to me, and had told me of that cataclysm nearly a century before:

"In the time before I was," he said, "a great island rose up where you see Anak Krakatau now. One day—BOOM—it blew up and was gone. The sky turned black. The sea rose up. Never was there another wave like that!"

Eighteen times more violent than the May 1980 eruption of Mount St. Helens, the explosion was heard in Ceylon, 2,000 miles away; the tsunami killed 36,000 in Sumatra and Java. Debris-laden "Krakatoa winds" circled the earth, creating brilliant sunsets.

No doubt the blast struck panic in the hearts of Sumatrans even in Palembang, now a port city of 600,000 some 50 miles up the broad Musi River. Here in the 7th century arose the Buddhist Srivijaya empire,

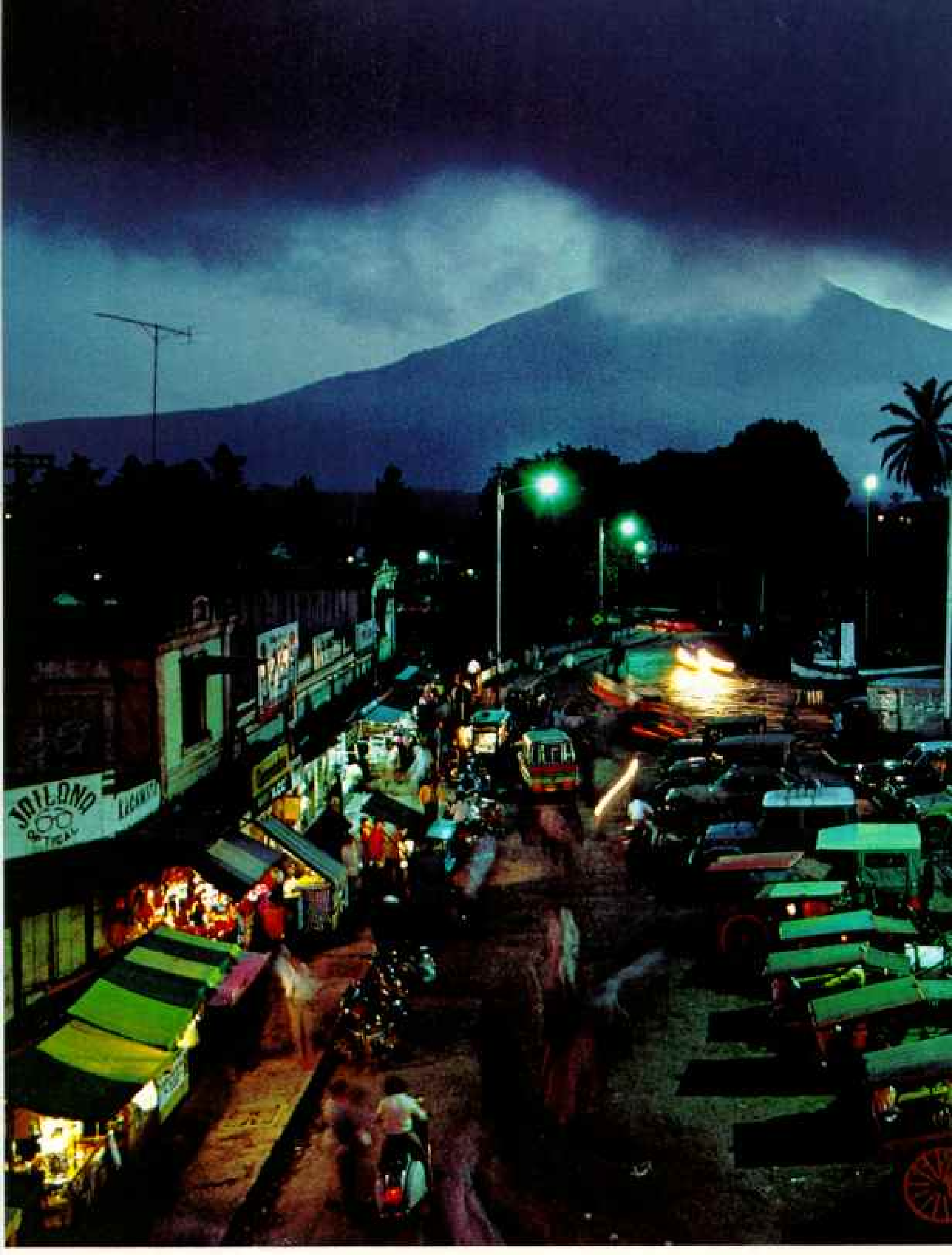
Sumatra

California-size Sumatra rides the Equator at Indonesia's western prow. Here bloomed the early Buddhist Srivijaya empire. European influence landed with the Portuguese in 1511; then the Dutch prevailed for 320 years until Indonesia proclaimed independence in 1945.

whose influence eventually extended to the Malay Peninsula. Great merchant fleets once anchored in the harbors of this Phoenicia of the East, paying fat tolls to the king rather than face his pirate fleets.

Today, however, a new empire flourishes at Palembang—an empire of oil called Pertamina, the state-run petroleum monopoly. I drove for an hour through the vast refinery complex at Plaju, across the Musi, virtually a city unto itself with miles of neat employee bungalows and executive homes, clubs and restaurants, swimming pools and tennis courts, even a mosque—all set against a backdrop of cracking towers billowing brilliant orange flags of fire.

For years run as a kind of fiefdom by company officers who amassed fortunes, Pertamina by 1975 had run up one of the biggest debts in commercial history—an estimated 10.5 billion dollars. To keep its oil flowing, Indonesia—a member of OPEC, the Organization of Petroleum Exporting Countries—renegotiated loans, bringing the debt to manageable proportions. Today the government keeps firmer tabs on Pertamina.



A lowering thundercloud *seems to erupt from Mount Singgalang, one of two volcanoes shadowing the bustling highland market town and tourist center of Bukittinggi. Dutch*

colonizers once made Bukittinggi their stronghold, aiming cannon from the heights of Fort de Kock into the town itself to preempt rebellion by the restive populace.

"*Sudah rusak!*—Already broken!" announced my driver, Jojo, whose battered Land-Rover I had hired to take me the 200 miles from Palembang to Bengkulu.

"Need water hose," Jojo said, arriving at my hotel door two hours late. "I get it fixed and come right back!" It would be 48 hours of rubber time before he returned.

Meanwhile, I visited Palembang's street of gold-cloth weavers, where women bend over looms from dawn to dusk for the equivalent of a dollar or two a day. "Time doesn't matter," I was told. "Price depends on how much gold goes into the fabric."

I wandered through a Chinese Buddhist red pagoda temple, thick with incense, adorned with elaborate altars. Here pray members of the large Chinese community, grudgingly respected for their business acumen by the native population. I noticed a thronelike red chair with hundreds of long nails protruding up from the seat. "Used in our penitential ceremonies," an elderly Chinese explained. He showed me a snapshot. "See, I do this a few weeks ago." The photograph showed him plunging both hands into a bronze vessel. "Filled with boiling oil," he said. "I wash my hands in it, but the gods protect me. Look." He held out his hands, wholly unmarked.

Jojo Versus the Potholes

Finally Jojo returned, and we set off for Bengkulu along pothole-cratered roads that are justly infamous. Even before the onset of the monsoon rains, we averaged barely 15 miles an hour, crossing sagging wooden bridges through whose broken railings less fortunate travelers had apparently plummeted. Jojo drove Sumatran style—hewing stubbornly to the middle of the road, swerving only to avoid onrushing perdition.

By nightfall the Land-Rover had broken down four times. Jojo tinkered at the engine with a screwdriver and pliers, his only tools. Finally he shrugged. "Can't go on. Mountains ahead," he said, and somehow coaxed the vehicle back downhill toward Palembang. Determined to go on, I remained with my luggage beside the road, alone in the inky equatorial darkness.

I recalled some advice given me in Jakarta by Martin Cramer, a German schoolteacher and a seasoned traveler in these parts. He had cautioned me: "Whatever happens, remember, don't panic. In Sumatra there's always a way out of every situation. Just be patient. Help will arrive."

After 45 uneasy minutes, a pair of dim headlights swung out of the darkness. A bus! I waved it down, dickered over price with the driver, and soon found myself jouncing along once again toward Bengkulu.

Beyond the mighty Bukit Barisan—Sumatra's narrow, thousand-mile-long

Freewheeling youths *spin through Medan, the island's biggest city, with a population of more than a million. These schoolgirls* ***(right)****, members of a figurehead royal family headed by the Sultan of Deli, are among those who can afford motorbikes. Life passes by at slower pace for a young woman* ***(left)*** *who, like 80 percent of the population, lives in rural Sumatra.*

National Geographic, March 1981

parade of mountains—we corkscrewed next day down the road to Bengkulu. The British held sway here from 1685 to 1825 before ceding Bengkulu to the Dutch in exchange for Malacca. Reconstructed Fort Marlborough still overlooks the commodious harbor on the milky blue Indian Ocean. The brilliant British statesman Sir Thomas Raffles ruled here briefly before going on to found, in 1819, the greatest entrepôt in Southeast Asia on a then obscure island to the north called Singapore.

My guide Kustarto, a forester who scouts out sites for transmigrasi settlements, agreed to take me into the rain forest in search of the rare rafflesia. Named for Sir Thomas, this parasitic plant blossoms with large orange petals surrounding a bowl that can hold six quarts of water.

"I'm a rare thing too—a Baptist in Bengkulu," Kustarto laughed as we drove up into the mountains. "I come from Yogyakarta on Java. Big Baptist community there. I studied two years for the ministry. But my first love is the forest. When I'm alone here, that's when I feel God."

Mosses and lichens cushioned the forest floor. Gnarled roots grabbed our ankles, thorns raked our legs. Sunlight filtering through the dense canopy turned the air a glowing emerald green.

"Many elephants and tigers out here, and leopards, too," Kustarto said. "But most dangerous is the little blue snake with the red head—one bite and you'll be dead in minutes. And watch out for scorpions!"

Kustarto sniffed the air.

"Best way to find rafflesia is to smell it," he explained. "The flower stinks like a dead rat; you can sniff it from 25 meters."

But two hours-long forays proved unrewarding. "Too late," Kustarto finally lamented. "Rafflesia gone for this year. A week earlier and maybe we find one."

No matter. The Sumatran rain forest itself, rife with primeval beauty and

***Latex trickles** from one of 375 trees lanced each day by a plantation hand and his son (**below**) near Bohorok. Though most rubber is grown on small landholdings, nationalized plantations contribute a third of Sumatra's crop.*

*Construction workers (**facing page**) take time for a song, a favorite pastime of the Batak, one of many ethnic groups in Sumatra's multicultural society.*

lurking terrors, was reward enough.

After returning to Bengkulu, Kustarto pointed out a house where the Dutch, back in 1938, had exiled the young nationalist leader Sukarno, later first president of the Republic of Indonesia.

We spoke of Sukarno's fall after the attempted Communist coup in 1965. Anti-leftist generals, including Indonesia's current president, Suharto, took control of the government. In the aftermath, an estimated 200,000 to 300,000 Communists and suspected Communists were massacred.

I asked Kustarto if he had taken part in the fighting. He nodded, grim lipped.

"I killed 24 men," he said flatly. "Like *this*." He made a thrusting motion with his hand, as if holding a dagger. "Very bad to kill, I know, but Communists very bad too. If we don't kill them, they kill us."

He looked at me intently.

"If you Americans understood that, Vietnam would not be Communist today."

Misery Rains on a Bus Trip

The bus ride from Bengkulu to Bukittinggi can be a horror story unto itself. In the rainy season, now upon us, the skies flush down such torrents that the roads dissolve. Mudholes ingest vehicles up to the headlights. Buses have to winch themselves out—which can turn a scheduled 36-hour ride into a weeks-long expedition.

Inside the bus, six or seven passengers sit shoehorned into seats intended for four. Your limbs quickly fall asleep. Unbearable heat rises from the engine. Loudspeakers only inches above your head blare down Indonesian pop music.

Aboard these buses you meet occasional Westerners—mostly young people in jeans following the "circuit" from Istanbul to Australia. I shared a few days of rubber time on a bus with bearded Californian Bill Dalton, who has traveled through 83 countries in Levi's, sandals, and T-shirt. Turns out he was in Sumatra to update his *Indonesia Handbook*, a manual for economy travelers like himself. "It's for people who can only afford to spend, say, five dollars a day in Indonesia," he said.

