VOL. 156, NO. 3 SEPTEMBER 1979

NATIONAL GEOGRAPHIC

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

THE EDITOR of a monthly journal that presents articles of a timely nature, yet solid enough to be of enduring interest, gets to be something of a worrywart. Because we expect our coverages to be complete and sound, we spend a lot of time on our articles. Because we want them to be timely, we schedule them with a view toward current interests and events. Then, as the presses roll, we wait to see if events will suddenly trump our aces.

That nearly happened earlier this year with Kenneth F. Weaver's notable article "The Promise and Peril of Nuclear Energy," which appeared a few days prior to the incident at Three Mile Island in Pennsylvania. The timeliness of the presentation drew many favorable comments from our members and the media. Yet, had it appeared a month later—without Three Mile Island included—we would have had a meltdown in staff morale from what would have been a major omission in a major piece of work.

As we were preparing this month's issue, we found ourselves hoping that no dramatic new changes would come to the Persian Gulf, or that no striking new early-man site would be discovered in the Americas.

Instead, the Caribbean island nation of Grenada underwent a quiet revolution, its government was toppled, and author Ethel A. Starbird and photographer Cotton Coulson found themselves hurrying back to interview the new leader. The article could still make the issue as Ethel set about revising her text and the photographic layout was reworked. We turned to other matters.

And what happened then was that a volcano erupted on St. Vincent, endangering a plantation that Ethel had featured. Back to the islands went she and Cotton—this time to await the whim of a mighty force of nature.

As time ticked away, we sought the best advice of volcanologists on what to expect. One hazarded the guess that the activity of the volcano was related to the tidal force that pulls constantly at the solid earth as well as at the seas. We took a gamble. The tide went out, as it were, and after more revision we went to press.

Our crystal ball is made up of a lot of hard thinking and hard work, but it has to be polished with a bit of luck from time to time.

Editor

NATIONAL GEOGRAPHIC

THE NATIONAL GEOGRAPHIC MAGAZINE VOL. 156, NO. 3

September 1979

COVER: *Ice Age hunters roaming Montana 11,000 years ago left stone points and knives and bone spear parts (page 349). Photograph by David L. Arnold.*

Bahrain: Hub of the Persian Gulf

By THOMAS J. ABERCROMBIE Photographs by STEVE RAYMER
BOTH NATIONAL GEOGRAPHIC STAFF

Impatient as a dune buggy on asphalt, Bahrain accelerates as banking center

THE ISLAND NATION of Bahrain, sighted from the sea, seems an unlikely candidate for Utopia.

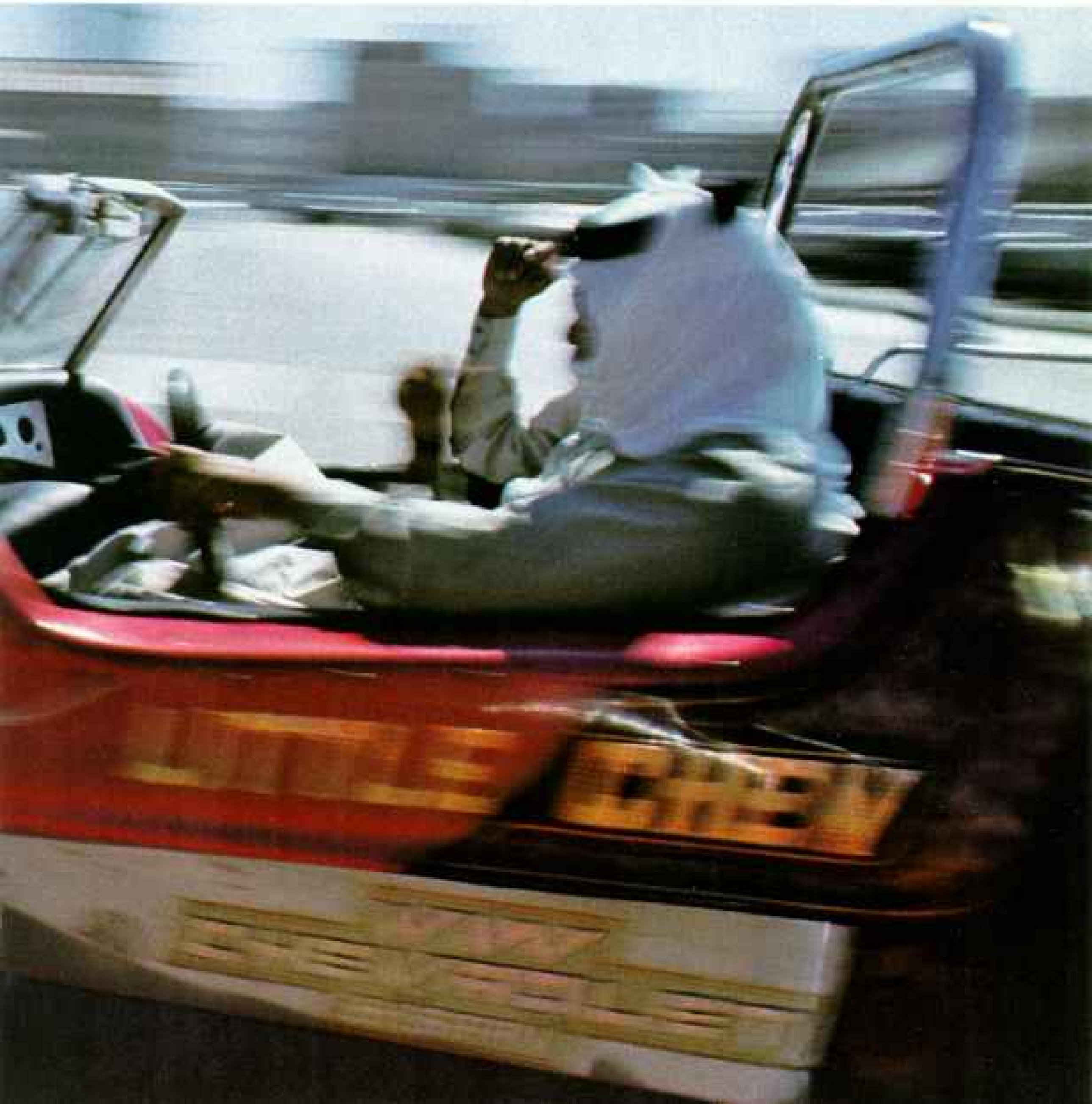
Scanning the turquoise horizon from the deck of a rolling dhow making landfall from the east, I barely make out the coastline. But there it lies, halfway down the strategic Persian Gulf, 14 miles off the oil-rich Arabian shore. It smolders, drab and flat, in the first faint haze of summer, hardly more than a mirage. But the eye deceives.

A seabound oasis sprouting from a wash of crumbling limestone and sand some thirty miles long, Bahrain has basked under fortune's smile ever since it first entered the rolls of history. In millennia past it grew rich on agriculture and later on shipbuilding and trade. In our own time it has prospered in pearling and petroleum. Today, as a booming banking center, the island's cash crop is . . . well, cash.

"*Yamiinak, shwayya!*" Ali, our captain, shouts back to his helmsman: "Starboard a bit!" We glide by an iron marker locating one of the dozens of undersea springs around the island.

Al-Bahrain, literally "a pair of seas,"

of the oil-rich Persian Gulf, still reverberating from the revolution in Iran.



SEAGIRT OASIS *of city life, Bahrain centers on its capital, Manama, home of more than half the population of 341,000. Expanding south and west* **(above)**, *the city engulfed luxuriant date groves; now it fills in the sea northward* **(right)**, *making room for offices and luxury hotels. The causeway arrows to Muharraq Island and the international airport, where the Concorde shuttles travelers to London or Singapore in less than four and a half hours.*

Since antiquity Bahrain has lured merchant sailors. Its freshwater springs provisioned cargo ships on the Mesopotamia-India sea-lane. From the early 1800's until 1971 it was a British protectorate. That presence plus oil—discovered in 1932—paved the way to modernity. Former date growers, fishermen, and pearl divers have become urban oil workers, merchants, and, more frequently, government employees. A massive new dry dock services supertankers that range worldwide.

owes its name to the two flows that washed its destiny: the warm salt sea around it and the deep freshwater table that bubbles forth in scores of artesian wells to green orchards of palms. In 1932 U. S. prospectors brought in Arabia's first oil well here, tapping still another reservoir, one that would float Bahrain far in the 20th century.

Now the humming derricks of the shipyard materialize out of the mist, then the refinery near Sitra, tall minarets, and soon the modern skyline of Bahrain's capital, Manama (preceding pages). The smell of land greets us, and the noise of traffic, as we slip under the Muharraq causeway to jostle for a berth amid a bobbing wooden fleet.

I make my way off the crowded quay through a flock of bleating sheep and huge stacks of other cargo: Honda motorcycles, crates of tea from India, apples from Washington State, Chinese tennis shoes. One small dhow eases away, a shiny American sedan lashed to its narrow decks.

After a while in this small but booming sheikhdom, such cultural tossed salad seems normal. Here one can visit camel herders, billion-dollar banks, the largest cemetery of the ancient world (pages 324-5), a service station for supertankers, or a hospital for falcons; see oil wells painted to look like giraffes and young sheikhs driving dune buggies; or watch a reading from the Koran on television. On every hand I found threads of a golden future woven into the frayed fabric of the past. The result was one lovely brocade.

The tiny sheikhdom, independent since 1971 after 150 years as a British protectorate, enjoys a standard of living much of the world might envy. Its annual per capita income of $3,800 ranks it with Italy or Venezuela. Some 50,000 cars, many of them Mercedes-Benzes and Rolls-Royces, roam the island, and Bahrain's 35,000 television sets pick up six color channels from its own station and those of neighboring countries.

A modern system of free education, begun in the 1920's, has provided one of the highest literacy rates in the gulf region. About eight hundred doctors and nurses furnish free medical care. Unemployment is negligible; indeed, the country has imported 75,000 workers from India, Pakistan, Iran, Britain, the United States, and, recently, South Korea. No one pays income taxes. Remarkably, even though the oil reserves are dwindling, the economy continues to grow.

"Our modest oil reserves were the bounty of Allah," a Bahraini friend told me, a businessman who had worked his way up through the ranks. "They helped finance schools, roads, hospitals, electricity, water—which any country needs to get started. But to succeed we still had to work," he said. "I'm glad. Now we can appreciate what we've built."

Old Charm, New Prices

From Manama's small dhow port south to Government Road lies new land, part of some seven square miles reclaimed from the sea over the past ten years and already built up with ministries and luxury hotels. But through the arches of the Bab al-Bahrain, main gate to the once walled town, streets narrow into a labyrinth where small shops overflow with rainbows of cloth, gleaming brassware, bicycles, fresh fruit, books, carpets—you name it.

In one short block I window-shopped for hi-fi components, nibbled a baklava, changed dollars to dinars, haggled for an Arabic typewriter, and bought a shirt of fine British cotton. I found prices high, nearly double those in the United States.

I inched through the crush along a nearby road, Sheikh Abdulla, where all that glitters *is* gold (page 316). Windows that line this noisy gold bazaar twinkle with the latest designs from New York City and Paris as well as primitive arabesques hammered out by local goldsmiths. A trinket hanging in one tiny stall caught my fancy. Soni Dulbhji Savji, one of many Indian merchants in the street, set the crescent-shaped necklace on delicate scales next to his bulky safe.