I raised an eyebrow. Five dollars a day?

"Excluding transportation, it's possible. You get a cot or floor mat in a cheap room

HORAS

Grup PARJAJANG !

Elders are looked up to *in Batak society, where grandson and grandfather share a special bond and some time in a "warung kopi," or coffee shop. The once cannibalistic Toba Bataks became Christians in the late 1800s but remain a minority in a land 80 percent Muslim.*

for about one dollar. Another buck buys all the fruit you can eat. A third buys you a hot meal of *nasi goreng*, Indonesian fried rice. Heck, that still leaves two dollars for mad money."

Bill's prime advice for *all* travelers: Never show anger, or even annoyance. "It can only backfire. Patience is inbred among these people. But if a Sumatran's all but infinite patience is finally worn thin by your hostile attitude, watch out. Going amok is an old custom here."

Calf Bests a Mighty Beast

According to a legend, a king from Java once challenged the Minangkabau people of West Sumatra to battle. The Minangkabau proposed the matter be settled by a fight between two water buffalo, one from each side. The Javanese agreed, fielding a huge female buffalo with enormous pointed horns. The Minangkabau, always known for their cleverness, fielded a mere calf, to whose fledgling horns they had tied sharp knives. When the two met, the buffalo allowed the calf to suckle—and a gory but brilliant victory was won by the Minangkabau.

To this day Minangkabau houses have roofs curved like buffalo horns. You see them around coastal Padang and highland Bukittinggi—large wooden structures with gracefully upswung gables. Each marks a room where a daughter of the house matriarch receives her husband and raises their children. Among the Minangkabau, property is inherited down the female line. Hence men must amass their own fortunes, and tend to go off to Java, where they have prospered in business and politics through their drive and determination.

During a ramble through the spectacular Bukittinggi highlands, my guide, known as Uncle Dee Dee, pointed out a small village called Kotagadang.

"Former Indonesian Foreign Minister Salim was born there," he said. "Many other famous leaders come from Minangkabau villages around here. It's because our men have little to stay home for that they've gone out into the world and won such fame.

"Did you know, among our people a child's father has little role to play. It's the uncle—the mother's brother—who sees to the child's welfare."

Uncle Dee Dee took out a photograph of himself as a young mustachioed dandy in the days when he himself went out to seek his

fortune as a merchant and businessman.

"I even worked as a circus clown for a while," he said, flipping a cigarette in the air and catching it deftly between his lips.

But Uncle Dee Dee's fortune never came. He settled down in Bukittinggi as a guide, selling herbal remedies to make ends meet.

Now he's often sought out for one of Uncle Dee Dee's "famous walks," but he takes only those he cares to and refuses payment. "Tourists spoiled me with their money," he says. "Now I do it only for love."

Our walk took us through some of Sumatra's most breath-stealing scenery, a world of soaring volcanic peaks—including 9,485-foot Mount Marapi—set amid terraced rice fields of an electric green. Here and there tin-roofed mosques flung back the blinding sunlight like mirrors.

We filed across a tumbledown bridge. "Built by the Dutch," Dee Dee said. "Never fixed since." The bridge invoked a memory.

"During our war against the Dutch," he recalled, "I was a pacifist—but still a

patriot. Other people carried guns. I carried words. Wherever people gathered, I spoke against the Dutch. And it worked, didn't it? It took words *and* guns to create our nation."

We reached a village where a bullfight was taking place. As in the Minangkabau legend, the contest was between two water buffalo, who butted heads until one trotted away in defeat. They fought in ankle-deep mud that splattered the spectators as well as the animals.

By the time the contest ended, it was dark. Walking back through the paddies in the blackness was nearly impossible. Once again, however, a bus came out of the night to the rescue. Hiring it on the spot, I invited a couple of dozen other stranded Westerners to join us—hard-core travelers all—and jabbering away in English, German, French, Dutch, and Norwegian, we bounced back through the potholed Sumatran night to Bukittinggi.

A Mountain Stirs, a Village Dies

Crossing the Equator in the cool, breezy highlands of the Bukit Barisan, we descended toward Pekanbaru in the swampy lowlands. En route we passed a village of thatched houses that had been crushed literally out of existence. "A river of rocks came down from the mountain," said a man picking among the ruins. "Many people killed."

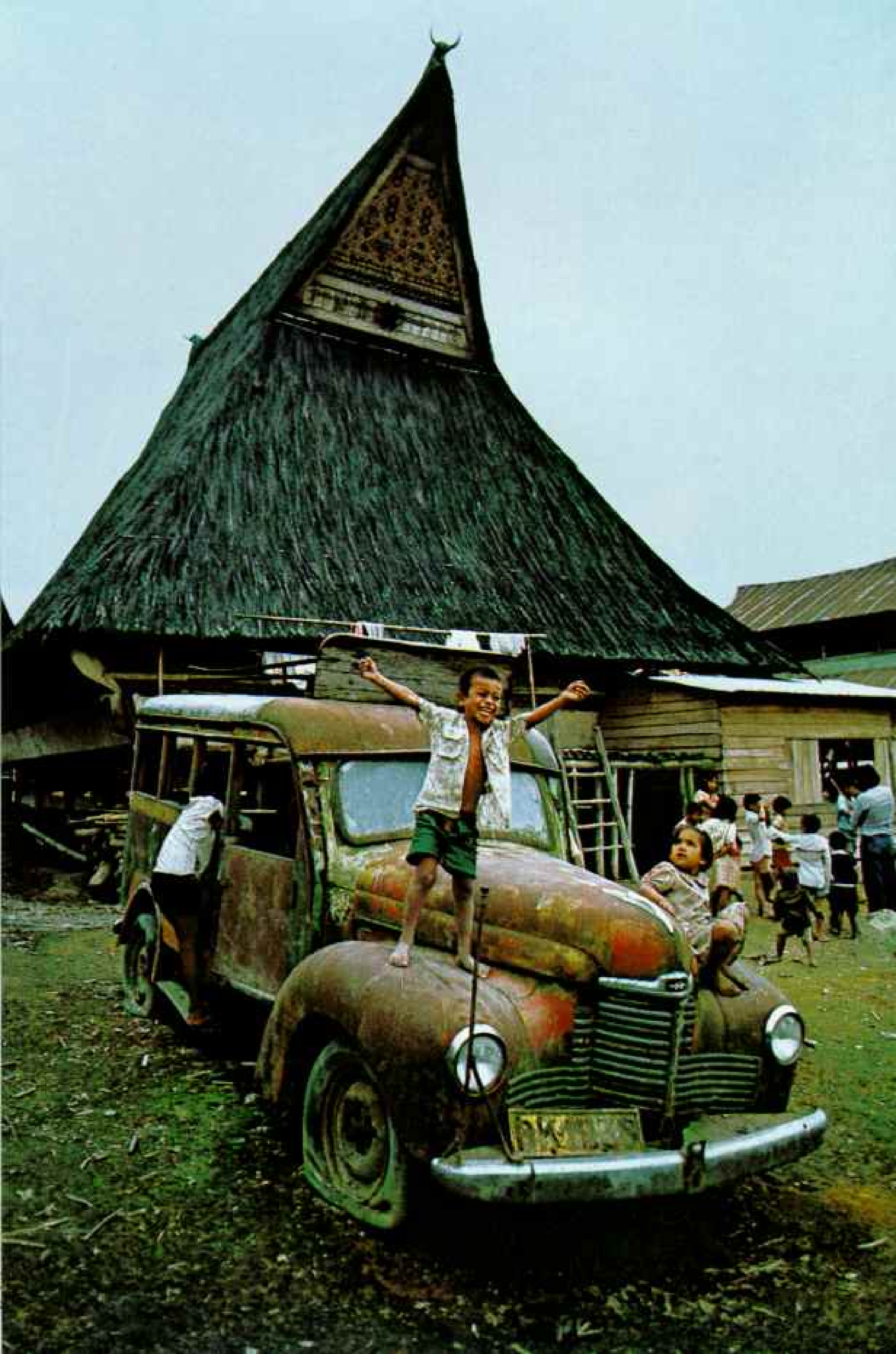
Mount Marapi, it appears, had shrugged its mighty shoulders, sending down the avalanche—a not infrequent occurrence in these parts.

We reached Pekanbaru, a bustling inland port of 170,000 surrounded by dense jungle and mangrove swamps—and Indonesia's most productive oil region. At nearby Rumbai I wandered the neatly trimmed lawns of P. T. Caltex Pacific Indonesia, jointly owned by Standard Oil of California and Texaco. It's a resortlike complex reminiscent of Pertamina's in Palembang.

"Today fewer than a hundred Americans remain," explained managing director Frank Robin. "Under the government's 'Indonesianization' program, we are training others to take our jobs. A few years more and the field operation will be run completely by Indonesians."

Nearby I visited the first oil well to siphon the rich Minas field's low-sulfur crude.

Wheeled jungle gym: *Batak children scramble over an old station wagon in front of a 300-year-old ancestral home* ***(right)****. Such dwellings are shouldered on woodpiles and topped by a saddle-shaped thatch roof, though tin is becoming more common. Inside, a communal room houses as many as eight families. Sumatrans raise large families, believing that many children bring prosperity. Youngsters are rarely left untended and are cared for by all. Such loving vigilance continues while this mother has her hair dyed* ***(below)****.*



In the morning-becalmed sea, *a man and son ready their handcrafted "perahu" for a day's fishing on the Indian Ocean. They seek tuna, mackerel, or anchovies.*

Japanese investment has underwritten a growing frozen-fish and shrimp export industry, but fishing generally remains small scale, mostly limited to local markets.

American engineers located the site just before World War II, but it was the invading Japanese who drilled the first well. Today the region sends more than 800,000 barrels a day to world oil markets.

Pushing northwest along the mountain spine of Sumatra, you come to a natural wonder: Lake Toba. Miles wide, deep and blue, it is cupped in the crater of an extinct volcano. In the center of the lake lies Samosir Island, ancestral home of the Toba Bataks, one of the most fascinating of all Sumatran peoples.

Formerly cannibals, the Toba Bataks today are peaceful and hardworking. For centuries Muslims from Padang to the Aceh region in the north tried, often by force, to convert them, but the animist Bataks resisted fiercely. Then, in 1862, a Lutheran minister from Germany named Ludwig Nommensen arrived in Batakland. Within a few decades, armed only with a Bible and a fiddle, he Christianized the people.

Today, any Sunday morning on Samosir Island, you hear lovely Christian hymns drifting out the open windows of Batak churches—as strange an anomaly as any to be found in this land of anomalies.

To Muslims, however, the Christian Bataks are still notorious. Though they've given up eating human flesh, they still eat pigs and dogs.

I took a ferry one morning across Lake Toba from Samosir Island to the market town of Haranggaul on the mainland. During the five-hour voyage Batak women sang charming Christian melodies from a hymnal. Near the stern a woman was cooking a pot of stew for sale to passengers. The odors wafting from her kettle roused my appetite.

Finally, ladling mounds of stew into tin plates blanketed with rice, the woman passed out portions to eager passengers for the equivalent of about 30 cents. Smiling, she held a piled-high plate before my twitching nose.

"Is good. Is good," she said. "Eat!"

I gazed into the plate. Sitting there in a bed of rice and vegetables was a dog's lower jaw, each white tooth neatly in place.

"Try! Try!" she implored.

"Sorry, I am Muslim," I lied, with silent apology to true believers.

She shrugged and started to eat the food herself, breaking the jaw apart as casually as I would a chicken bone and gnawing hungrily. *Ping, ping* went the dog's teeth as she spat them one by one into the tin plate.

Cultures Continue to Clash

In Medan, Sumatra's biggest city—a boisterous metropolis of a million people—I lunched at the plush Medan Club with my gracious Indonesian host, Dr. Soekardja, and a Dutch engineering consultant, Hans Veenhuyzen.

Most of the Dutch left Indonesia during the 1945–49 war for independence. The few who remained were expelled in 1957-58, during Sukarno's confrontation with the Netherlands over Dutch New Guinea, now called Irian Jaya. After Sukarno's fall, Dutch businessmen were allowed to return—among them Hans Veenhuyzen.

Hans, the son of a Dutch planter, had been taken prisoner by the Japanese in 1942, at age 16, along with hundreds of others.

"For a time we worked building roads and railways, but then I was sent here to Medan," he said. "The Japanese had us build a Shinto temple with a special platform for sumo-wrestling exhibitions."

Dr. Soekardja smiled. "This is the very building," he said. "When the Dutch retook Medan in 1946, they turned it into the White Society Club. Now, of course, it is for Indonesians, though not exclusively. Hans here is now one of our members."

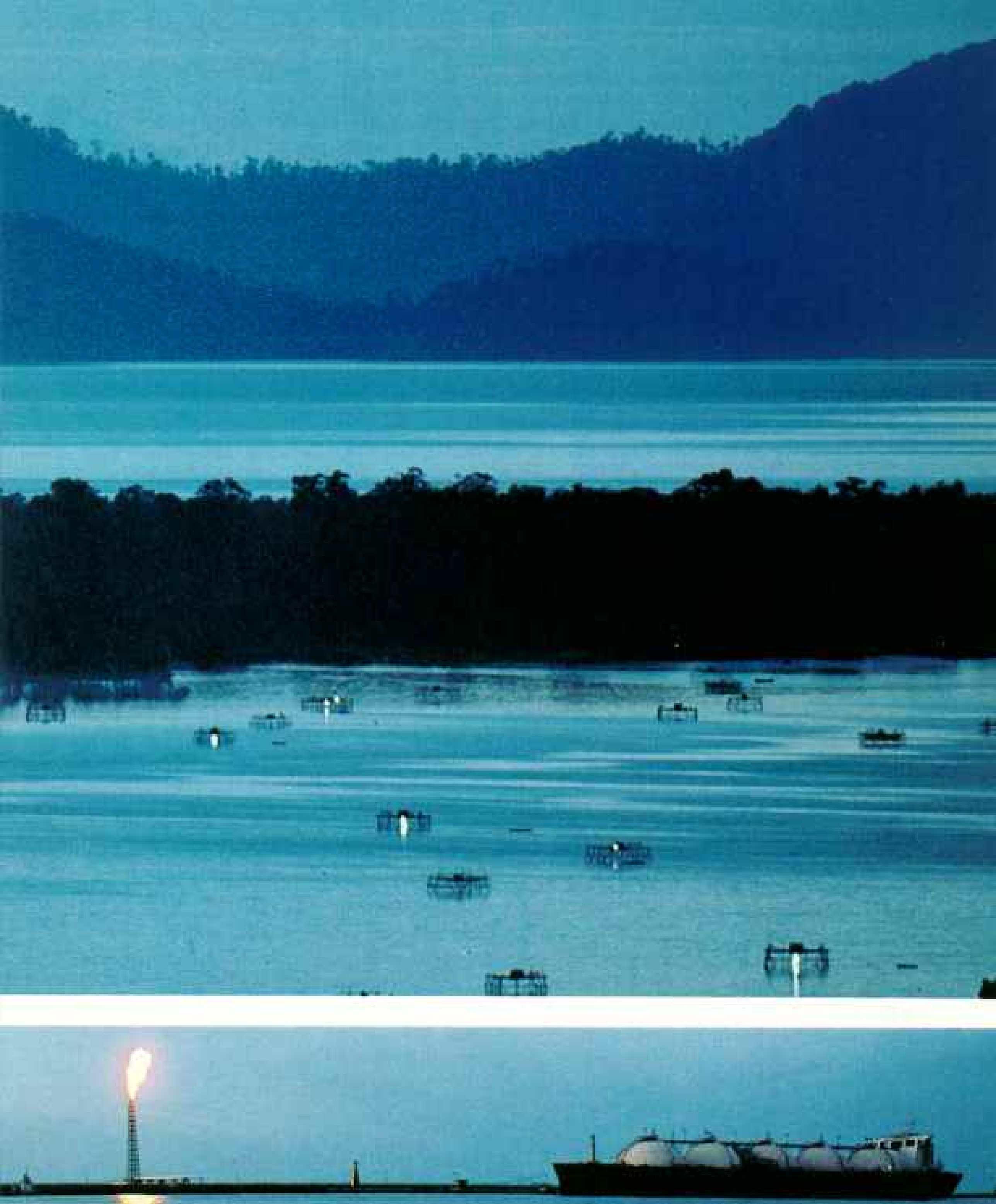
Hans pointed out the thick beams supporting the structure's roof. "I helped carry those and put them in place," he told me. "No doubt I'm the only member here who helped build the club as a slave laborer."

My final stop in Sumatra was Aceh, the

With star-cluster brilliance, *a battery-powered headdress lights up the three-day-long wedding between bride Martini binti Amin and Sutan Rajo Hamid of the Minangkabau people. According to custom the bride's family does the proposing. Family names and property pass down the maternal side of this ethnic group, centered in western Sumatra. Ambitious men make their own fortunes.*

Like fireflies at rest, *fishing huts hung with lanterns speckle the Gulf of Tapanuli* **(above)**. *Baited by these lights, herring-size fish called "gembung" blunder into waiting nets.*

Other lights, from a gas-liquefaction plant's flare-off **(right)**, *singe the night sky over some of the world's largest natural-gas fields at Arun, in Aceh province. The oil-soaked eastern flank of the island produces about 50 percent of Indonesia's petroleum exports. Relatively little of the income benefits Sumatra directly, however, since most of the revenue goes to Jakarta, Indonesia's capital. Such frustrations of Sumatrans are cushioned by their unflinching and patient acceptance of the caprices of fate.*



island's northernmost province. One hears forbidding rumors about this, the most zealously Muslim part of Indonesia. Famed warriors, the Acehnese fought the Dutch without letup from 1873 to 1904, and kept up sporadic guerrilla warfare right up until World War II. Thousands of Dutch died here, many ambushed by Acehnese who disemboweled them with razor-sharp daggers called *rencongs*.

In the capital, Banda Aceh, I visited a cemetery where the slain Dutch were buried. One might expect it to be overgrown with weeds by now, but not so. An Indonesian caretaker was meticulously trimming the grounds with a mower.

"We hated the Dutch, yes," he said, "but we respected them too. After independence, no hard feelings. We honor their dead as we do our own."

The few Westerners who make it up this way are cautioned to respect local customs. I heard that women wearing shorts have been stoned here, and that men have been *renconged* for dallying with Acehnese women. But these are exceptions.

I found the Acehnese friendly, gracious, welcoming, among the most highly cultured people in Indonesia. The Arab influence can be seen not only in the culture but in the physiognomy, including almond-shaped eyes and Semitic noses.

There's a definite air of prosperity about Banda Aceh, with its solid homes, well-clad citizens, elaborate mosques, and wide, clean streets.

"Yes," a prominent Acehnese told me, "we are one of Indonesia's richest provinces, with gold, copper, molybdenum, quartz, natural gas—riches beyond counting.

"And yet, we are a disappointed people. Much of the profit goes to Jakarta, too little remains in Aceh. You see how bad the road from Medan is—we are hardly connected to the rest of Indonesia. When the railway broke down, it was never repaired.

"Several times since independence some of our people have revolted against the rule of the central government. They say once we were colonized by the Dutch, now we are colonized by the Javanese.

"Many of our people would like to see Indonesia become a strict fundamentalist Muslim state; they feel the Javanese mix up Islam with the old Hindu and Buddhist ways. They would also like Acehnese wealth to stay in Aceh."

Four-legged Mowers Groom Airport

The plane due to take me back to Jakarta from Banda Aceh was late, of course. "Too cloudy," I was told by the agent at the airport. "No radar here. When the clouds lift, the plane will come. Watch for the man on the bicycle."

The man on the bicycle?

Well, it seems, water buffalo are used here to trim the grass on the landing strip—a veritable cow pasture. When a plane is due to arrive, a man on a bicycle rushes out and chases the buffalo out of the way. His appearance signals passengers that it's time to check in.

At last the man on the bicycle appeared, the buffalo were waved away, and the plane landed. Boarding for the flight back to Jakarta, I glanced at my watch.

"Hmmmm, only three hours late," I said to myself, and sat back to relax. At last I had gotten used to things, just as I was leaving this fascinating, maddening, marvelous world of rubber time. □

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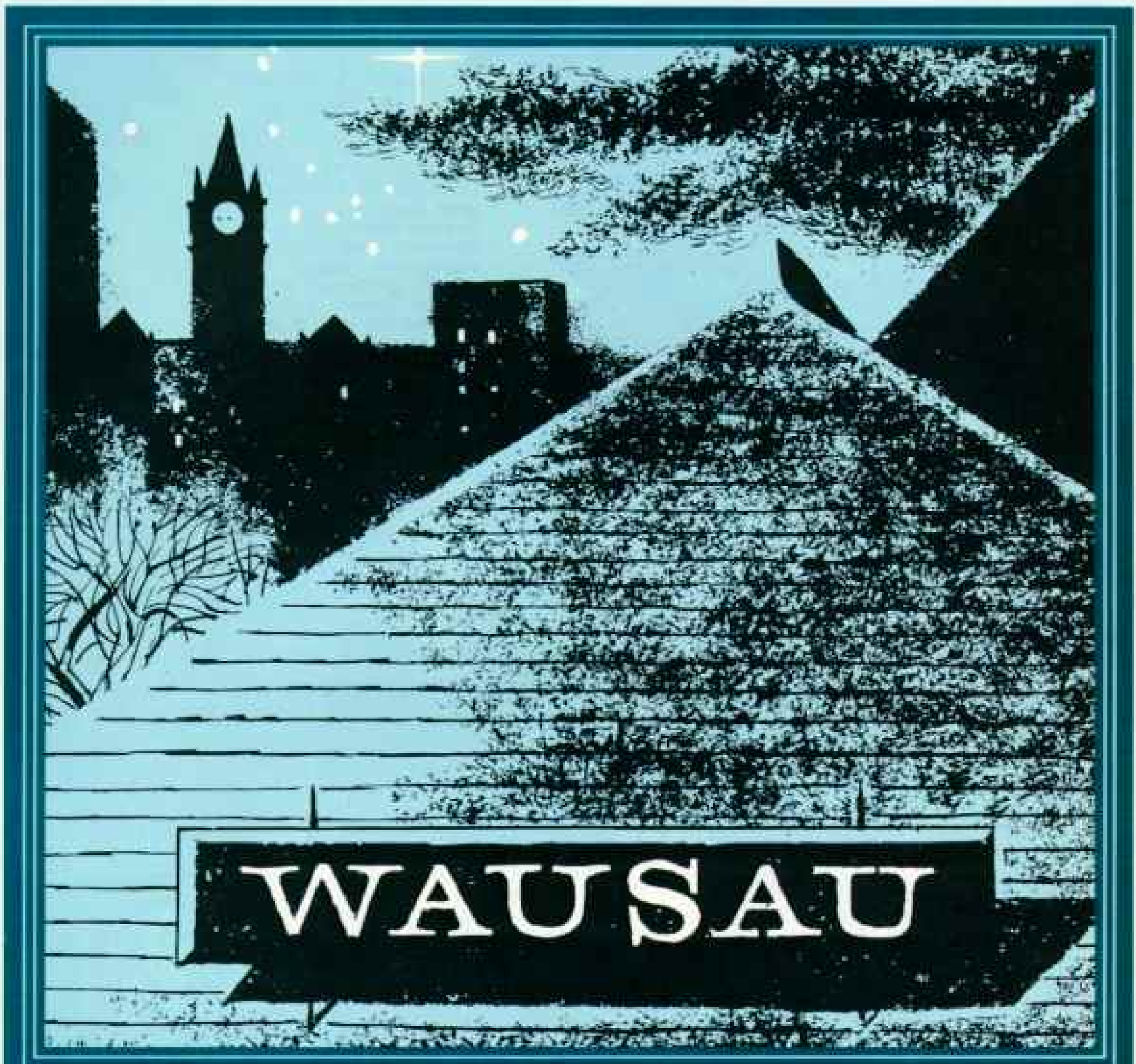

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These books include novels like Melville's *Moby Dick*, Dickens' *A Tale of Two Cities*, Hawthorne's *Scarlet Letter*, Bronte's *Wuthering Heights*. They include serious—yet highly readable—works of thought like Plato's *Republic*...heroic epics like Homer's *Iliad*...sharp-witted satire like Swift's *Gulliver's Travels*...brilliant poetry like Whitman's *Leaves of Grass*.

On everyone's list would be the great works of Shakespeare, Chaucer, Dante, Darwin, and Twain. These are books you want on your bookshelf. Books you want your children and their children to read. And now you can have them—the ultimate private library.

The Volumes Themselves are Works of Art

Your pride in this collection will be two-fold—arising both from the significance and stature of each literary masterpiece...and from the sheer beauty of each volume. Every volume in this unique private library will exemplify the ultimate in the art of printing, binding, and illustration.