"That makes 94 grams. At two dinars seven the gram, plus labor charges—minus a generous discount of course . . ." he pecked away at a worn pocket calculator. I flinched when I saw it come out in greenbacks: $840!

Most shoppers combing the gold bazaar seemed to be women. One trio, walking hand in hand, spanned three generations of Bahraini couture—and feminine progress. Grandma moved like a shadow under layers of black, and a dark mask covered her eyes and nose. Mother wore the same black aba,

or cloak, but with exposed face and hands she carried on a lively conversation. The youngest, in her teens, sported a fashionable red pantsuit.

When I think of the modern Bahraini woman, I automatically think of Sorbonne-educated Shaherazad Yateem. I chatted with her in her small art gallery at the Gulf Hotel, surrounded by a mixed feast of local landscapes, Picasso prints, Iraqi abstracts, and graceful Arabic calligraphy.

"Returning to Bahrain after eight years of schooling abroad was a bit of a shock," Sherry said. "I wasn't ready to settle down. I wanted to live my own life. Fortunately here in Bahrain a woman can do it. We are rid of the veil, we can drive a car, choose our own husband.

"Yes," she said, anticipating my next question, "I want to marry someday—that is a woman's most important career. But only when the right man comes along: well educated, a good Muslim—and one willing to accept me as an equal."

Sherry's father, Husain Ali Yateem, is a walking encyclopedia of Bahrain. Small wonder. His life spans the most dramatic phase of the island's checkered history, a rise from camel power to the jet age. Indeed, he played no small part in the drama himself. More than once I stopped for a chat at his office in the bazaar, where, garbed in traditional Arab dress, he holds forth in impeccable English learned at boarding school in Brighton. Even the interruptions were interesting: the "walking jewelry store," Jafar Ali, who proffered us pearls from the deep pockets of his robe; a man collecting money for the Palestine Liberation Organization; a Cypriot architect.

"One of my first jobs, after I came back from England, was to help negotiate Bahrain's first oil contracts, with a British firm," Mr. Yateem said. "Later I worked as interpreter with the Americans who finally took up the lease. But we were a merchant family—pearls, timber, cement. The business world was my destiny.

"While visiting the New York World's Fair in 1939, I was fascinated by one gadget on display," he continued. "So I signed up for the Bahraini dealership."

Thus air conditioning came to humid Bahrain—where summer temperatures crowd 110°F—and changed a way of life.

After World War II, Mr. Yateem bought up several hundred acres of palm groves south of Manama and developed sixty homesites. The city's first subdivision, Yateem Gardens, remains its most exclusive, home to bankers and diplomats.

"This is the latest project." He smiled, nodding toward an architect's model on his desk, then to the window. Across the street bulldozers were leveling a whole city block. "Our new shopping center will have space for fifty new shops, 24 offices, and—even more important in Manama these days—parking, for a hundred cars."

Oil Profits Built Modern Nation

For nearly half a century now, the boom on Bahrain has been fueled by oil. Its revenues have helped transform the small island into a modern nation. I visited the Bahrain Petroleum Company (BAPCO), a subsidiary of Caltex Petroleum Corporation, driving through vast tank farms and a sprawling 255,000-barrels-a-day refinery, one of the largest in the Middle East. A jetty reaches three miles into the gulf to fill deep-draft supertankers at the rate of three a day. South of 443-foot-high Jabal ad-Dukhan, Bahrain's only "mountain," I paused at Well No. 1, Arabia's first oil strike. It has been flowing since June 1932.

"Although first, Bahrain never became an oil giant compared to its neighbors," said BAPCO president Russell N. Trackwell at his Awali office. "We reached our peak—76,000 barrels a day—in 1970. Today production averages about two-thirds of that. Single wells in Iran or Saudi Arabia could produce nearly as much as Bahrain's 235 wells combined. Already 80 percent of the crude processed at our refinery is piped in from Arabia.

"The natural-gas picture looks brighter. Bahrain has enough for forty years, at least," said Mr. Trackwell. "Gas makes the island's electricity, fuels its seawater desalination plant, and drives the big generators at Bahrain's aluminum smelter."

Yousuf Shirawi, as Bahrain's Minister of Development and Industry, is chief architect for the nation's new, post-oil economy. Trained in Glasgow, Mr. Shirawi wears a dark business *(Continued on page 312)*

LIKE THE PROVERBIAL BIRD IN HAND, oil has proved its worth for 47 years and now pays 70 percent of government expenses. This painted bird—a migratory bustard—decorates one of 235 wells spewing 52,000 barrels a day, a droplet by Arabian standards. The flow goes to Bahrain Petroleum's refinery (**below**), *which ships varied products from jet fuel to asphalt to the Far East. Once ignored, natural gas produces electricity for an aluminum smelter whose cableway, silhouetted against the sun, carries Australian alumina.*

In the 1960's Bahrain began to diversify, planning jobs for the '70's and income for the year 2000, when the oil is expected to run out. The shipyard, funded by seven members of the Organization of Arab Petroleum Exporting Countries, gives a paint job to the supertanker Bonn (**bottom**). *South Koreans built the yard and Portuguese manage it, reflecting the internationalism of the new economy.*

TURKEY

Baku

Krasnovodsk

Caspian Sea

50°

52°

38°

Tabriz

IRAQ

Arab Iraq keeps strong ties with the Soviet bloc but cooperates with conservative regimes to the south. Like its neighbors, it spends billions on developing natural-gas, petrochemical, and refining industries.

U.S.S.R.

World's leading oil producer at 11.4 million barrels a day, the Soviet Union exports 20 percent, ranking it fourth behind Saudi Arabia, Iran, and Iraq among oil exporters in 1978. The Soviets buy natural gas from Iran and suffered from cutbacks last winter.

Kirkuk

Tehran

Kermanshah

Baghdad

Isfahan

IRAN

After Britain withdrew from "east of Suez" in 1971, the West helped arm the Shah of Iran. From 1974 to 1978 oil earned 100 billion dollars. Yet civil disorder among the shah's 35 million Shia subjects toppled him last winter. The new regime has lowered oil production and raised prices.

Jabal Fauqui

MESOPOTAMIA

Euphrates

Tigris

Basra

Masjed Soleyman

Paris

Abadan

Shiraz

Kuwait

Kharg I.

Hout

Marjan

29°

Persian Gulf

Called the Arabian Gulf in the Arab world

KUWAIT

This Sunni Muslim monarchy of a million people reaps the benefits of high oil flow, low production costs, and access to the sea.

Ras Tanura

Dammam

BAHRAIN

ENLARGED AT RIGHT

Lavan I.

Halul I. (QATAR)

Proposed causeway

Doha

Umm Said

Das Island (U.A.E.)

Riyadh

SAUDI ARABIA

Holding production below 10 million barrels a day, this oligarchy earns 40 billion dollars a year, providing a total welfare state for its 8 million residents while funding poorer nations and investing in foreign securities.

QATAR

Like most of its neighbors, the traditional monarchy of Qatar has taken over oil production from the companies that developed it. Old rivalries kept Qatar and Bahrain from joining the U.A.E., yet they cooperate in development schemes.

BOUNDARY UNDEFINED

UNITED ARAB EMIRATES

By 1972 seven Sunni sheikhdoms, the former Trucial States, had joined in loose federation. Abu Dhabi with the most land, people, and oil provides leadership and revenues. Dubai, the major port, is building a dry dock to rival Bahrain's. Half the U.A.E. population of 850,000 is Indian and Pakistani.

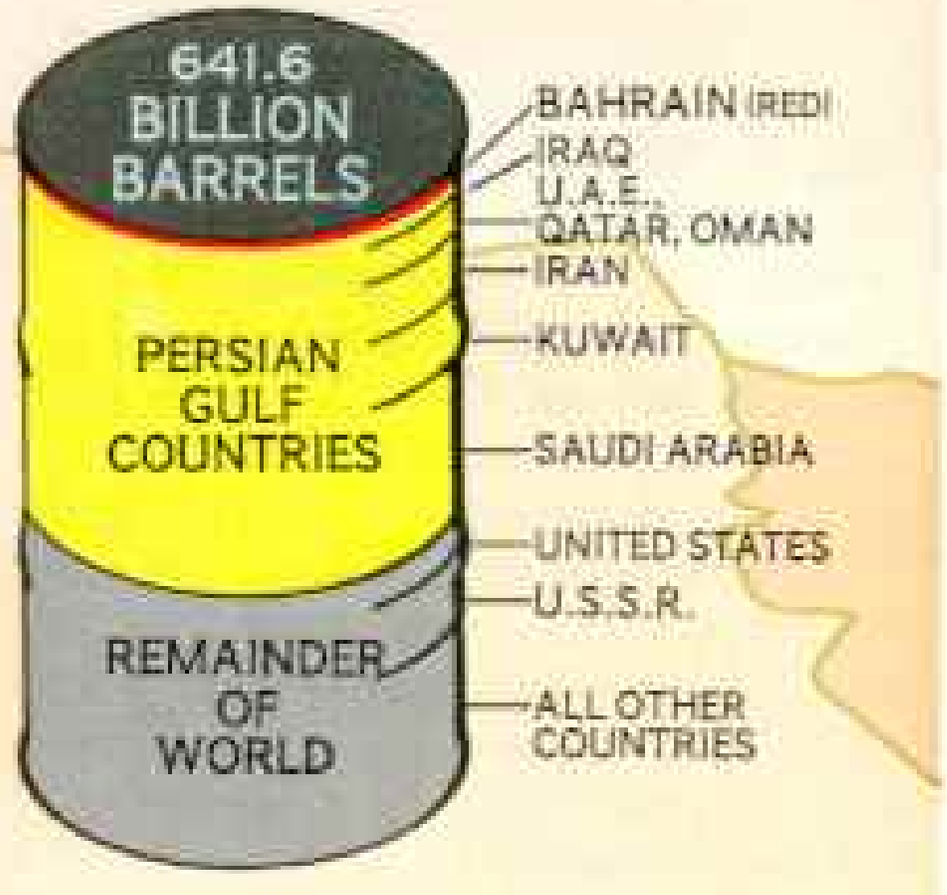
Oil refinery

Oil field

Oil pipeline

Scale varies in this perspective view

DRAWN BY ISAAKSAR BASAN
COMPILED BY MARGUERITE B. HUNSAKER
NATIONAL GEOGRAPHIC ART DIVISION



World oil reserves

With constant exploration, estimates change annually. The Persian Gulf now has fully half the world's oil reserves, more than a fourth the natural gas.

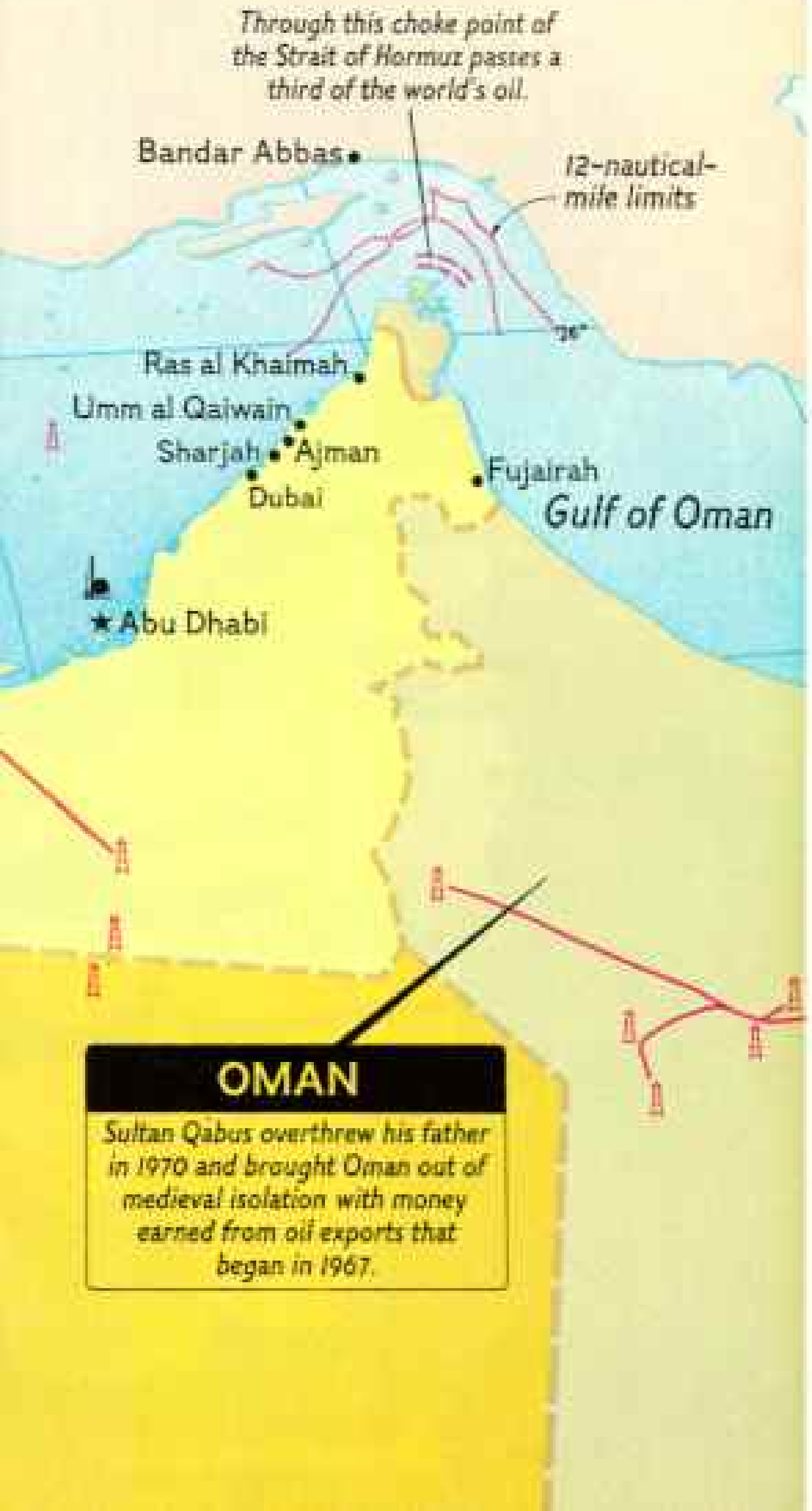
Bahrain and the oil giants

THE ARAB ISLAND NATION, one-fifth the size of Long Island, sits on the world's major oil highway in a region that could continue to fuel the economies of the United States, Western Europe, and Japan for the next thirty years.

Bahrain looks to Saudi Arabia as its benefactor and cultural cousin. The port of Mina Sulman, backup to Arabia's Dammam, handles some of Saudi Arabia's 20-billion-dollar imports. The Saudis send oil to Bahrain's refinery, share profits from an offshore field, and join in planning a causeway between the nations, another link in their friendship.

AREA: 258 square miles. **POPULATION:** 341,000. **RELIGION:** Muslim. **LANGUAGES:** Arabic and English. **ECONOMY:** Oil products, banking, aluminum smelting, shipping. **CAPITAL:** Manama. **CLIMATE:** Hot and humid, especially July to September, with temperatures reaching 110°F and humidity 80 percent. Pleasant December to March (60°-70°F).

Through this choke point of the Strait of Hormuz passes a third of the world's oil.



*SHAKING THE MONEY TREE, Bahrain has now surpassed Beirut as the Middle East center for international finance. Capitalizing on the rain of cash that oil producers amassed after the 1973 price rise, the government has allowed 48 foreign banks to set up "offshore" banking units, OBU's. These branches lend, take deposits, and trade currencies for foreign corporations and nations in a tax-free, no-reserve setting. At the Citibank OBU (***below***), foreign-exchange dealer Mohammed al-Shroogi sees a favorable rate from Singapore. Instantaneous direct-dial telephone and telex are channeled by Bahrain's own earth-satellite station.*

*Commercial banks have increased to 19 since independence. The oldest three still prosper—the British Bank of the Middle East, whose massive bronze doors (**right**) illustrate the seals of the ancient Dilmun civilization, the Chartered Bank, and the National Bank of Bahrain (**bottom right**). Banking has helped spur local investments, bringing thousands of jobs to Bahrainis (**center right**).*

(Continued from page 305) suit to his office at Government House but, as we spoke, he thumbed a strand of Muslim worry beads. Behind him hung his photograph, taken in Mecca, in the humble white costume of a pilgrim.*

"Here on the Arabian side of the gulf we were the first nation into the oil business—and we'll be the first one out," Mr. Shirawi said. "But more than 12 years ago we started doing something about it.

"Diversification is the answer," he emphasized. "By 1971 we had completed ALBA, the aluminum-smelting plant, and two years ago, our supertanker dry dock. These, including backup industries, provide 5,000 jobs, and employ about 8 percent of the Bahraini work force.

"Bahrain has always led in the vital service industries—engineering, transportation, communications, banking—serving commerce throughout Arabia and the gulf. We are taking over more and more of the functions Beirut once performed."

Causeway to Saudi Arabia Proposed

One of Mr. Shirawi's current projects is a new 14-mile causeway to connect the island to Saudi Arabia. The Saudis have offered to finance the billion-dollar span, which will symbolically clinch Bahrain's ties to the ancestral home of its ruling family and the island's close cultural cousin.

Historically, Persia long occupied the island. Modern Iran formally relinquished its claims in 1970, but they were reasserted last spring by Iranian religious leaders. A slight majority of Bahrainis embraces the Shia branch of Islam, Iran's predominant religion. Recently some took to the streets to demonstrate for the Ayatollah Khomeini.

Some in Bahrain worry that the causeway may threaten the island's relaxed way of life if Saudi Arabia, with its more strict interpretation of Islamic law, expands its influence on the small island. "I can order a drink at a bar, dance in a cabaret, read uncensored magazines, or go to a movie theater," one Bahraini friend told me. "Those pastimes are forbidden on the mainland."

Mr. Shirawi, however, found no cause for concern: "We already have strong links with the shore—12 flights a day, half a dozen passenger boats. We watch each other's TV programs. No, the reason for the causeway is economic, a direct road link to the rest of the Middle East—and Europe."

Among the island's schemes to diversify and develop, none has had more success than "offshore" banking. More and more surplus Middle East capital, once deposited in London or Beirut, now flows to Bahrain.

"The fact is, Bahrain is one of the fastest growing banking centers in the world," said Mr. Nooruddin Nooruddin, Deputy General Manager of the National Bank of Bahrain. We talked in its new 15-story headquarters in Manama (preceding page). The son of a Bahraini shopkeeper, Nooruddin started his career at BAPCO, then studied accounting in London. After a stint with Chase Manhattan in New York he joined the National Bank in 1976.

"Forty-eight international financial houses have established offices here since 1975," Mr. Nooruddin continued. "From nearby Kuwait and Jordan, from Zurich, New York, London, Hong Kong. Their combined portfolio already exceeds 23 billion dollars, ranking us with Singapore."

To better understand offshore banking, I sought out Mr. Alan Moore. From the counting houses of London he came to masterminds the island's financial plan, and he is now adviser to the board of the Bahrain Monetary Agency. I found him in his lofty rosewood-paneled office with a sweeping view of Manama and its harbor. Behind him a television readout blinked up current exchange rates in Hong Kong and Singapore.

"Offshore banking, essentially, means a free port for high finance," Mr. Moore explained. "As oil prices climbed after the 1973 embargo, Middle East producers began accumulating enormous money surpluses. The area was ripe for a major banking center of its own, a place where clients could deal freely, in riyal and dinars as well as in dollars and sterling.

"Bahrain was a natural, located close to potential Arab clients and halfway between the financial centers of Europe and the Far East. By working 7 a.m. to 7 p.m., we cover both money markets. Long a center of British administration in the gulf, the island has

*In November 1978 NATIONAL GEOGRAPHIC followed Islamic scholar Muhammad Abdul-Rauf on an annual hajj, or pilgrimage, to Mecca.

***Exotic customs**—the disco, alcohol, and cinema—forbidden in neighboring Saudi Arabia, are enjoyed openly in Manama. On a Saturday night English and Korean workers join local Arabs at a disco in the Tylos Hotel. While Bahrainis take a relaxed attitude toward the behavior of others, they stress privacy and discretion for their own families.*

a ready supply of schooled manpower. And communications. . . ."

A ringing phone interrupted.

"Ten? Yes, we can carry his ten until Thursday." He spoke softly. "Who? Quite. His quotation looks good. We'll take twenty at that rate."

Click. He was talking millions, of course. Thirty changed hands in thirty seconds!

"Where were we? Ah, communications. We lie on the main round-the-world air route; London and the Far East are only a Concorde flight away, about four hours. Bahraini telephones are second to none."

I already knew about the phones. From my hotel I dialed my home in Maryland in 14 seconds. Oilmen fly over from Saudi Arabia to call their stateside offices.

"Bahrain's liberal banking policies are the major appeal," Mr. Moore said. "There is a minimum of red tape—and no taxes!"

International Know-how Imported

An important factor in Bahrain's heavy-industry plans is international participation. Take Aluminium Bahrain (ALBA) for instance. The government owns four-fifths of the vast facility, but a U. S. firm, Kaiser, holds 17 percent, and a West German firm holds 5 percent. Recently Bahrain offered Saudi Arabia a 20 percent slice of the 230-million-dollar smelter to help finance a profitable expansion.

Near the huge plant I saw ships offloading alumina from distant Australia; gleaming ingots make another journey halfway around the world to markets in Japan. Donning hard hat and goggles, I hiked through the noisy, half-mile-long inferno with ALBA spokesman Jassim al-Ameer.

"With the expansion and by adding only a hundred people to our work force—less than 5 percent—we will be able to increase production 30 percent, to about 165,000 tons a year," Mr. al-Ameer shouted over the roar of the equipment. "By saving a hundred dollars a ton, ALBA would be more competitive in the world market."

Bahrain's latest industrial venture is even more cosmopolitan, the 340-million-dollar Arab Shipbuilding and Repair Yard (ASRY). First such enterprise in the Arab world, ASRY is owned jointly by Bahrain, Iraq, Kuwait, Libya, Qatar, Saudi Arabia, and the United Arab Emirates.

In 1974 a Dutch dredging firm began creating a hundred-acre island and connected it to Muharraq, four miles north. Then an army of 2,000 uniformed South Korean workers landed to erect the quays and workshops. By mid-1976 a team from Portugal's LISNAVE, the world's largest ship-repair yard, arrived to manage the site. Sixteen months later ASRY opened its locks to its first supertanker—three months early.