Genuine Leather Bindings

Today it is rare to find books bound in genuine leather. The cost of such bindings and the time required to create them has made the crafting of such bindings an almost vanishing art. **But each book in this collection will be bound in genuine leather!**

Intricate Cover Designs Accented With Real 22kt Gold

Each luxurious leather binding will be deeply inlaid with real gold on the spine and in perfectly-matched golden designs on the front and back covers. Then, to bring out the full beauty of each cover design, the pages will be gilded along all three sides with a special golden finish.

Elegant Finishing Touches

Each volume will have beautiful endsheets of rich moire fabric and a matching ribbon page marker. Each volume will be bound with a "hubbed" spine that is characteristic of only the finest books. In every respect, this is to be a collection which rivals anything seen in the great private libraries of days gone by.

Exciting Diversity

The hallmark of a distinctive library is diversity. Therefore, the volumes in the collection will vary in size, in the leathers used, in the distinctive cover designs, and in the illustrations. Yet the collection as a whole will exhibit an unmistakable harmony, because the volumes will be of consistent quality throughout.

Convenient Acquisition Plan

Because of the extreme care and craftsmanship required in printing and binding, the books in the collection will be issued at the rate of one per month. It will give you great pleasure to see your collection becoming more impressive with

(continued on next page)

(continued from previous page)

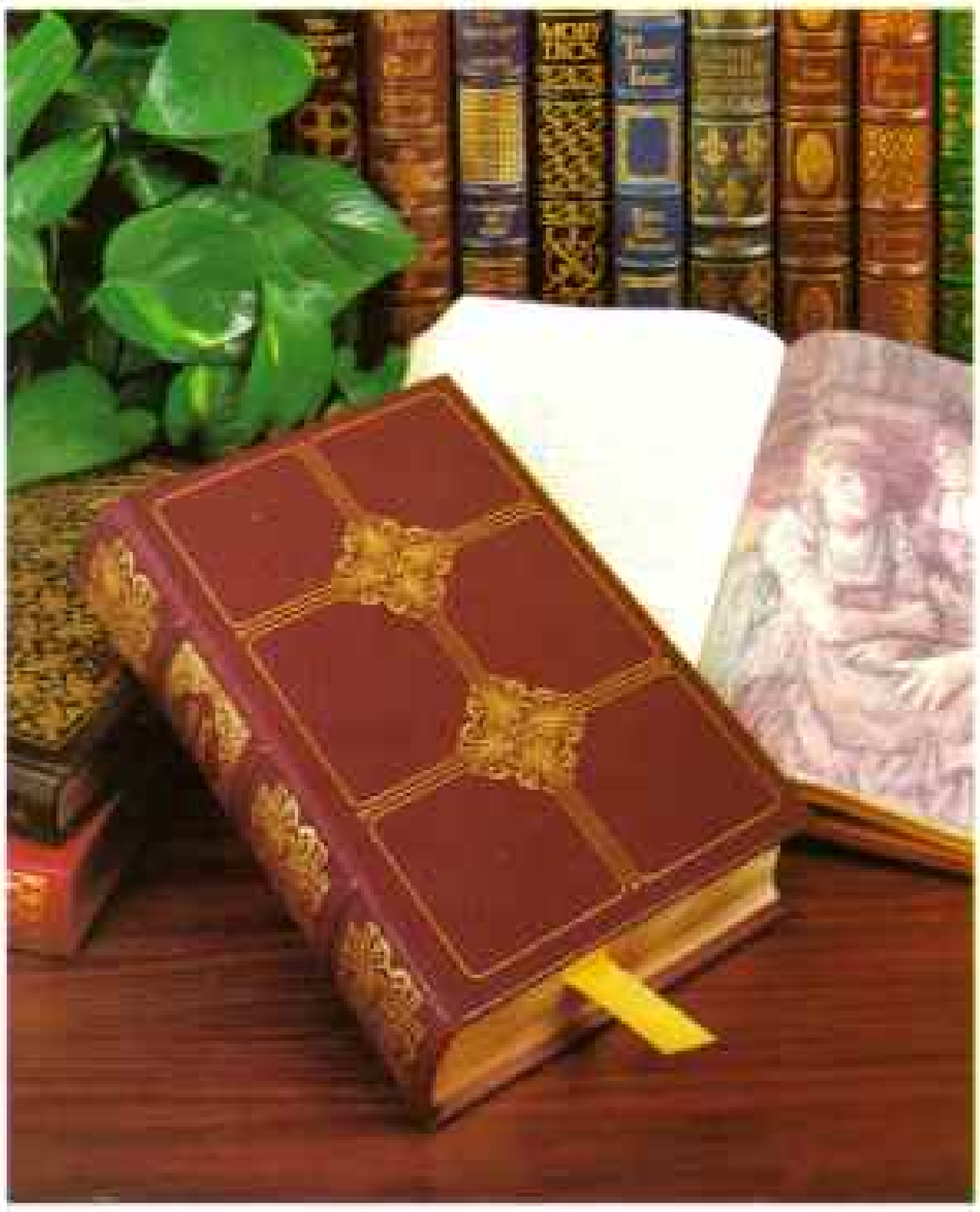
each passing month.

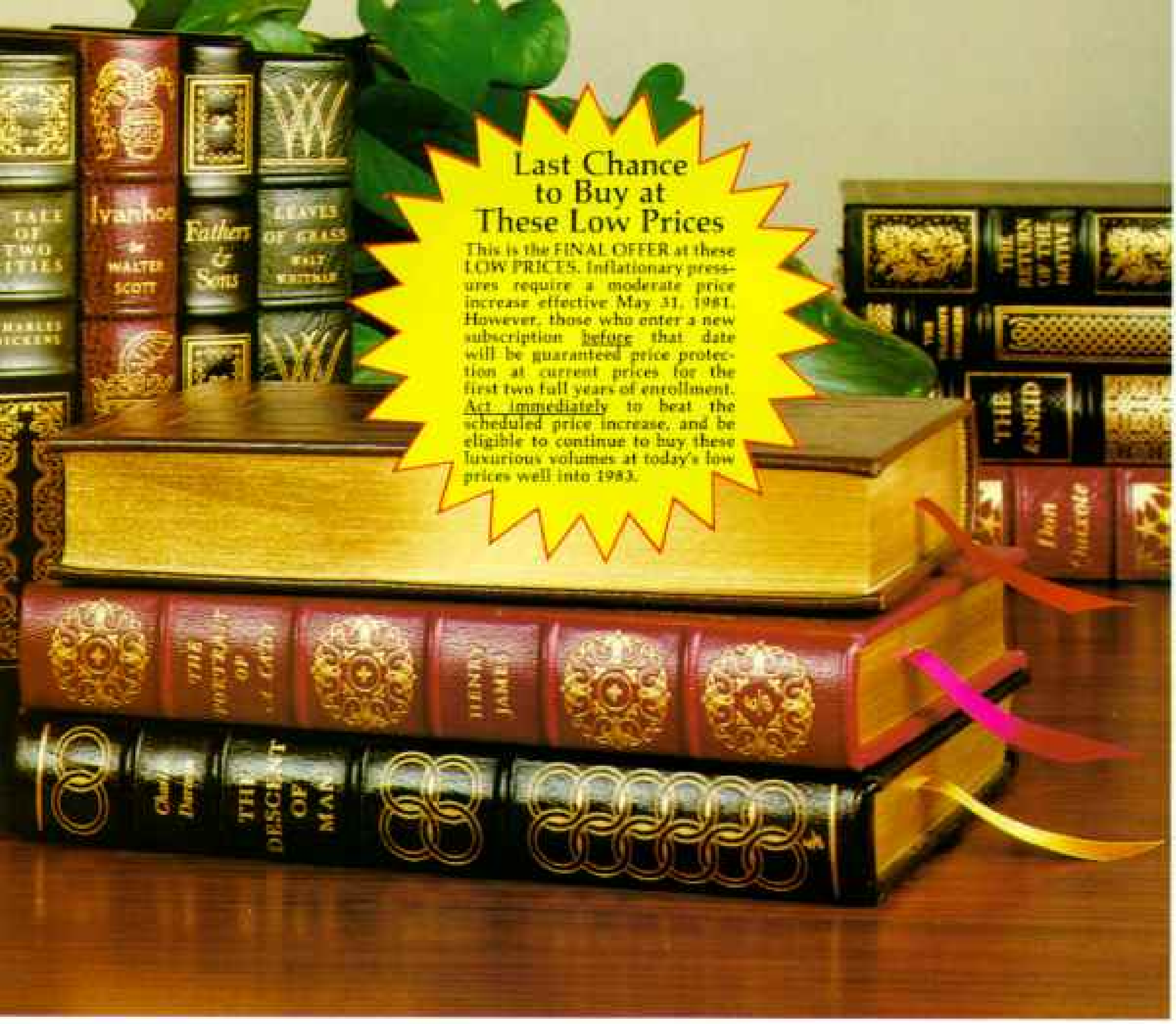
Comparable books bound in genuine leather command as much as $75 per volume. However, you will be pleased to learn that the volumes in this collection will be priced at only $33.50 each for the first two full years. Future volumes will be similarly priced subject to minor periodic adjustments to reflect varying material costs.

If you desire, you may return any volume within 30 days for a full refund. Moreover, you may cancel your subscription at any time.

R.S.V.P.

To accept this invitation, you need only complete the Preferred Subscription Reservation and return it to us. This simple step is all that is necessary for you to begin building a private library of your own that is sure to be envied by all who see it.





MUST BE POSTMARKED BY MAY 31, 1981 TO QUALIFY
FOR TWO YEAR PRICE PROTECTION AT CURRENT LOW PRICES

467

The 100 Greatest Books Ever Written.

The Easton Press
47 Richards Avenue
Norwalk, Conn. 06857

**No payment required.
Simply mail this
subscription reservation.**

Please send me the first volume of "The 100 Greatest Books Ever Written" bound in genuine leather and reserve a subscription in my name. Further volumes will be sent at the rate of one book per month at $33.50* each. This price will be guaranteed for the next two full years.

A list of books scheduled for future monthly shipment will be sent to me. I may indicate which titles on this list, if any, I do not want to receive, thereby insuring that I never receive any books I do not want. I understand that I may return any book within 30 days for refund, and that either party may cancel this subscription agreement at any time.

**Plus $1.75 per book for shipping and handling.*

Payment Options (Check One):

☐ Charge each volume to my:
☐ Master (Charge) Card ☐ VISA

Credit Card No. _____ Expiration Date _____

☐ Enclosed is $35.25** (payable to Easton Press) for my first volume.

☐ Bill me $35.25** prior to shipment for my first volume.