The yard was *(Continued on page 318)*

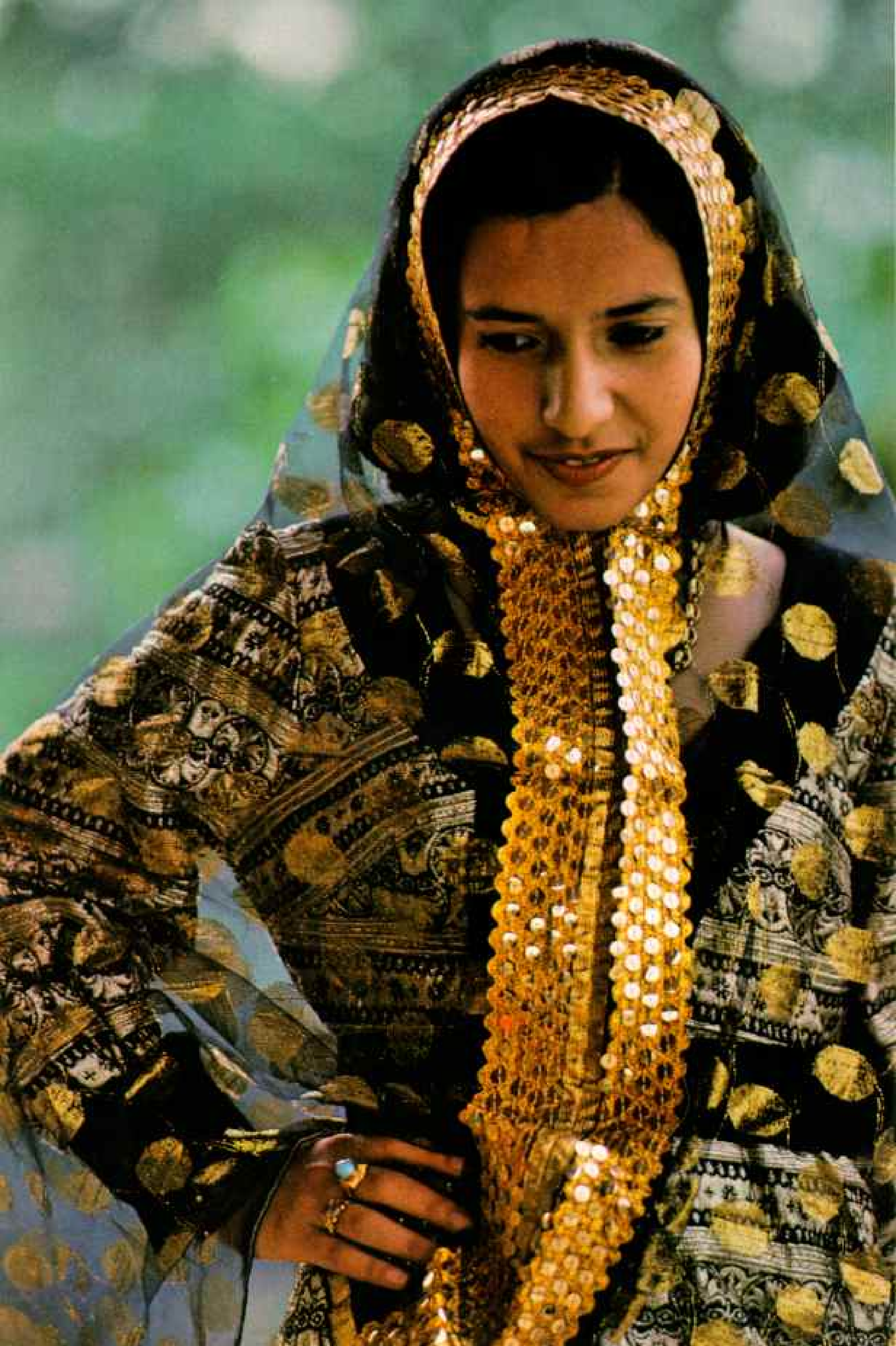
*FRIDAY-AFTERNOON FEVER: With nowhere to go after Friday mosque, young men and women have turned an abandoned airstrip at Sakhir into a Main Street—a place simply to see and be seen. Some women arrive with husband, father, or brother; others come—and leave—unescorted; Western-style dating is unknown. One man (**above**) brings his television to watch soccer beamed from Iraq.*

This generation associates across class, tribal, and religious lines at work, school, and in the army. They have access to jobs and consumer goods, but political parties and labor unions are illegal; the press is "self-censored." However, the ruling emir is accessible to anyone and consults regularly with community and, especially, religious leaders. He and associates adhere to the Sunni branch of Islam, while a slight majority of the people follow the conservative Shia branch.

*COSMOPOLITAN and hospitable, the suq, or market, in Manama is a last bastion of the traditional economy. Treating a customer as a guest, a merchant may, by snapping his fingers, order hot tea from a passing vendor (**upper left**).*

*With a foot-powered machine, a tailor (**above**) changes a length of cloth into a garment that has only been described to him. Secretary Sawsan Kanter (**right**) will wear her gold-lace robe to a family feast.*

*A gold merchant (**left**) arranges his wares on the curb to draw buyers. Finely crafted chains from Italy and locally made pendants sell by weight. Grandfathers of some Arab gold merchants were pearl traders when Bahrain was a world center. It supported 10,000 divers until competition from Japan and oil-field wages drew men from the sea. Today's small merchants include many from India, Iran, Pakistan, and Zanzibar.*



Henna party, *preceding a wedding, unites close friends—busy students and secretaries who save the cosmetic for special occasions. They paint florets with the paste* ***(below)****, which dries, leaving a design that lasts several weeks.*

HOLLY RECKORD

(Continued from page 313)

humming when, 18 months and some 160 ships later, I visited general manager Antonio Machado Lopes at his office overlooking the dry dock, longer than four football fields. A 300,000-ton Norwegian supertanker lay like a beached whale as workers scrambled to grit-blast and paint. Three screaming pumps, working at 1,500 cubic meters of water a minute, had dried the huge basin in two and a half hours—enough suction to empty an Olympic-size swimming pool in a minute. Nearby a crane lowered a repaired, 15-ton turbine rotor back into the engine room of the 508,000-ton tanker *Esso Pacific*. Ships from Greece, South Korea, and Iraq lined other quays.*

"Bahrain, of course, is a logical location for our facility," Mr. Lopes said. "Where is

*Noel Grove reported on supertankers in the July 1978 NATIONAL GEOGRAPHIC.

National Geographic, September 1979

most of the world's tanker traffic? Right here in the middle of the gulf.

"Besides routine maintenance, we handle steel plate and pipework, electronics, and major engine repairs. Our 1,150-man staff covers all phases of marine engineering and ranges across twenty nationalities."

Later I watched bright yellow tugboats ease a newly painted supertanker from Bremen out of the dry dock. Filipino crewmen on the tugs shouted back and forth in Tagalog; firemen standing by bantered in Bahraini Arabic. Pier master Santos Carvalho, running the show through his walkie-talkie, alternated English with his native Portuguese. And when the leviathan lightly nicked the basin wall, crumbling concrete and scratching her new paint, I caught choice phrases in German.

Shipbuilding an Ancient Art

Bahrain's shipwrights and sailors inherit a long tradition. Medieval Arab ships called there on their way south to the Indian Ocean and distant China. Of the hundreds of dhows that ply the gulf today, many are built in Bahrain. In the clutter of boatyards across from Manama's Central Market, I counted 25 wooden vessels on the ways.

I stopped to watch Mohammed Najib's men hewing frames from mangrove knees to brace the teak planking of a fifty-footer. "The same sort of ship had sailed out of that harbour before the Book of Genesis was written," a naval historian once wrote. With one notable difference.

"A Japanese diesel costs more than a mast and sail," Mr. Najib said, leaning on his razor-sharp adz. "But a motor is simpler, faster—cheaper in the long run. You need a crew of six or eight to sail a large dhow; only two, under power."

A far cry from a century ago, when as many as 1,500 lateen-riggers sailed out from Bahrain for a three-to-four-month season on the storied pearl beds nearby. A 4,000-year-old Sumerian inscription mentions a shipment of "fisheyes" from Dilmun (probably an ancient name for Bahrain); two thousand years later, the Roman Pliny the Elder mentions "numerous pearls" found there. An early Arab writer, al-Masudi, described harvesting of pearl oysters, a system little changed from his century to ours.

It was a grueling game. Weighted by stone, the divers sank to the beds, often 60 feet down. Their equipment was absurdly simple: tortoiseshell noseclips, leather thimbles to protect fingers from sharp coral, and sometimes a wad of beeswax in each ear. Fifty dives a day were usual.

A diver profited little from the riches that passed through his hands. By season's end his share was rarely enough to cover the food and expenses advanced to him by the *nakhoda*, or skipper. Inevitably he was committed to dive the next season, and the next.

"Fifty years ago the Bahraini Government passed reforms to protect the divers, but it was too late," Ahmad Fardan told me in his small jewelry shop. The Fardans had been pearl merchants for generations, but Ahmad said he was the last of the line.

"During the 1930's pearl prices fell and Japanese cultured pearls flooded the market," he said. "By 1954 hardly a dozen boats went out. Today on Bahrain the pearling trade is only a memory."

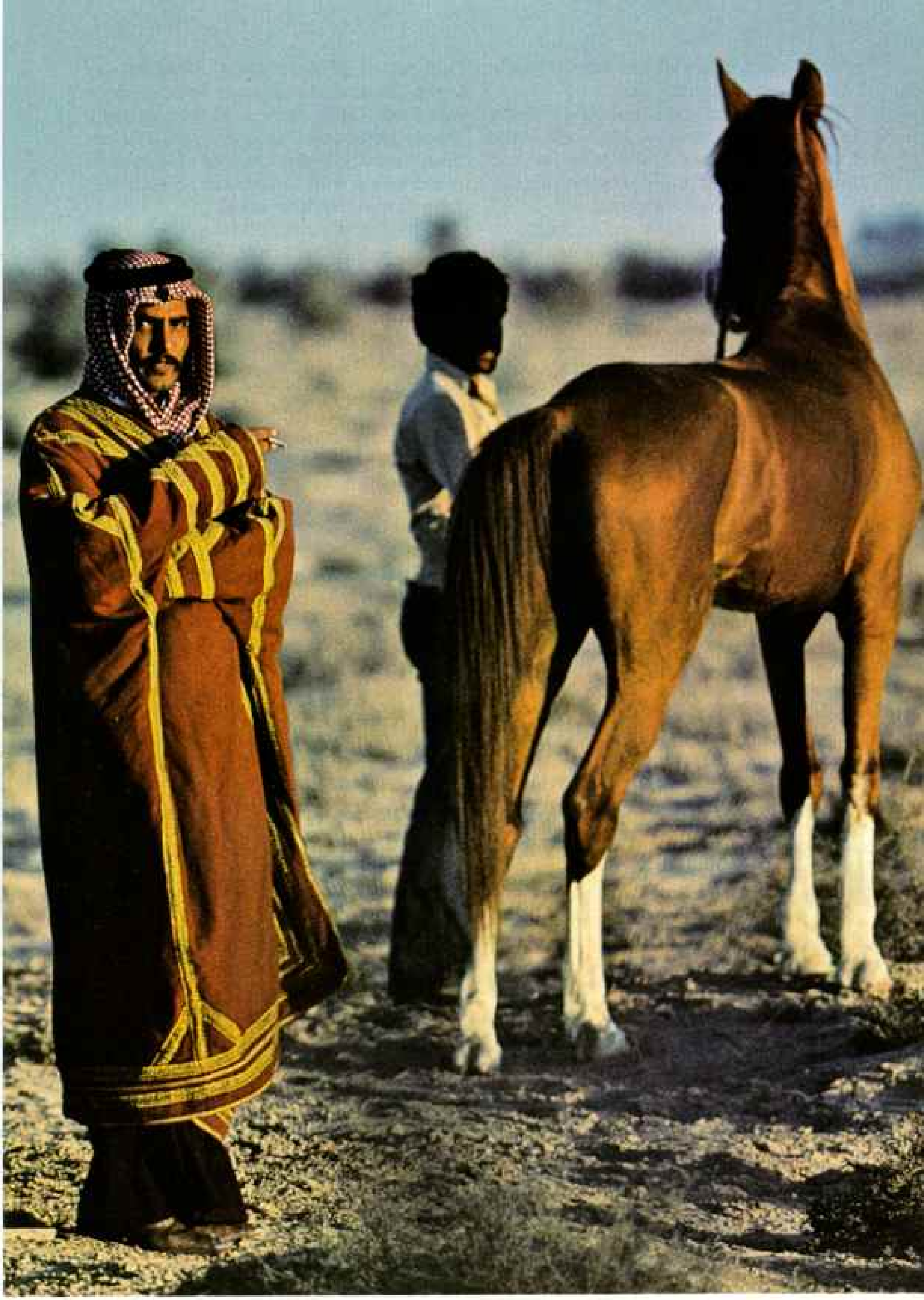
I watched that memory kept alive by retired divers and captains who meet every week at their favorite *dar*, or clubhouse, to dance and sing traditional chanteys. To the strumming of a lute, the boom of drums, and a hand-clapping staccato, the men, dressed in long gowns and headcloths, whirled and leaped with surprising zest. One knotted his scarf around his hips to grind out a sensuous Oriental dance.

A septuagenarian named Sultan Isa, a tiny bundle of man with eyes long dimmed, poured out an ancient pearling song.

Perhaps blind eyes see the past more clearly. His song evoked glass-clear waters, the creaking rigging, the meals of fish and dates, and sleeping beneath the stars—as well as the constant dangers of the deep:

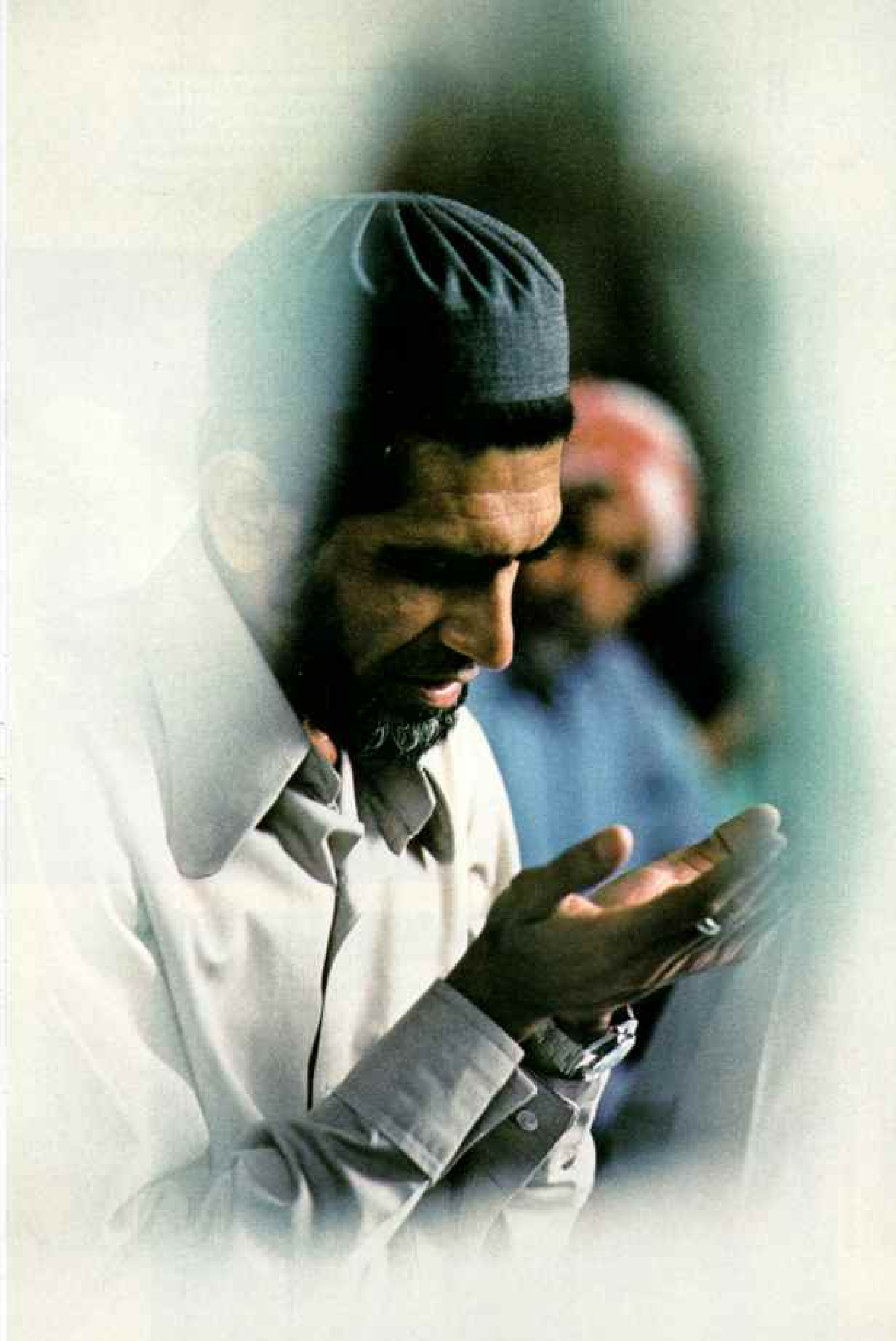
Oh, Allah, watch over me.
Oh, Allah, see me safely home again
To the one I love.

Another island tradition that remains is the noble, ancient art of falconry. Once a livelihood for hard-pressed Bedouin hunters, it survives today as sport—an expensive sport. At his small house in the village of West Rifaa I found Ali bin Hassan, one of the island's leading falconers (pages 326-7). At 70 plus, Ali *(Continued on page 323)*



*RULING BY DECREE, Sheikh Isa bin Sulman al-Khalifa (**below**) authorized the election of a National Assembly but then suspended that body in 1975. His ancestors from Arabia conquered the island in 1782, and the emir still keeps Arabian racehorses, inspected by Sheikh Ali al-Ghatam (**left**).*

*In the style of tribal democracy, the emir meets petitioners at a regular open house at his palace, reflected in a brass gate ornament (**bottom**). Commoners fill half the cabinet posts, members of the ruling family the rest. Minister of Defense and heir apparent, the emir's son Hamad checks out a West German helicopter.*



was taut and lean. His hawk profile and his alert, piercing eyes were a match for those of any of his feathered charges. We sat on small carpets around the fire pit while he ground coffee beans, Bedouin style, in a heavy brass mortar. He poured the grains into a brass pot simmering on a small Primus, then added cardamom and a pinch of saffron. From a perch spiked into the earthen floor beside his master, Nawaf, a 6-year-old falcon, sat motionless as we sipped.

"One of our best birds," Ali said, deftly lifting the leather hood from Nawaf's head. "These eyes can see prey several miles distant. Those strong feet, the beautiful tawny coloring show he is a champion." There are still about three hundred trained falcons on Bahrain, Ali told me. "But little hunting is done here. The main quarry, the houbara bustard, rarely winters here any more."

With Iranian hunting grounds now closed to them, Bahraini falconers travel as far as Morocco. Trade restrictions and a shortage of falcons have driven up costs. A prize bird now fetches up to $15,000.

Supported by the heir apparent, Sheikh Hamad bin Isa, an American ornithologist has recently begun breeding them. At the new $250,000 falcon center in Zallaq, I peered with Dr. Joseph Platt through one-way glass into seven temperature- and humidity-controlled chambers where pairs of breeding-age falcons roosted.

"Ten years ago the peregrine falcon was finally bred successfully in America," he said. "But this is the first such operation in the Middle East.

"At first the old-time falconers on the island wrinkled their noses," Dr. Platt added. "But now they bring their sick birds here for treatment. We've saved many birds—and converted most of the skeptics."

Is Bahrain Legendary Dilmun?

The Arabic and Islamic traditions that underlie Bahraini culture today hark back to the emissaries of the Prophet who converted the island more than 1,300 years ago. Yet for Bahrain, this is all recent history.

A growing consensus of scholars identifies the island with an ancient trading center called Dilmun. The *Epic of Gilgamesh*, a legend based on a Sumerian king and pieced together from cuneiform tablets, antedates Homer by some 1,500 years. In the poem the hero crosses the sea from Mesopotamia seeking the "flower of immortality" in a land that most likely was Bahrain. Another tablet portrays Dilmun as a veritable Eden:

The land of Dilmun is holy,
the land of Dilmun is pure. . . .
In Dilmun the raven utters no cry . . .
the wolf snatches not the lamb, . . .
Let your furrowed fields and acres
yield you their grain;
Let your city become the dock-yard-house
of the land.

*"**In the name of God,** Most Gracious, Most Merciful," a Muslim prays in Manama's Juma Mosque (**facing page**). Sacred backdrop for the ubiquitous soccer game, a new mosque (**above**) rises in Isa Town, a community of 35,000 built to relieve the housing shortage for low-income families.*

THE PUZZLE OF DILMUN, *a fabled land in Sumerian texts, perplexed scholars until they excavated in Bahrain, drawn by the 170,000 burial mounds that stipple its desert* (**facing page**). *Temples, pottery, copper, cuneiform tablets, and seals came to light, clues to a trading civilization that flourished around 2000 B.C. A merchant may have worn the gazelle-decorated seal* (**above**), *pressing it into clay to mark his cargoes.*

Bahraini archaeologist Mohammad Ibrahim (**right**) *works with urgency in the path of causeway construction. Others* (**top**) *are nonchalant: Potters and lime makers use tombs at Aali for ovens.*

Today the island's most startling features are the clusters of burial mounds embossing its desert landscape. South of the village of Sar, I visited a party of scholars excavating some seventy of the tombs, and spoke with Dr. Moawiyah Ibrahim, a Jordanian archaeologist leading the Bahrain Department of Antiquities expedition.

"Oil-company aerial photographs have shown there are more than 100,000 mounds," Dr. Ibrahim said. "This makes it the world's biggest ancient burial ground."

I tagged along with Bruno Frøhlich, a Danish physical anthropologist, as he carefully recorded some recently opened graves with his camera. In the distance a herd of camels grazed, but the early morning desert silence was broken only by the squeaking of wheelbarrows and the scraping of archaeologists' trowels. In one stone chamber he

An alert falcon awaits the commands of Ali bin Hassan, falconer to the emir.

arranged a compass and yardstick next to a 4,000-year-old skeleton lying on its side, hands tucked under its head as if sleeping. The camera clicked.

"He was about 40," Bruno said. "Like all we have exhumed so far, about a hundred, he probably died of natural causes. For most of them it was old age.

"One would guess they were a healthy people, about 5 feet 8 inches tall on the average and fairly well off," he continued. "How else could they afford such elaborate burials for so many?"

At S-137 he photographed a small seal carved from a seashell, a ring, and a crumbling bronze dagger. But there were few other clues among the bones.

"Trouble is the mounds were hit by grave robbers, probably 3,000 years before we got here," Bruno lamented.