Name _____

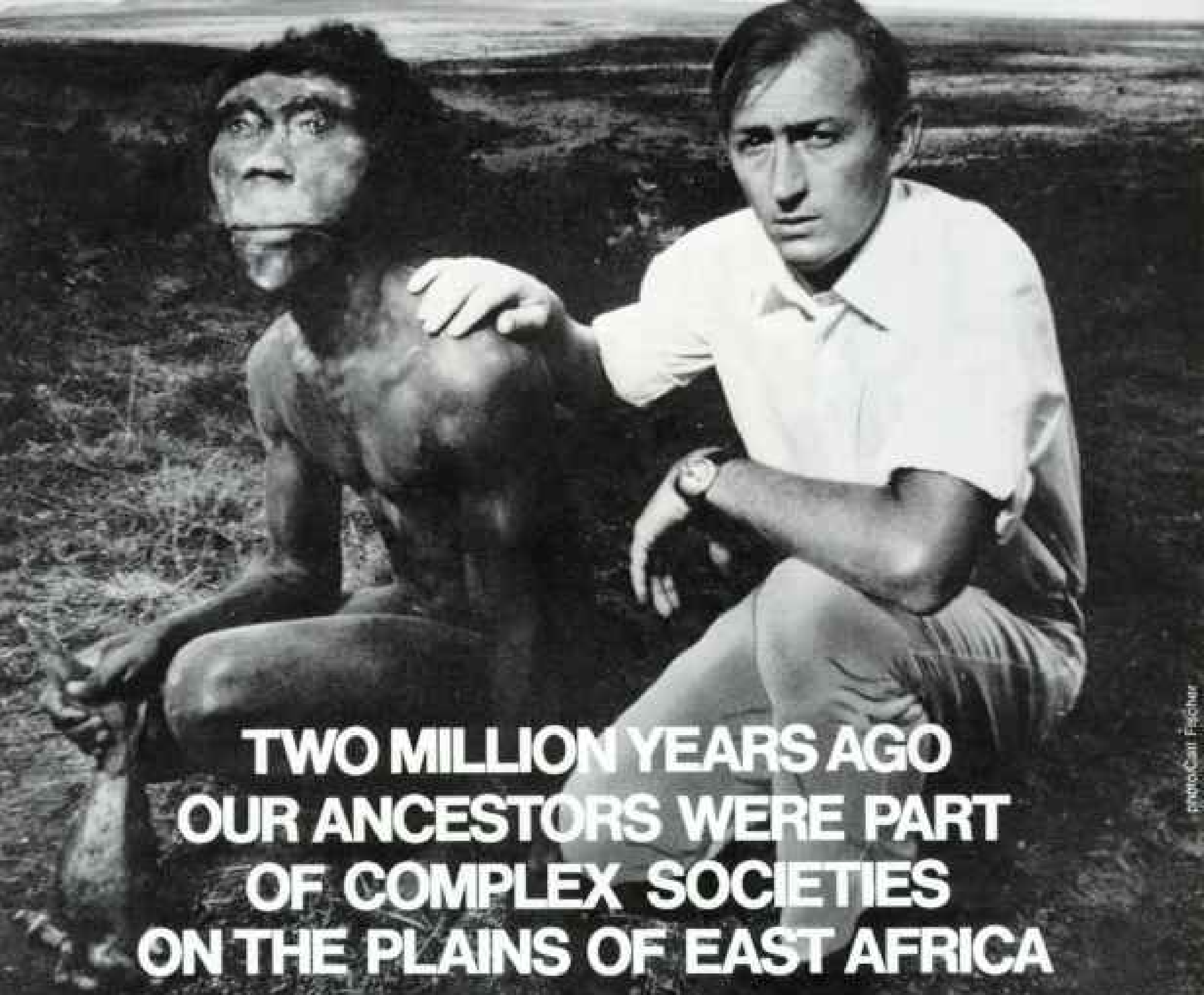
Address _____

City _____

State _____ Zip _____

Signature _____

**Connecticut residents pay $37.90 to include sales tax.



TWO MILLION YEARS AGO OUR ANCESTORS WERE PART OF COMPLEX SOCIETIES ON THE PLAINS OF EAST AFRICA

Scientists believe that these hominids walked on two feet, made stone tools, and developed "human" family structures—with long term pair bonds and different roles between males and females.

Scientists hope that by studying hominids, more may be understood about ourselves—and about the evolutionary forces that shaped modern Homo sapiens. By continuing research into the past, problems of survival—facing us today and tomorrow—may be solved.

Richard Leakey, pictured above with Homo habilis, established the FOUNDATION FOR RESEARCH INTO THE ORIGIN OF MAN (FROM) in 1975 to support the on-going scientific research of human origins and promote public understanding of the scientific evidence relating to early human development.

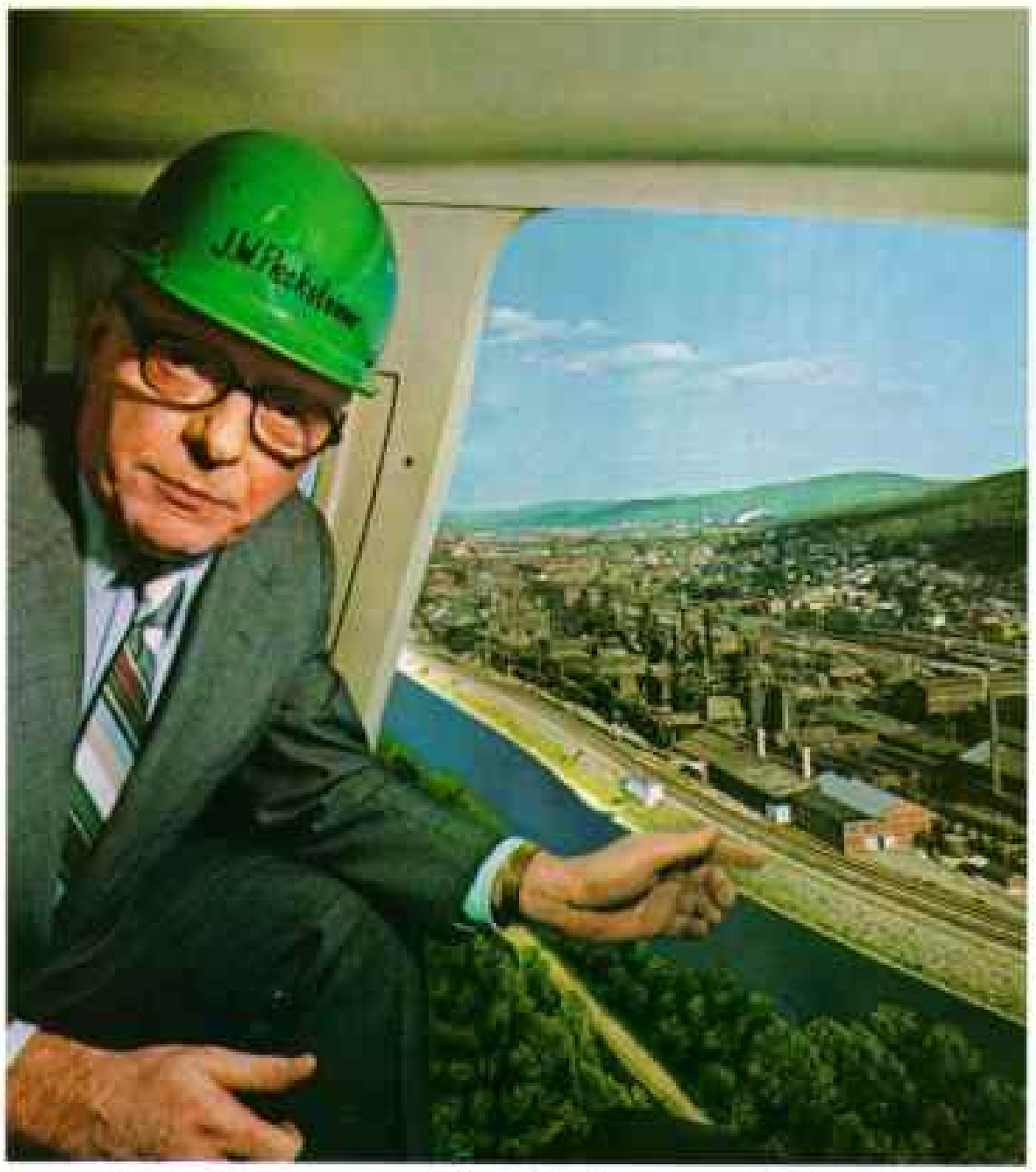
As a non-government public foundation, FROM depends entirely on your contributions. The Foundation would be pleased to send you additional information about its goals and membership program.

FROM

Contributions are tax-deductible and may be sent to :

FOUNDATION FOR RESEARCH INTO THE ORIGIN OF MAN
41 EAST 42ND STREET NEW YORK, NEW YORK 10017

"The air over our Bethlehem, Pa., steel plant is a lot cleaner now than it was in 1953."



John Fleckstein, Superintendent of the Environmental Control Division, went up in a helicopter with a photographer to get the "how it looks now" photo of our Bethlehem, Pa., steel plant. John is proud of the part he's played in helping to make this plant, which is located right in the City of Bethlehem, a "good neighbor."

Bethlehem Plant 1953.

"Back in the fifties, smoking stacks meant progress—prosperity, jobs, an improvement in our standard of living.

"But today, little or no smoke means progress—a concern for our quality of life, for our environment.

"Here at Bethlehem Steel we share that concern. And we're doing something about it at all of our plants, mines, quarries and shipyards. We're making great strides in cleaning up the air, as you can see from these before-and-after photos of our Bethlehem, Pa., steel plant. And we're doing just as well at cleaning up the water.

"It takes time, a lot of expensive hardware, and a lot of hard work to solve pollution problems. At this plant alone, we've spent more than $100 million for air and water quality controls."

Bethlehem's commitment: To do what is necessary to protect public health

We've made substantial progress and are now controlling more than 95% of our major air and water pollutants. In our view, before new and tighter environmental regulations are implemented or proposed, our nation should stop... carefully assess the situation... review our accomplishments... and ask how much additional clean-up is necessary, practical and affordable.

Our position is clearly explained in our booklet, *Steelmaking and the Environment*, which includes a copy of our *Statement on Environmental Quality Control*. Write: Rm. 476MT, Public Affairs Dept., Bethlehem Steel Corp., Bethlehem, PA 18016.

Bethlehem

Here's mileage you can be proud of in a car you can be proud of.

The V6 Cadillac.

With 29 hwy. est.... [18] EPA est. mpg.*

The V6 Cadillac is the successful merger of two beautifully compatible propositions. Namely, that your next car can (1) combine the inherent quality and value of a Fleetwood Brougham or DeVille with (2) the inherent efficiency of a V6.

New Automatic Overdrive is standard.

The four-speed automatic transmission includes a fuel-saving overdrive gear that helps the V6 Cadillac achieve a most impressive 29 mpg highway estimate.

725 miles est. hwy. range... [450] miles est. driving range.*

The V6 Cadillac also saves time because you don't have to stop so often to refuel.

Or combine a V6 with front-wheel drive...the V6 Eldorado and the V6 Seville.

Their scores of standard features embrace everything from front-wheel drive and four-wheel disc brakes to three-speed automatic transmission and four-wheel independent suspension.

The Diesel Cadillac.

With 33 hwy. est. ... [21] EPA est. mpg.*

The Diesel Cadillac boasts the best EPA mileage estimates ever for Fleetwood Broughams and DeVilles.

891 miles est. hwy. range... [567] miles est. driving range.*

The more you drive, the more you need a Diesel Cadillac.

Cadillac outselling Mercedes in Diesel cars.

Figures for the 1980 model year show Cadillac Diesel models outselling Mercedes Diesel models. Source: Ward's Automotive Reports.

Our front-wheel drive Diesels...the Diesel Seville and the Diesel Eldorado.

The Diesel Seville is the only car in the world equipped with a Diesel V8 as standard.

Now you must decide which Cadillac is best for you... with available Diesel or V6. To buy or lease, see your Cadillac dealer.

***Use estimated mpg for comparison. Your mileage and range may differ depending on speed, distance, weather. Actual highway mileage and range lower. Mileage and range lower in California. Range estimates obtained by multiplying EPA est. mpg and hwy. est. by standard fuel tank rating ... 25 gallons for V6 Fleetwood Broughams and DeVilles ... 27 gallons for Diesel Fleetwood Broughams and DeVilles.**

Cadillacs are equipped with GM-built engines produced by various divisions. See your Cadillac Dealer for details.

GM

Cadillac
CADILLAC MOTOR CAR DIVISION, U.S.A.

Let her know romance is not a dead language.

The piece shown is available for about $2,250. The price may change substantially due to differences in diamond quality and market conditions. Your jeweler can show you other diamond gifts starting at about $450.

A diamond is forever. De Beers

GM

You believe a car should gladden the heart and engage the mind.

Monte Carlo is your car.

You firmly believe that a car should be every bit as good as it looks.

So as your eye plays over the sweeping lines of Monte Carlo for 1981, make your mind aware it's engineered for the real world.

The new Computer Command Control system continuously monitors engine functions and adjusts Monte Carlo's performance to meet driving conditions.

Corrosion-resistant primers, special undercoatings, and zinc-rich precoated metals help assure the lasting beauty of your Monte Carlo.

The powerful surge of an optional 3.8 Liter Turbocharged V6 will further individualize your Monte Carlo.

And power steering, power brakes, and automatic transmission are standard in an aerodynamic Monte Carlo with these EPA estimates:*

	HIGHWAY EST.	EPA EST. MPG
Standard 3.8 Liter V6	26	19
Optional 3.8 Liter Turbo V6	27	19

Also be mindful that all this, plus an elegantly appointed interior, comes together in a personal car as individual as you.

Buy or lease the 1981 Monte Carlo from your Chevrolet dealer. And let it gladden your heart, while its Chevrolet price eases your mind.

*Remember: Compare the "estimated MPG" to the "estimated MPG" of other cars. You may get different mileage, depending on how fast you drive, weather conditions, and trip length. Actual highway mileage will probably be less than the estimated highway fuel economy. Estimates differ in Calif. Chevrolets are equipped with GM-built engines produced by various divisions. See your dealer for details.