Game is so scarce that sportsmen take their birds to Morocco to hunt.

I asked Dr. Ibrahim if this enormous cemetery on such a small island might not imply that ancients from the mainland chose it for their resting place, or perhaps it *was* the fabled land of Dilmun.

"We have yet to prove that," Dr. Ibrahim admitted. "But Bahrain is certainly the most likely candidate."

Of Bahrain's early history much remains to be unearthed. After the Islamic conquests of the seventh century it was governed by the caliphates of Damascus and Baghdad, then later by nearby independent Arab dynasties. The Portuguese occupied the island from 1521 until 1602. The ruins of their fort, a few miles west of Manama, are an island landmark. For the past two hundred years Bahrain has been ruled by the al-Khalifa family, immigrants from Arabia. In 1820 the island, along with other sheikhdoms on the gulf, came under British protection. Finally, eight years ago the small nation reached full independence—and a seat in the United Nations.

Emir's Council Open to All

To pay my respects to the present emir, or ruler, Sheikh Isa bin Sulman al-Khalifa (page 321), I entered the white crenellated walls of the royal palace in West Rifaa, eight miles south of Manama, for the regular Friday morning majlis, or council.

These days the gathering is largely ceremonial. At eight o'clock sharp the olive drab honor guard snapped to attention as Sheikh Isa wheeled through the wrought-iron gates in his powder blue Chevrolet. Ministers, company presidents, ambassadors, religious leaders, and members of the royal family dominated the crowd that pressed around as the emir, in gold-trimmed desert robes, stepped out. But I saw Bedouin and villagers too; the majlis is open to all. Each shook the ruler's hand and many, in traditional respect, kissed the tip of his nose.

Inside the carpeted majlis hall, hung with cut-glass chandeliers, some two hundred of us sat in chairs along the wall for the brief ceremony. Some stepped forward with a letter or a whispered request for the emir, who presided from the head of the long room. Tall, lean men wearing heavy gold-trimmed daggers poured coffee from shiny brass pots. Then tea. Then another round of coffee. One last time they swept in with censers of glowing myrrh. When my turn came, I took my lead from the old man next to me and with both hands fanned the fragrant smoke into my beard. Then Sheikh Isa stood up. We all rose. The majlis was over.

Floating Between East and West

Afterward I met briefly with His Highness in his private office. Small of stature, the emir nonetheless has the large presence of a man who speaks for a nation.

"We are proud of our long and friendly relation with Europe—and the Americans," Sheikh Isa said. He showed me a tribute from a U. S. Navy ship engraved on a cartridge case, memento of a 21-gun salute once fired in his honor.

In 1977, sensitive to a new mood of independence, Bahrain officially closed the U. S. Navy facility on the island, but U. S. ships still resupply from Mina Sulman, the island's busiest harbor.

"The dialogue between the West and the Arab world grows more and more important," said Sheikh Isa. "We are a small nation, but we are at home with both sides. Perhaps we have a role to play."

During my stay in Bahrain I had twice driven down to Mina Sulman, to meet two very different ships. One, Her Majesty Queen Elizabeth's yacht *Britannia*, replete with its own 24-piece band, carried the British sovereign on a swing through the vital gulf states. Officially a goodwill tour, the royal visit certainly also reflected the continuing British concern for stability in the Persian Gulf.

A few days later I watched the docking, with far less fanfare, of the U.S.S. *La Salle*, a converted landing-support vessel that serves as American flagship in the Middle East. Off the *La Salle* trudged three hundred exhausted American refugees, clutching small bundles, evacuated from Iran.

For Western diplomacy, one step forward, two steps back.

The gulf, major link between ancient powers, has become the main highway for a third of the world's oil. The drama that unfolds along its shores affects us all.

Surely Bahrain, with its centuries of experience as cultural go-between, will continue to play its part. □

Once restricted to home and veil, *city women balance tradition with a degree of emancipation their mothers never knew. A black aba covers a dress when this matron visits one of the few segregated settings, Women's Garden. Ever since the oil boom triggered both inflation and labor shortage, many women have taken jobs in government, banking, and even the police force of a nation dedicated to gradual change.*

THE SEARCH FOR

The First Americans

By THOMAS Y. CANBY
NATIONAL GEOGRAPHIC SENIOR STAFF

Photographs by KERBY SMITH

Paintings by ROY ANDERSEN

THEY WERE PREDATORS supreme, those Ice Age hunters who exploded upon the New World 12,000 years ago. Preying on lumbering mammoths, bison, and camels, on fleet horses and sluggish ground sloths, they killed so efficiently that their depredations may have caused the extinction of the creatures they stalked.

Success lay partly in their awesome firepower. Thousands of years before the bow and arrow appeared in the Americas, they apparently carried ingenious spear-throwers that could plunge a stone-tipped shaft deep into a mammoth's body.

Archaeologists call them Clovis people, after a cluster of bone-strewn mammoth kill sites and camps discovered in the 1930's near Clovis, New Mexico. Here bands of hunters downed and butchered four of the great elephants, along with horses and bison. Similar remains occur at a score of other western locations. At each the spearmen left their distinctive stone points—handsome tips with grooved, or fluted, bases that have been called the first American patent.

More than a hundred radiocarbon dates firmly establish the Clovis presence in the West. Almost simultaneously, similar fluted points appear by the thousands across the rest of the continent and through much of Central and South America.

With Clovis, a hemisphere that seemed virtually unoccupied erupted with a people who left their imprint boldly on the land. They are the first clearly visible actors on the American stage.

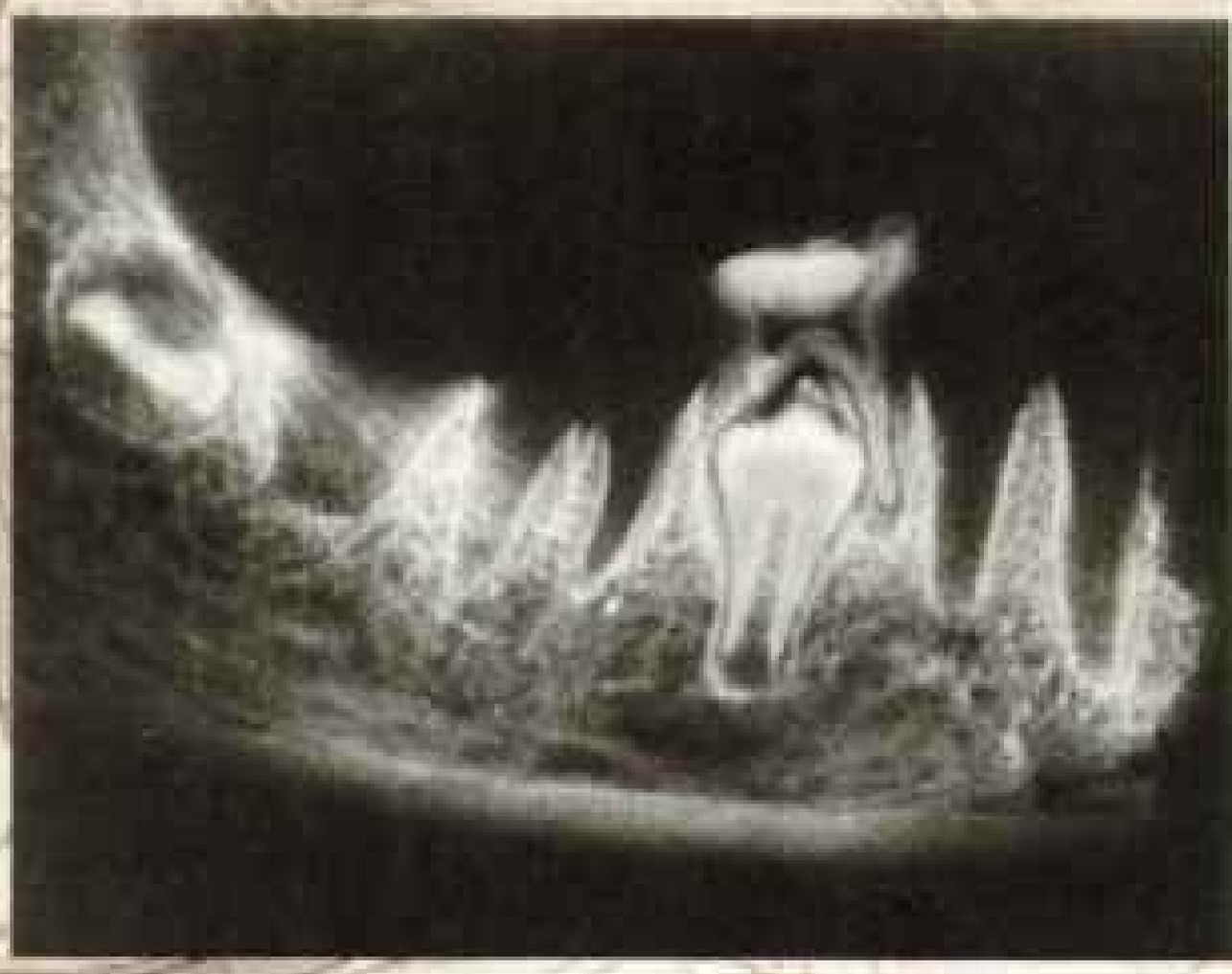
But much further back in time, earlier settlers apparently colonized the hemisphere. Theirs are shapes only dimly seen, a shadowy people who came on stage on tiptoe, when the lights were low.

Who were these earliest Americans? When did they arrive? These are the most often asked and hotly debated questions in American archaeology.

In search of answers, archaeologists have launched a sweeping manhunt across both hemispheres. For more than a year I rode with these academic posses, seeking out clues about early man from the Bering Strait to the Strait of Magellan. Many of the

Jawbone of a child *rests on a map of the Yukon's Old Crow Basin, where it was found with artifacts similar to those carbon-dated at 27,000 years old; a premolar (X ray, inset) shows beneath the baby tooth. Archaeologists agree that humans first came to the Americas from Asia. But who were they, and when did they come? New finds quicken the debate.*

DAVID L. ARNOLD, NATIONAL GEOGRAPHIC STAFF; CHRISTINE M. ANDERSON (INSET)



archaeological sites I visited were excavated with the help of grants from the National Geographic Society's Committee for Research and Exploration, which for decades has supported studies of early man.

"There's a great gray area out there, all right," acknowledges Dr. Dennis Stanford, director of Paleo-Indian Research for the Smithsonian Institution.* "Our understanding is in a state of transition.

"The last big breakthrough occurred in the 1920's and '30's with the discovery that Paleo-Indians were here toward the close of the Ice Age, nearly 12,000 years ago, hunting giant bison and mammoths. Now the cumulative evidence from a host of sites convinces most of us that man was here many thousands of years earlier. But so far we haven't found that unarguable site that establishes to everyone's satisfaction just who these people were or when they came."

Why such disagreement?

"A site that's passionately believed in by one archaeologist may be sincerely distrusted by another," explains Dr. Stanford. "Carbon-14 dates may be suspect, especially if made on fossilized bone or on material that might have been contaminated by other substances. Often there's doubt whether an artifact was found in clear association with the plant or animal remains used for dating it; slumping soils or the burrows of digging animals can hopelessly jumble a site's stratigraphy. We even face questions of whether a stone or bone artifact is actually the work of man, or whether it's a 'geofact'—a rock chipped by natural process, a bone shaped by an animal's gnawing."