1981 Monte Carlo.

A matter of personal pride.

Chevrolet

WHEN YOU WET YOUR WHISTLE...

BLUE DIAMOND® ALMONDS!

Something on the rocks?
Enjoy it with Smokehouse® almonds.
Champagne? Serve Blue Diamond®
blanched salted almonds. Sherry?
It's a natural with our whole natural nuts.
Whatever your beverage, it goes better
with one of our seven snack flavors.

The Almond People®
California Almond Growers Exchange
P.O. Box 1768, Sacramento, CA 95808

A celebrated artist captures the charm and beauty of the woodland year . . . on plates of fine porcelain . . .

The Woodland Year

by Peter Barrett

Plate shown smaller than actual size of 9½" diameter.

Fawns in the June Meadow

The changing seasons . . . and the delightful creatures of the forests.
Portrayed in a collection of twelve charming collector's plates . . .
one for each month of the woodland year.

Each plate crafted in fine porcelain and decorated with a border of pure 24kt gold.

Limited Signature Edition.
Available exclusively from Franklin Porcelain.
Advance Subscription Deadline: March 31, 1981.

The beauty and grace of a young deer frolicking in the summer meadow . . . the delight of a baby raccoon being startled by a tiny green frog . . . the charm of two chipmunks sharing their food with a little bird . . . such scenes from nature have a very special fascination for us all. To be able to capture these qualities in visual form is a unique gift—and the renowned English painter Peter Barrett has that rare gift in abundance.

Because Barrett is a trained naturalist as well as an artist, he is able to portray in his work not only the personality of nature's most captivating creatures—but also their distinctive features in realistic detail.

This distinguished wildlife artist will now undertake a uniquely challenging assignment. He will create a series of new works of art exclusively for a collection of twelve porcelain plates—plates that will depict woodland animals at play throughout the twelve months of the year.

Each of these works by Peter Barrett will be created for "The Woodland Year" porcelain plate collection to be issued exclusively by Franklin Porcelain. And the first edition of this collection will be a special, limited "Signature Edition."

Each plate portrays a different animal . . . in a different month of the year

To capture the beauty of these woodland scenes, Peter Barrett will depict each animal in a different natural setting . . . and during a different month of the year. And each delightful animal—the raccoon for April, the deer for June, the badger for October—symbolizes especially well that particular time of the year.

The January plate, for example, portrays two Grey Squirrels in the forest on a snowy winter's day. The April plate depicts a family of raccoons—mother, father and baby—poised on the side of a pond observing the antics of a tiny green frog. For May, two little foxes are startled by the sudden appearance of a butterfly in the tall grass. And the August plate depicts two chipmunks sharing their breakfast with a White-Breasted Nuthatch.

Every one of the twelve plates that make up the collection has a charm about it that is irresistible. Because no detail, no matter how subtle, escapes the eye of Peter Barrett.

A unique way to depict nature's most delightful creatures

Consummate artist that he is, Peter Barrett is always seeking ways to make his art different and original. And here he has found a most ingenious one. He has portrayed each scene as though it were being viewed secretly, without the animals knowing you were there. Thus, as you look at the plate, you have the illusion of having peered through an opening in the forest—and suddenly come upon this delightful scene! It's a technique which Barrett uses in the most winning manner . . . and each of the twelve works of art becomes a new and pleasant surprise.

In order to capture the art of Peter Barrett in the most appealing manner, each plate will measure 9⅝" in diameter. And the entire collection will be crafted of a fine porcelain that has the whiteness and richness well suited to dramatizing the colors Barrett uses in his art. Moreover, each of these lovely plates will be decorated with a border of pure 24 karat gold. Franklin Porcelain has entrusted the creation of the plates for this collection to its affiliate, Franklin Porcelain of Japan.

Signature Edition available for a limited time

The Signature Edition of "The Woodland Year" by Peter Barrett will be distinctive because it is the only edition of this collection that will bear the signature of the artist on each plate.

In the tradition of fine porcelain, the plates in this desirable Signature Edition will be issued only during a single year—and will never be made available again. Thus, the total number of sets in the Signature Edition will be forever limited to the exact number of valid subscriptions entered by the end of 1981, plus one set for the artist and one for the archives of Franklin Porcelain.

The collection of twelve plates will be sent to subscribers at the rate of one every *other* month, and the issue price for each plate is just $55, payable in two convenient monthly installments of $27.50 each. This favorable price is guaranteed to subscribers for each of the twelve plates in the collection, regardless of any rise in costs during the entire subscription period.

To enter your subscription for the Signature Edition, be sure to mail the application at right to Franklin Porcelain by the advance deadline of March 31st.

Displayed in your home, these original collector's plates will bring the magic of the woodlands—and its delightful creatures—to your family and friends.

ADVANCE SUBSCRIPTION APPLICATION

The Woodland Year

Valid only if postmarked by March 31, 1981.
Limit: One collection per person.

Franklin Porcelain
Franklin Center, Pennsylvania 19091

Please enter my subscription for the special Signature Edition of "The Woodland Year," consisting of twelve collector's plates to be crafted for me in fine porcelain and decorated with a border of pure 24 karat gold.

I need send no money now. The plates will be sent at the rate of one every other month. I will be billed for each plate in two equal monthly installments of $27.50* each, the first installment in advance of shipment.

**Plus my state sales tax*

Signature _____
ALL SUBSCRIPTIONS ARE SUBJECT TO ACCEPTANCE.

Mr.
Mrs.
Ms. _____
PLEASE PRINT CLEARLY

Address _____

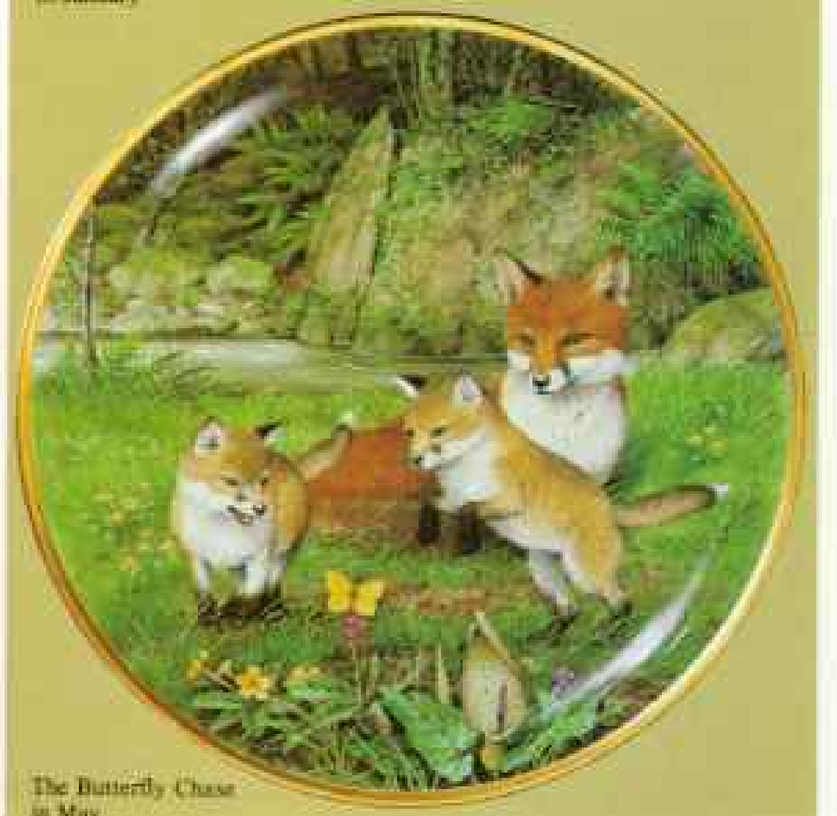
City _____

State, Zip _____

24

Curious Raccoons at an April pond

Squirreling for Nuts in January



The Butterfly Chase in May

World praise for the new World Car

"...almost a dream car..."
EXPRESSEN, SWEDEN

"...Ford's cam-in-head [engine] can produce both economy and...energy."
CAR & DRIVER, USA

"The most advanced technical characteristics Ford has ever produced."
AUTO SPRINT, ITALY

"This destiny car is marvelous all around..."
BILD ZEITUNG, GERMANY

"Economical, fuel-and-space efficient... entertaining to drive..."
ROAD & TRACK, USA

"Road Test magazine's Car of the Year!"
ROAD TEST, USA

Ford engineers all around the world worked together to build a technologically advanced, economical automobile—Ford Escort, the new World Car.

Now both the American and the overseas versions are winning accolades from automotive experts in their countries.

And no wonder. The compact Escort has front-wheel drive, a new-design hemispherical head engine, 4-wheel independent suspension, and better gas mileage ratings than subcompacts like VW Rabbit, Honda Accord, Toyota Corolla Hatchback.

See it at your Ford dealers.

44 EST HWY* (30) EPA EST MPG*

*Applies only to sedans without power steering or A/C. For comparison. Your mileage may differ depending on speed, distance, weather. Actual hwy mileage and Calif. ratings lower. Excludes diesels.

Built to take on the world... and doing it!

ONE SYSTEM STANDS ABOVE THE REST. VERTICALLY. SIMPLY. MITSUBISHI.

This is the system destined to turn the audio world on its ear.

If you find that hard to believe, take another look. What you see is the InterPlay X-10.™ The world's first *vertical format* complete audio system.

No trick photography here. The way you see it is the way you play it. Vertically.

Play a record. Play a cassette. Play the tuner. Any way you play it, it's Mitsubishi.

The vertical *linear-track* turntable allows the X-10 to sit on a small bookshelf. It needs only 10" of shelf depth.

And we've integrated an AM/FM stereo tuner and cassette deck.

Hook up the speakers, plug it in, and turn it on. The InterPlay X-10 is stereo at its upright best.

For your nearest dealer, call toll-free (800) 447-2882 or in Illinois, (800) 522-4400 and ask for operator X-10.

Shown here with optional CX-10 Cabinet and SX-10 Loudspeakers.

MGA/MITSUBISHI

MITSUBISHI ELECTRIC SALES AMERICA, INC. 3010 E. Victoria St., Compton, Ca. 90221

Satisfaction Guaranteed
Or Your Money Back

Whatever you buy at Sears, you have the right to use it for a reasonable time before you determine it is satisfactory and decide to keep it. If you decide it is not satisfactory, return it to us at our expense. We will do whatever is necessary to correct the cause of your dissatisfaction.

If we can't satisfactorily provide a remedy, or if you request a refund, we will refund your full purchase price including any appropriate delivery charges, finance charges and applicable taxes.

Sears Pledge of Fairness

If, after you have decided to keep your purchase, it doesn't give you the service or performance you reasonably expect of it and there isn't a specific written warranty on the item that will satisfactorily correct the problem, please let us know.

We want to make an adjustment that you will consider fair.

You Can Count On Sears

You can count on Sears for satisfaction

Satisfaction guaranteed or your money back is a promise Sears has lived by for half a century. Other things you can still count on at Sears: fair prices, good workmanship, wide selection, competent service.

Sears believes that you should be completely satisfied—with performance, workmanship, fit, styling, even *color.*

Suppose you buy a blue sweater through the catalog and the blue looks different, however slightly, from the blue on the printed page. Says Sears catalog: "In such a case, as with everything we sell, we guarantee your satisfaction or your money back." Among the steps Sears takes:

1. *Sears people spend thousands of hours a year at factories that make Sears products.*

They study the needs and desires of Sears customers—and work personally with manufacturers to make certain that Sears products perform as expected.

2. *The Sears Laboratory tests over 10,000 products a year.* Sears maintains one of the world's largest private laboratories for testing consumer goods. It tests for strength, durability, handling, and performance.

3. *Sears employs engineers to help manufacturers improve their efficiency.*

This is one of many steps Sears takes to help hold down costs. Others include an almost fanatically efficient distribution system. Dozens of small efficiencies explain why Sears regular prices are so reasonable, and Sears sale prices such bargains.