Despite these uncertainties, many things are generally accepted about these ephemeral ancestors of today's Indians. For example:

- They came out of Asia, bearing with them such Mongoloid traits as coppery skin, dark eyes, straight black hair, wide cheekbones, and distinctively curved incisors characterized by anthropologists as shovel-shaped.
- They came by way of the Bering Strait, the only place where the New World is visible from the Old.
- They probably wandered across dryshod, when a vast land bridge linked Siberia and Alaska (although many experts believe they could have traveled those 55 miles by boat, just as other pioneers reached

*Dr. Stanford described a bison kill by Paleo-Indians in the January 1979 NATIONAL GEOGRAPHIC.

Australia at least 40,000 years ago), or they may have walked across on pack ice that clogs the strait some winters.

• They were probably "modern" men, of our subspecies *Homo sapiens sapiens*, with a full-size brain and spoken language.

• They were a people of the Stone Age, but their tools were not primitive. When Dr. Donald Crabtree, dean of the nation's flint knappers, underwent open-chest surgery, he equipped his surgeon with hand-flaked obsidian blades (page 355) that were sharper than the finest steel scalpels.

• They conquered the longest frontier ever traversed—more than 10,000 miles from Alaska to Patagonia. Not until man occupies another planet, notes French prehistorian François Bordes, will he explore a domain so vast.

• They came at seemingly the most difficult time, when the 60,000-year deep freeze of the Ice Age gripped the planet and lay most harshly on North America.

WHAT A WILD WORLD it was! To see it properly, we must board a time machine and travel back into the Ice Age. The northern half of North America has vanished, buried beneath ice sheets two miles thick (map, pages 339-341). Stretching south to Kentucky, they buckle earth's crust with their weight. Frigid winds roar down their edges, whipping up blinding dust storms across the continent.

Alternately cooling and warming, the restless ice masses shoot forth giant lobes that crumple forests and drive all life before them. In retreat their melt creates immense lakes whose sterile waters are shattered by calving icebergs.

Animals grow oversize, stamped with the gigantism typical of cold climates; paleontologists know them as Ice Age megafauna. Elephant-eating jaguars stand as tall as lions, beavers grow as big as bears, South American sloths as tall as giraffes. With arctic cold pushing so far southward, walrus bask on Virginia beaches, and musk-oxen graze from Maryland to California.

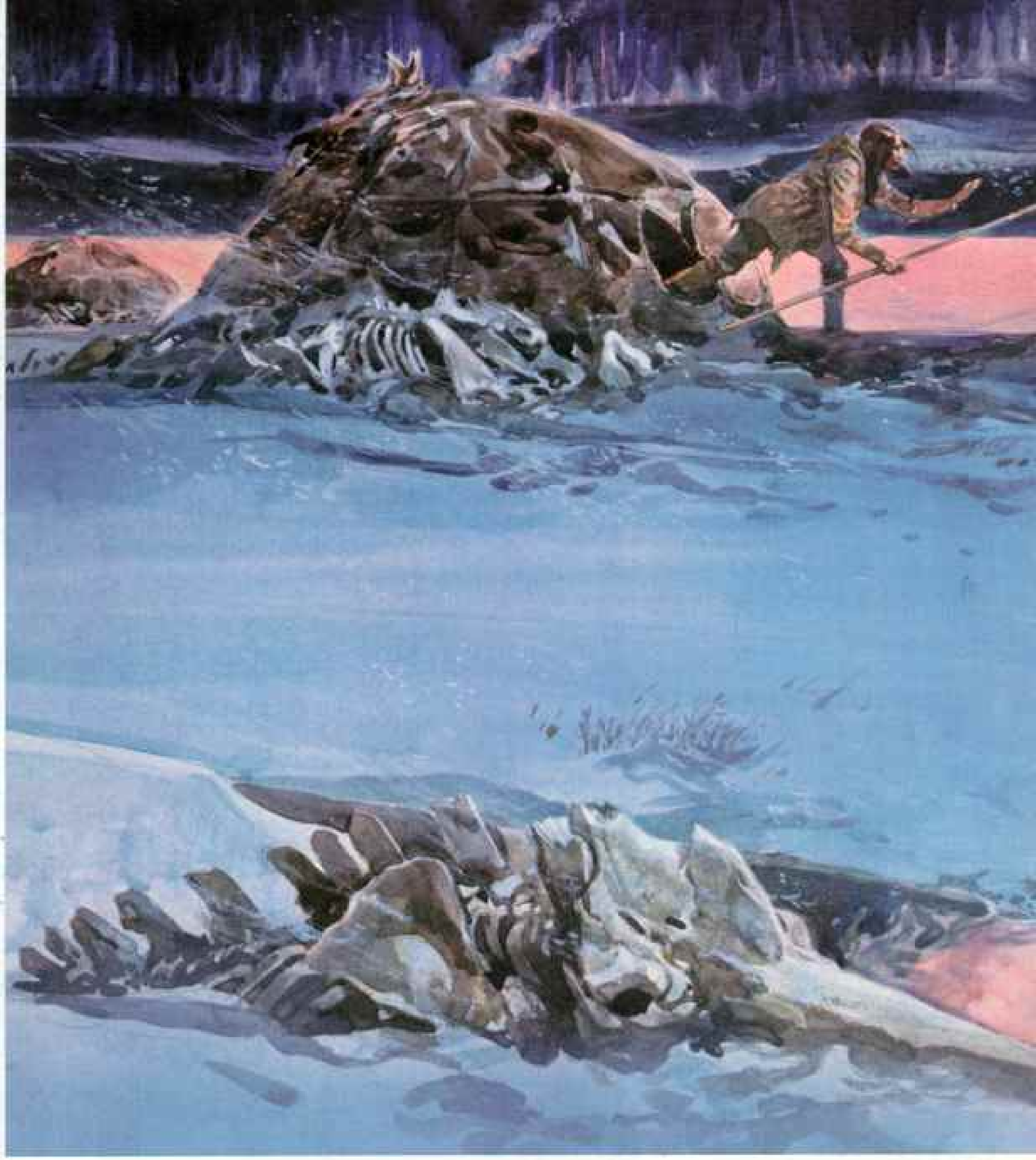
The ponderous ice sheets hold so much of earth's water that ocean levels drop and continental shelves emerge from the sea. Grasslands and forests invade these new realms; with them advance grazing mammoths and browsing mastodons, so that today trawlers fishing over the drowned

COURTESY WASHINGTON STATE UNIVERSITY

The oldest American? *The skull of the Del Mar Man* ***(left)****, found in a California coastal cliff, engages children at the San Diego Museum of Man. A new dating technique that analyzes amino acid changes puts the skull's age at 48,000 years. This has not been wholly accepted for lack of supplementary evidence and because of variables that may have affected the test results.*

Found in the haystack *of a dig in southeastern Washington, a bone needle* ***(right,*** *at left) compares favorably with a modern steel counterpart. By 10,000 years ago when the needle was delicately crafted, the entire hemisphere had been searched and settled by those intrepid explorers, the ancestors of American Indians.*

The First Americans



shelves often bring up their ancient bones.

For early man these exposed shelf lands held portentous meaning.

"One of the places the shelves spread the widest," observes Dr. David Hopkins, an Arctic specialist with the U. S. Geological Survey, "is in the shallow region of the Bering Strait. An ocean-level drop of only 160 feet was enough to close the gap between Alaska and Siberia. By 18,000 years ago the seas had dropped more than 300 feet. Then an undulating plain stretching a thousand miles wide—the land bridge—fused America and Asia.

"Little moisture falls on this part of the Arctic," the geologist explained, "and thus the land bridge, Alaska, and the northern Yukon escaped the ice that entombed the rest of Canada. Sealed off from North America, this area became in effect part of

Siberia—a domain we know as Beringia."

Beringia's broad grasslands became a highway for Asian animals passing into the New World—mammoths, mastodons, bison, musk-oxen, deer. With these came the beasts that preyed on them—lions, saber-toothed tigers, short-faced bears, swift dire wolves, swifter cheetahs. Among these predators, possessing neither swiftness nor immense *(Continued on page 342)*

***The hunter's cry**—a herd of mammoth has been spotted—rings out under northern lights on the Ice Age land bridge from Asia to America. Stalking game, bands move toward what is now Alaska. Hides from their kills give clothing and shelter. Whale bones, in foreground, were deposited in a warmer era when the bridge lay underwater.*

27,000-year-old flesher. *Close examination shows that the original caribou leg bone (this is a cast) was modified when the bone was still green, or fresh.*

COURTESY NATIONAL MUSEUM OF MAN, OTTAWA

Hide-working tool. *The wear pattern on this bison-bone fragment suggests its use.*

The journey begins

*WHEN DID HUMANKIND first cross the land bridge from Asia and enter the Americas? This highway to the east was open during several periods, as the world's ice cover and sea level varied over millennia to expose or drown the land that today lies under the Bering Strait (map, **right**). But scholars disagree as to when man first traversed it. Some say there is no conclusive evidence for humans in the New World earlier than about 12,000 years before the present (BP). Other scholars argue for a date of about 30,000 BP; still others speculate that dates far more remote will eventually be proved. Recent finds in the Yukon's Old Crow Basin—ice free during even the most severe glacial periods—support an occupation date of at least 27,000 BP. A caribou bone found there (**left**) shows unmistakable evidence of human modification. The bottom edge has been serrated for use as a fleshing tool to scrape hides. Even today some Eskimo use an almost identical method. A bone from a bison's leg (**below**) from Old Crow apparently has been deliberately fractured to make a hide-working tool.*

Another fundamental question remains: From where in Asia did the migrants come? A number of Old World sites have yielded tools and other artifacts that suggest a people who may have been ancestral Americans. Someday, perhaps, archaeologists will find proof at one site or another—or prove an entirely new theory. As of now, that day would seem to be many digs in the future.

Across Asia into Alaska

MAN HAD LIVED in eastern Asia at least half a million years at the onset of the last stage of the Ice Age, slowly moving farther east and north. By perhaps 70,000 years ago, expanding ice sheets had lowered ocean levels and exposed a land bridge linking Siberia and Alaska. Animals had used such a bridge before, and man, too, would drift across in search of game, unknowingly occupying the Americas.

Giant moose joined the parade of ice Age animals that moved from Old World to New.

All-purpose hand ax could have dug roots and dressed carcasses some 200,000 years ago.

Bone and ivory female figures were carved 14,750 years ago.

Bone spearhead, saw-toothed with tiny flakes of stone, tore animal innards and caused massive hemorrhaging.

The saiga antelope traveled the land bridge from Asia but later became extinct in North America. A herd of at least two million survives in Siberia.

The woolly rhino, a forest creature, did not cross the land bridge's grassy steppe.

Stone bead may have adorned a necklace 13,000 years ago.

Awl, carved from the wing bone of a loon, punched holes in hides for clothing and shelter.

Man hunted the woolly mammoth, used its hide and bones for shelter and tools, and may have derived nutritious marrow from its bones.

22,500-year-old stone bifaces, possibly used as knives, show strong similarity to New World tools.

Mainstay of Peking Man's tool kit was the chopper, such as this one made 300,000 years ago.

Multipurpose hand ax of 40,000 years ago could cut, smash, or chop as a job might require.

Leaf-shaped implement, flaked on both sides, exemplifies bifacial stone-working technique thought by some to have originated in the Diuktai complex on the Aldan River.