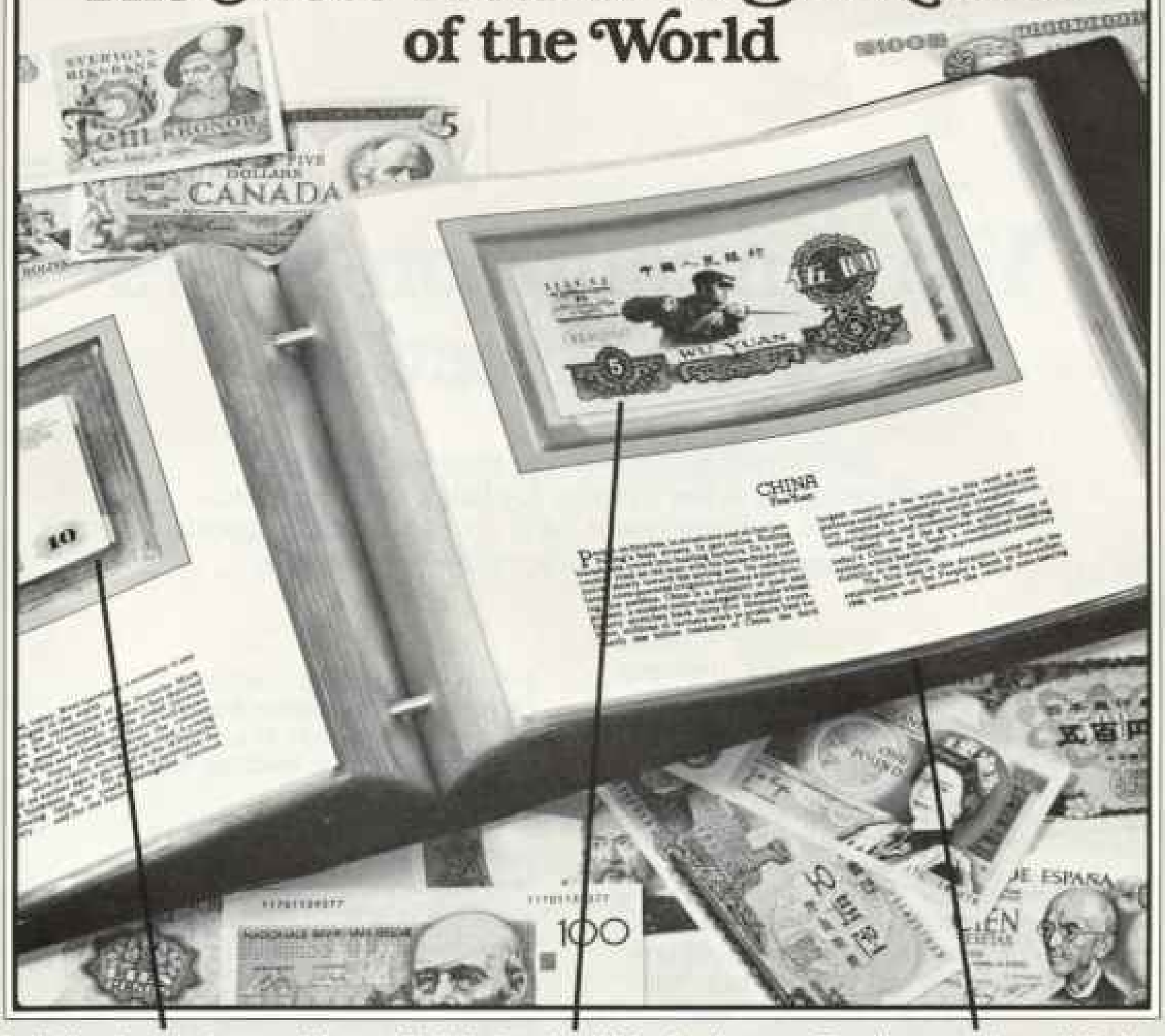
So it's first to Sears for millions of shoppers. They have found again and again that they are likely to spot exactly what they're looking for at Sears, to pay a fair price for it—and to be completely satisfied with it once they get it home.

Sears

Satisfaction Guaranteed or Your Money Back has been firm Sears policy for over half a century. The words on this plaque stand behind every purchase by every Sears customer.

Announcing an unprecedented collection:

The Most Treasured BankNotes of the World



Both sides of each banknote are fully visible, making minute examination possible. Authoritative narratives are educational and informative.

Each banknote is valid, legal tender of the country of issue, protected by the special display page to keep it in mint-perfect, uncirculated condition.

The album organizes and displays your collection — so you can easily share it with family and friends.

Overall size of display pages is 8¾ by 11¾ inches. Shown here considerably reduced.

Available to you now for a limited time by special arrangement with central banks and officials around the globe.

A limited edition.
Order Limit: One Collection per person.
Advance Reservation Deadline: April 30, 1981.

Even for world travelers, there is simply no collection more elusive . . . potentially more exclusive . . . than the **Banknotes of the World**. Until now, it has been only a dream . . . until now always just beyond reach.

Beyond reach . . . even for those with the time and resources to visit each country personally. For, many nations prohibit — under severe penalty of law — anyone from taking their banknotes beyond their borders.

The opportunity of a lifetime.

Yet, you have the opportunity to acquire the Banknotes of the World today by special arrangement between Fleetwood and government authorities around the world . . . including most countries which normally prohibit the export of their banknotes. As a result, this collection is a milestone in collecting. One which will be a rewarding legacy for future generations of your family.

Legal tender, uncirculated: fascinating and mint-perfect.

These are not specimens or banknotes withdrawn from circulation. But real money: valid, legal tender that is valuable.

And what gloriously colored and richly varied subjects and designs! Some banknotes pay tribute to heroes and leaders. Others portray famous monuments and great works of art. But all capture the nations' special character and ideals.

This collection makes it possible for you to hold each banknote to the light to discover secret watermarks and random security threads. To examine the intricate engraving of both sides . . . including lacework, rosettes, and scrolls that defy the crafty counterfeiter.

A treasure-trove.

From Hong Kong's unusually large 10 Dollar note, to Switzerland's 10 Franc note, the collection includes such issues as: Canada's colorful 5 Dollar note with its fishing scenes. The 2000 Lire Italian note — an exquisite tribute to Galileo. The 5 Yuan note of China, combining superb oriental artistry and modern day landscapes. Egypt's 1 Pound note recalling the rock-cut Temple of Ramses II. And much, much more . . .

A specially-designed album for you.

The handsome, gold-stamped album shown in the photograph at left is included without additional charge — including its specially-designed pages and authoritative reference information. You will be able to examine both sides of every note — yet ensure that each one will remain in mint-perfect condition.

An extraordinary and precious collection at a surprisingly modest cost.

The cost of building this elusive . . . and exclusive . . . collection is just $8.75 per banknote, including all shipping and handling charges.

Why a Black and White Ad?

This advertisement does not illustrate the banknotes in full color or at actual size — and for good reason.

Since these notes are real money — not specimens or banknotes withdrawn from circulation — Federal law prohibits their reproduction in any way but in black and white, and at a size which differs substantially from the real thing.

You must see these banknotes for yourself to fully appreciate their beauty and fascinating detail.

Moreover, you need send no payment at this time. You will be billed for each monthly shipment of two banknotes — either directly, or to your credit card.

A Fleetwood exclusive — strictly limited edition.

The Most Treasured Banknotes of the World is available only through Fleetwood, with a further limit of one collection per person.

The reservation deadline from this announcement is April 30, 1981. Unless you mail your reservation promptly, you will lose what's truly the chance of a lifetime. To assure your personal ownership of one of the most exclusive collections ever offered . . . fill out the Reservation Form below and mail it to: Fleetwood, One Unicover Center, Cheyenne, Wyoming 82008-0001.

Advance Reservation Form

THE MOST TREASURED BANKNOTES OF THE WORLD

Limit: One Collection per Person
Deadline: April 30, 1981

Fleetwood C3
Cheyenne, Wyoming 82008-0001

Please accept my reservation for **The Most Treasured Banknotes of the World**. The collection will include well over 100 banknotes from around the world, each mint-perfect and uncirculated, valid and legal tender of every nation in the world, except where government regulations still prohibit. The banknotes will be sent to me at the rate of two per month beginning in late May, 1981. The price of $8.75 per banknote includes all shipping and handling. A handsome gold-stamped album with special pages and reference information is included at no additional cost.

I need send no money now, and prefer to pay:

☐ DIRECTLY. Please bill me for each shipment as it is made.

☐ BY CREDIT CARD. Please bill my:

☐ MasterCard ☐ Diners Club
☐ Visa ☐ American Express

Card Number _____ Expires _____

Signature _____

All orders must be signed and are subject to acceptance by Fleetwood.

Mr.
Mrs.
Miss _____

Address _____

City _____ State _____ Zip _____

Fleetwood will acknowledge your subscription.
Since 1928, Fleetwood has been recognized by collectors for outstanding quality. Not affiliated with any government agency, it is a division of Unicover Corporation.

You know how an airplane simplifies business travel. Find out how Beech simplifies owning an airplane.

The Pressurized Beechcraft Duke carries six in cabin class comfort and quiet at over 280 mph.

A company airplane simplifies business travel, many ways.

By freeing you from airline schedules that don't match your schedules.

By providing direct flights to everywhere the airlines go, plus literally thousands of places they don't.

By allowing your scarcest resource, qualified management, to be there, when and where they're needed.

You may know dozens of other ways.

But you may not know how Beech simplifies airplane ownership and operation.

It starts with the comprehensive information in your free *Management Guide to Business Aviation* that helps you decide whether a Beechcraft can, indeed, be a profitable investment.

The Beechcraft Super King Air gives first class accommodations for 8-15 passengers at near jet speeds for over 2000 miles.

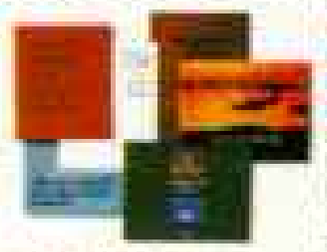
It extends throughout the network of Beechcraft Aviation Centers, where aviation professionals can help in every aspect of airplane purchase and operation.

And once you have purchased a Beechcraft, this same organization can teach you to fly or find you a qualified pilot. They can manage your maintenance. They've even gone so far as to operate a customer's airplane for him. Flying it, scheduling it, maintaining it, because that's what the customer wanted.

And finally, simple, reliable operation and fuel-efficiency comes standard with every Beechcraft business airplane. In its uncompromising quality, you find the reason why Beechcraft owners experience minimum maintenance, low depreciation and a ready resale market.

If you would like to find out more, simply let us know.

Send for your free 1981 kit.



Write us on your company letterhead, and we'll send you everything you need to make an initial decision on the profitable use of a Beechcraft in your company. Write to: Beech Aircraft Corporation, Dept. AD, Wichita, Kansas 67201. If you'd rather call, call collect and ask for Dick Schowalter, Jr. 316-681-7072.

Member General Aviation Manufacturers Association

Beechcraft

Be there in a Beechcraft.

A Raytheon Company

Superb picture and more.
More sharpness. More sound. More channels.

We're moving television into the future. With our new PRP (Peak Resolution Picture) circuit. For 25% more picture sharpness than ever before.* With four speakers, separate amplifiers, even an audio control center. For more fidelity, more true-to-life sound.

With built-in cable tuning (no converter needed). For access to more channels. A hundred and five channels. Zenith System 3. For superb picture. Dependability. And more.

*70 more lines of resolution than previous Zenith models. The PRP Circuit is available on 19" and 25" (diagonal) System 3 models.

Features available on selected System 3 models and screen sizes. Shown: The Andantino, model SM2575E. Mediterranean styled console. Genuine Oak wood veneer top and sides with parquet top. Decorative front and base of simulated wood in matching finish. Simulated TV picture.

ZENITH

SYSTEM 3

The quality goes in before the name goes on.®

AAIOHA

Now, The No.1 Choice takes off for Hawaii.

#1

AAGAIN

*For the third straight time, American Airlines has been named the number one choice for domestic travel in the Airline Passengers Association survey of the most demanding passengers in the sky: Frequent Fliers.**

The main reason: our service.

And now you can get this number one service, with a bit of Hawaiian flavor added, on convenient daily flights to The Islands.

So call your Travel Agent. And say you want number one service to Hawaii.

We're American Airlines. Doing what we do best.

**1979 independent mail survey of 37,495 APA members with 11,931 responding.*

Ford Granada 1981. Built for a changing world. Designed with a commitment to quality.

In a world calling for change, no American-built sedan has changed more for 1981 than the new Ford Granada. Count the ways:

Granada is smaller than last year.
Granada has more interior room than last year.
Granada has rack-and-pinion steering this year.
Granada has a new type of suspension for this year.

And, best of all, Granada's efficient 4-cylinder engine for 1981, combined with its new sleek aerodynamic styling, gives it the best mileage in its history—21% better than last year!

34 EPA EST HWY **23** EPA EST MPG

For comparison. Your mileage may differ, depending on speed, distance and weather. Actual highway mileage and California ratings lower.

Granada is built with Ford's attention to detail. Every seat is fitted by hand and every door is adjusted by hand. Every car is examined during assembly by no less than 38 quality-control inspectors. That's attention to detail you can see, feel and hear.

Your Ford Dealer can discuss buy or lease arrangements and tell you about Ford's Extended Service Plan.

FORD GRANADA

FORD DIVISION Ford

The New Ford Granada

The Gold Coins of Mexico.

50 Peso "Centenario"
Fineweight:
1.2057 troy ozs.

20 Peso "Azteca"
Fineweight:
.4823 troy ozs.

Once you know the story behind them, you'll know why so many Americans are purchasing them.

The Gold Coins of Mexico are official restrikes of the government of Mexico, minted by the Casa de Moneda de Mexico, the oldest mint in the western hemisphere, established in 1535. Exclusively minted for the Mexican Federal Reserve Bank, Banco de Mexico, The Gold Coins of Mexico have enjoyed a fine reputation throughout the world for many years.

Now, Americans who have made the decision to purchase gold coins have the opportunity to acquire The Gold Coins of Mexico in the United States at the following banks: Citibank, Swiss Bank Corporation and Republic National Bank of New York.

The Gold Coins of Mexico not only provide the convenience, portability and liquidity of owning gold in coin form, but they also offer more alternative choices for purchasers. Mexico's 50 peso gold piece, more commonly known as the "Centenario," is the heaviest of all high circulation gold bullion coins in the world—boasting a high gold content of 1.2057 troy ounces. The "Azteca," Mexico's 20 peso gold piece, features a .4823 troy ounce gold content for purchase on a small scale. A variety of Mexican gold coins of smaller denominations are also available.

ACTUAL SIZE

Many people consider the value and purchasing power of gold as an alternative hedge against inflation. Of course, the decision to own gold is a highly personal one in which risks and advantages should be carefully considered in light of one's specific financial and investment goals. Since gold is a commodity, its value is subject to continual market fluctuations.

Over the years, The Gold Coins of Mexico have become among the most popular gold bullion coins in the world. Due to the careful craftsmanship of Casa de Moneda de Mexico and the wide distribution of these coins, you can usually avoid the cost and delay of determining their authenticity upon resale. As with all gold coins, your purchase price includes a premium above the then current market price of gold bullion to cover minting and distribution. Furthermore, purchases may be subject to state and local taxes.

Call any of the following toll-free numbers for up-to-the-minute prices. For additional literature, write: The Gold Coins of Mexico, Information Center, Grand Central Station, P.O. Box 1812, New York, N.Y. 10017.

THE℠ GOLD COINS OF MEXICO

The Gold Coins of Mexico are exclusively supplied to:

Citibank, N.A. 800-223-1080
N.Y. State call collect: 212-559-6041

Swiss Bank Corporation 800-221-9406
N.Y. State call collect: 212-938-3929

Republic National Bank of New York 800-223-0840.
N.Y. State call collect: 212-930-6338

The Gold Coins of Mexico are also available at coin dealers plus selected banks throughout the country.

House Dressing

What more beautiful way is there to dress up your remodeling or replacement project than with Andersen® Perma-Shield® angle-bay windows. Their crisp, classic lines bring an elegant touch to any home.

Their long-lasting rigid vinyl exteriors won't need painting every few years.

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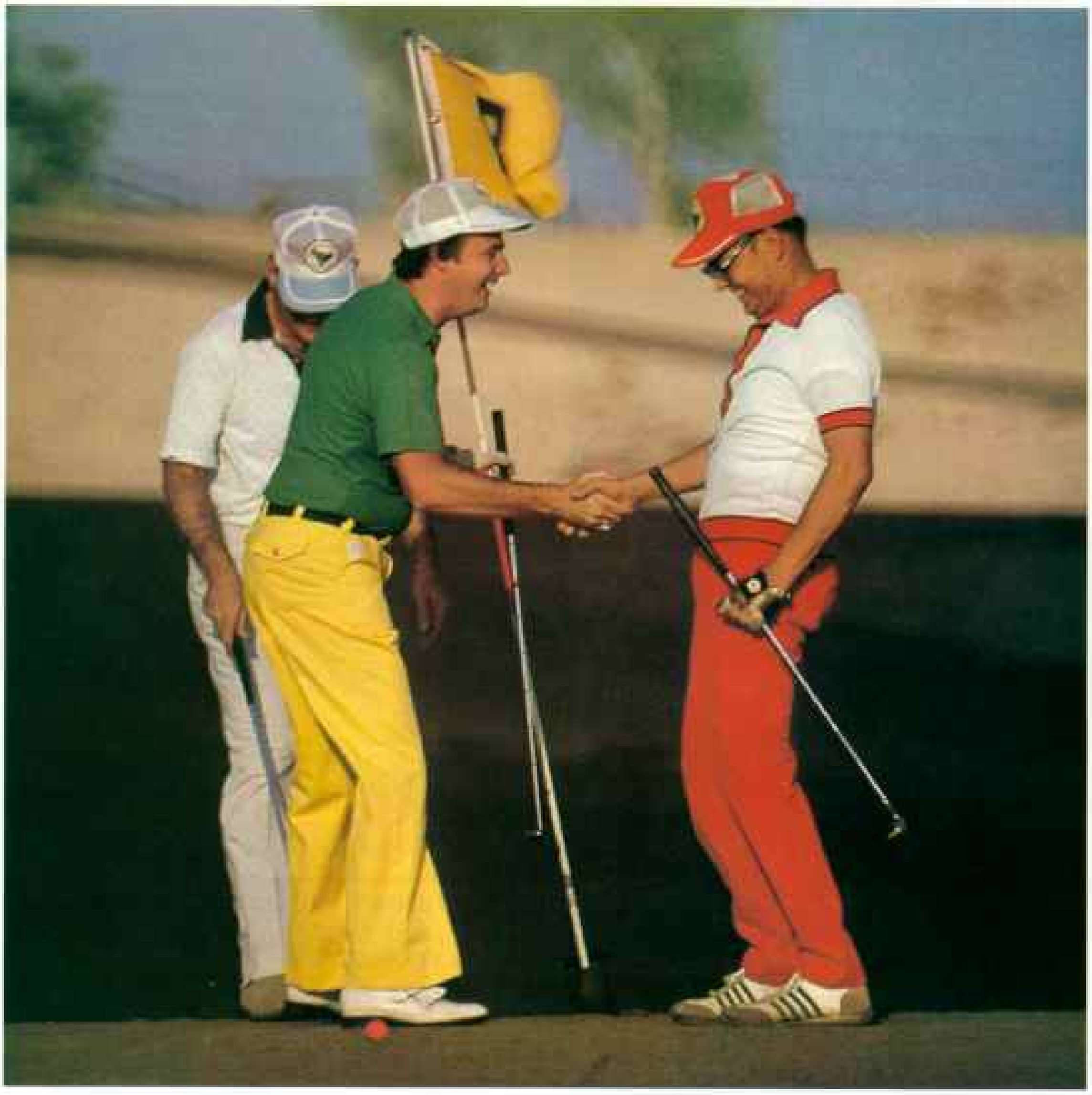
We provide the students. You provide the love.

Confused?

Read the instructions in your tax package—they can clear up the confusion and make doing your tax return easier and faster.

A public service message from the Internal Revenue Service.



Arabian desert dwellers engaged in traditional game

Right, golf.

To people who work for us, a round of golf is an ordinary part of life in Saudi Arabia. There's no grass, so each player carries a portable "fairway" of artificial turf.

We're Aramco, the Arabian American Oil Company. There are 13,000 North Americans in Saudi Arabia with us. And some things about our lives there might surprise you.

1. We're doing something important. Aramco produces more oil than any other company. Badly needed oil. Including about 15 percent of the oil America imports.
2. The Saudi Government and Aramco are working on some *incredibly* large energy projects, communications networks, electric utilities, and more.
3. Our people are glad to be in Saudi Arabia with Aramco. They came for excellent pay and professional challenge.
4. After 46 years, Aramco is still growing fast. So is the number of rewarding jobs we offer.
5. Jim Burchett, center, birdied the 16th to beat Mike Ehlers and "Sib" Sibley.

ARAMCO
SERVICES COMPANY

1100 Milam Building, F.S.GG, Houston, TX 77002
(713) 750-6965

Isn't it time to give a real tax break to savers?

On the average, Britons save 13% of their disposable income. West Germans save 15%. Japanese, 26%. But Americans save only 4.5%!

A major reason people in other nations save more is that they are given tax incentives by their governments.

The U.S. actually discourages savings, by taxing the interest that is earned.

Isn't it time Congress gave savers a real tax incentive? We think the annual tax-free limit on savings interest should be raised to $1,000 for individuals and $2,000 for joint tax returns.

This would encourage more savings, which would help stabilize the economy and bring inflation under control.

What do you think? Please fill out the ballot, and let us know. If the ballot has already been removed from this page, you can still vote at your nearby Savings and Loan Association.

If we all speak up, Washington will listen.

The Savings & Loan Foundation

BALLOT

Question: Should the first $1,000-$2,000* of interest on your savings be tax-free?

*$1,000 for individuals, $2,000 for joint tax returns.

☐ Yes ☐ No

Please fill out this ballot and drop in the ballot box in your nearby Savings and Loan office, or mail to The Savings and Loan Foundation, Inc., Dept. G 2, 1111 "E" St., N.W., Washington, D.C. 20004

Name _____

Address _____

City _____ State _____ Zip _____

If we all speak up, Washington will listen.

The big idea behind our little limousine.

The 1981 Century.

The idea behind a limousine is to make you feel comfortable, elegant, uncrowded and well . . . big.

And that, in a nutshell, is also the idea behind our Buick Century Limited Sedan.

There are, however, some noteworthy differences. While true limousines are large and expensive, our Century is small and inexpensive. Yet still carries six people quite comfortably.

And while a big limo needs a big engine, our little limo hums along with an efficient 3.8 liter V-6.

EST. HWY.	EPA EST. MPG
30	21

The elegantly appointed, graceful, yet economical Buick Century Limited Sedan.

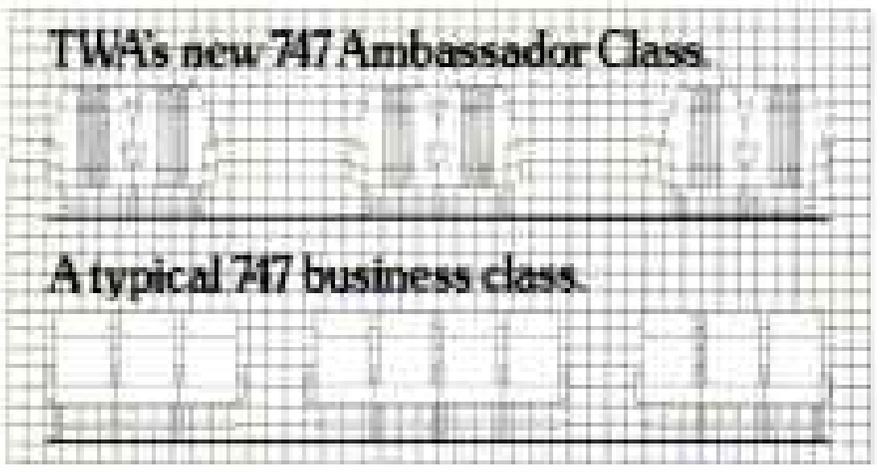
A car that makes you feel very well-to-do, without making you pay the price.

REMEMBER: Compare the "estimated mpg" to the "estimated mpg" of other cars. You may get different mileage, depending on how fast you drive, weather conditions and trip length. Actual highway mileage will probably be less than the estimated highway fuel economy. Estimates lower in California. (Buicks are equipped with GM-built engines supplied by various divisions. See your dealer for details.)

BUICK

TWA unseats the competition.

TWA's new 747 Ambassador Class to Europe. Wider seats and more legroom than any other airline.



Now there's a business class with only six seats across instead of nine or ten. With only window and aisle seats—no middle seats. And with seats a lot wider than the usual business class seats. TWA's new Ambassador Class to Europe. Today, several of our 747's have it; by June, all of them will.

Along with the extra comfort, you'll find a lot of extras. Like a special check-in area to speed you through the airport. Free drinks and appetizers, to relax you in the air. And more. TWA's new Ambassador Class. Compared to other business classes, there's no competition.

You're going to like us

TWA