Key to sites

- Sites more than 100,000 years old
- Sites possibly more than 100,000 years old (no consensus on artifacts or dating)
- Sites 40,000 to 100,000 years old
- Sites 18,000 to 40,000 years old
- Sites 11,000 to 18,000 years old

Brown shows land mass 70,000 years ago; blue shows oceans, lowered here by 230 feet, and possible lakes; white shows possible distribution of ice. Present-day names appear in blue.

Sites mentioned in article printed in boldfaced type.

DRAWN BY JOHN G. WEBER
ANIMALS AND ARTIFACTS BY PAUL W. BRISCOE
RESEARCHED BY OLIVER G. A. M. PAYNE
NATIONAL GEOGRAPHIC ART DIVISION

18,000 years ago

Peopling a world of ice and giant animals

Enormous ice masses, exposed continental shelves, and radically different vegetation mark the hemisphere as the ice sheets reach their maximum. Man occupies the Alaska-Yukon region. But how did he venture south of the ice? Most archaeologists suggest passage through an ice-free corridor along the eastern slope of the Rockies; others support a Pacific coastal route.

Native to the New World, horses provided food for early hunters, then fell into extinction. Europeans reintroduced them to the Americas.

Lion-size scimitar cat competed with man for big game.

Implement of caribou antler was used to hammer bone and stone into tools.

Beauty and deadliness combine in this unique bifacial projectile point.

Almost entirely unglaciated, the land bridge stretched 1,000 miles wide at the peak of the last phase of the Ice Age about 18,000 years ago, permitting a two-way flow of man and animals between the Old World and the New.

Ice-free corridor, blocked only during the peak of glaciation, provided a probable pathway south.

The bison was destined to replace the mammoth as man's staple in the West.

The mastodon, a rugged woodland browser, was little hunted in North America.

Mammoth kills associated with man have been found only in the West, although four species of the animal grazed throughout the continent.

Graceful Clovis points tipped the spears of western mammoth hunters. The distinctive grooved, or fluted, base probably aided in hafting. The sudden appearance of fluted points 12,000 years ago offers the earliest irrefutable evidence for man's New World presence.

Early hunters in the Americas may have found the heavily armored glyptodon a "pushover" — a simple flip exposing the vulnerable underside.

The camel, like the horse, originated in North America and was butchered by Clovis-period hunters in the West.

Small flaking scars on edges show that man resharpened this quartz scraper.

Mastodons of South America were probably more widely hunted than their northern cousins.

Crude stone chopper was found in a cave along with the remains of a giant ground sloth.

Giant ground sloths, some as big as elephants, grazed and browsed throughout both continents.

North American vegetation patterns are based mainly on evidence from bog and lake sediment cores and plant remains. In South America such accurate records are scarce, but scientists, using geological and zoological records, speculate that 18,000 years ago tropical forests had retreated to isolated areas known as refugia.

Vegetation in Caribbean Islands omitted because of insufficient data.

Laurentide Ice Sheet

Cordilleran Ice Sheet

Maximum extent of late Wisconsinan ice

Beringia

Old Crow (30,000)

Chuwash Gold Claims (20,000)

Taber (50,000)

Selby Dutton (20,000)

Couperton (20,000)

Calico Hills

Del Mar (48,000)

Texas Street (21,500)

Yuha Burial (21,500)

Santa Rosa Island (40,000)

Tlapacoya (22,000)

Valsequillo (22,000)

El Bosque (32,000)

Pikimachay (20,200)

Driftwood Creek

Trail Creek

Bluefish Caves

Putu

Fairbanks

Dry Creek

Healy Lake

Mesa

Hidden Falls

Hatchet Rockshelter

Agate Basin

Anzick

Jaguar Cave

Colby

Simon

Wilson Butte Cave

Owl Cave

Union Pacific

Fort Rock Cave

Smith Creek Cave

Borax Lake

Dent

Dutton

Blackwater Draw

Clovis

China Lake

Ventana Cave

Lehner

Naco

Murray Springs

Lubbock Lake

TUNDRA OR POLAR DESERT

BOREAL FOREST

WESTERN CONIFEROUS FOREST

SHRUB STEPPE

GRASSLANDS (PRAIRIE)

MONTANE EVERGREEN WOODLAND

TAIGA WOODLAND

TEMPERATE DECIDUOUS FOREST (WITH CONIFERS)

MONTANE EVERGREEN FOREST

EVERGREEN WOODLAND

STEPPE TUNDRA OR STEPPE

TROPICAL WET FOREST

DESERT SCRUB

HIGH ANDEAN VEGETATION

SUBTROPICAL AND TROPICAL DECIDUOUS WOODLAND OR SAVANNA

SUBTROPICAL AND TROPICAL DECIDUOUS FOREST

MEDITERRANEAN-TYPE WOODLAND

SUBANTARCTIC FOREST (MAINLY BEECH)

Washington

Los Angeles

Miami

Panama

Brasília

Santiago

today

With the ice sheets greatly diminished, today's climate and vegetation differ markedly from those of 18,000 years ago. For example, the Amazon Basin probably is now much wetter, the Great Plains drier and grass covered.

Key to sites

- Sites most widely accepted as more than 18,000 years old
- Sites possibly more than 18,000 years old (no consensus on artifacts or dating)

Site dates in parentheses rounded to nearest 100 years

Sites mentioned in article printed in boldfaced type

KILOMETERS 2000 0 2000

STATUTE MILES 0

KILOMETERS 1000 0 1000

STATUTE MILES 0

11,000 years ago

Flourishing hunters in a waning ice age

The great ice sheets have retreated to central Canada; the land bridge is submerged. Throughout the Americas, archaeologists can trace an explosion of the human presence. The technology of fluted projectile points, for example, spreads suddenly across much of the hemisphere, raising the question: Did use of the points spread through an existing population, or was it introduced by a people newly arrived?

Maps researched by Oliver G. & M. Payne, National Geographic Art Division, with special help from the following scientists: Dodson, P.V. Wells, P. and M. Delcourt, P. A. Colinvaux, E.S. Deevey, Jr., T. van der Hammen, D.M. Hopkins, V. Markgraf, P.J. Mehringer, Jr., G.T. Prance, and A.M. Ab'Saber (natural vegetation); K.R. Fladmark, J.H. Mercer, V.K. Rowe, R.W. Rutter, M. Vigliarchi, and the CLIMAP group (ice); M. Bender, C.S. Churcher, C.B. Harington, and L.D. Martin (fauna); R.E. Ackerman, J.S. Aigner, Kwang-Chih Chang, C.S. Chard, R.L. Humphries, F. Rowe-Smith, T.F. Lynch, R.E. Morlan, W.R. Powers, and H.M. Warmington (sites and artifacts)

Possible Clovis-point precursor lacks refined form and fluting of later weapons.

Ice Sheet

Debert

Munsungan Location # 14

Gulf Brook

Shawnee Minisink

Parkhill

Dutchess Quarry

Shoop

Holcombe, Meadowcroft Rockshelter

Thunderbird

Williamson

Wells Creek Crater

Angus

Shriver

Kimmswick

Miami

Domebo

Lewisville

Aucilla River

Little Salt Spring

Levi Rockshelter

Sea level 11,000 years ago was about 165 feet lower

Taquiquiac

Valsequillo

Taima-Taima

El Abra

Although mystery shrouds its origin, the El Jobo point's proximity to mastodon bones at Taima-Taima attests to deadly effectiveness.

Abrigo do Sol

Pikimachay

Las Vilos

Tagua Tagua

Uncertain use of discoid-shaped stones stimulates speculation: Did man use them as grinding tools?

Los Toldos Cave

Fell's Cave

Estimates of sea level lowering, shown on this map at 430 feet, range from about 300 feet to 600 feet.

The camel-size macrauchenia roved over South America and survived to the time of man's arrival.

Hunters probably fastened this crudely crafted 14,000-year-old bone point to a wooden shaft.

The hippopotamus-like toxodon wallowed in the swamps of South America.

Man designed this basalt "fishtail" point to penetrate deeply into his quarry.

Key to sites

- Clovis and related fluted-point sites
- Other dated sites, 11,000 to 18,000 years old
- Sites, 11,000 to 18,000 years old (no consensus on artifacts or dating)

KILOMETERS 1000 0 1000

STATUTE MILES

MAPS PREPARED BY JOHN QUINDEN PRODUCED BY LEO B. LEBHERZ NATURAL AND ARTIFACTS DRAWN BY KARL M. KROEGER NATIONAL GEOGRAPHIC MAP DIVISION

(Continued from page 335) strength, came man, unknowingly crossing the threshold of a new world.

Oceans replenished by the long-melted ice washed over the land bridge when I walked its Alaska abutment at the Bering Strait. Yet a sense of the affinity between Old World and New was overwhelming. Only 55 miles away glinted the snowy peaks of Siberia—the other end of the land bridge. Halfway across, the date line passed invisibly, so that technically I looked into tomorrow. But for me those ermine peaks beckoned back into yesterday, to the origins of the first Americans.

From eastern Asia to westernmost Europe, hundreds of Old World archaeological excavations contribute clues to the life-style of the ancestors of the first Americans. Chronologically they offer no tidy step-by-step progression across the great Eurasian landmass toward Alaska. But they tell much about a people honing their skills as big-game hunters and showing an early adaptation to cold climate (map, pages 337-8).

By half a million years ago, long before the appearance of modern man, his sloping-browed predecessor *Homo erectus* had penetrated to wintry northern China and was preying on elephants and deer. Some American archaeologists, pointing to suggestive skulls found in the New World, speculate that these early men may have crossed the land bridge of a previous ice age.

Neanderthals, a subspecies of *Homo sapiens*, appeared about a hundred thousand years ago in Europe and western Asia. Soon they pushed to within a hundred miles of the Arctic Circle, hunting mammoths along the Soviet Union's Pechora River.

"This is the time," notes Washington State University prehistorian Dr. Robert E. Ackerman, a specialist in Arctic archaeology, "when man occupied Asia on a broad front, from the Ural Mountains to the Pacific. One advance spread across central Asia to southern Siberia and Mongolia and came to be known as the Mal'ta-Afontova culture. A second wave penetrated eastern Siberia. Excavations along the Aldan River by Soviet archaeologist Yuri A. Mochanov show these people, of the Diuktai culture, hunting mammoths, musk-oxen, bison, and giant woolly rhinoceroses about 35,000 years ago. One of these cultures may have produced the first emigrants to cross the land bridge into Alaska."

Suppose that we could join a band of these "Proto-Americanoids" encamped on the grassy land bridge. . . .

WE NUMBER fifty men, women, and children—a group large enough to be relatively self-contained, yet small enough not to quickly exhaust the game within hunting range.

We are not a beautiful people. Our faces are pocked with grime and blackened by soot of our campfires. But we enjoy extraordinary health. The frigid region in which we live serves as a germ filter, and we know nothing of such Old World diseases as pneumonia, influenza, and measles.

Next to fire our most important tool is the sewing awl. Without sewn shoes we would suffer crippling frostbite, which we nomads fear above all else. Nor could we survive without tailored trousers and shirts that trap body heat despite clawing arctic winds.

In this monotonous, grassy steppe we will pass our lives without seeing trees or even knowing they exist. Virtually all our material needs are met by a single resource—the animals we kill. Meat and marrow provide most of our food. Hides make our clothes and sleeping mats and cover our shelters; small bones and dung fuel our fires. Hunters' spears are carved from mammoth leg bones and straightened by boiling in water until soft.

Perhaps our camp has several huskylike dogs, to serve as beasts of burden, as hunters, or as mobile sources of food.

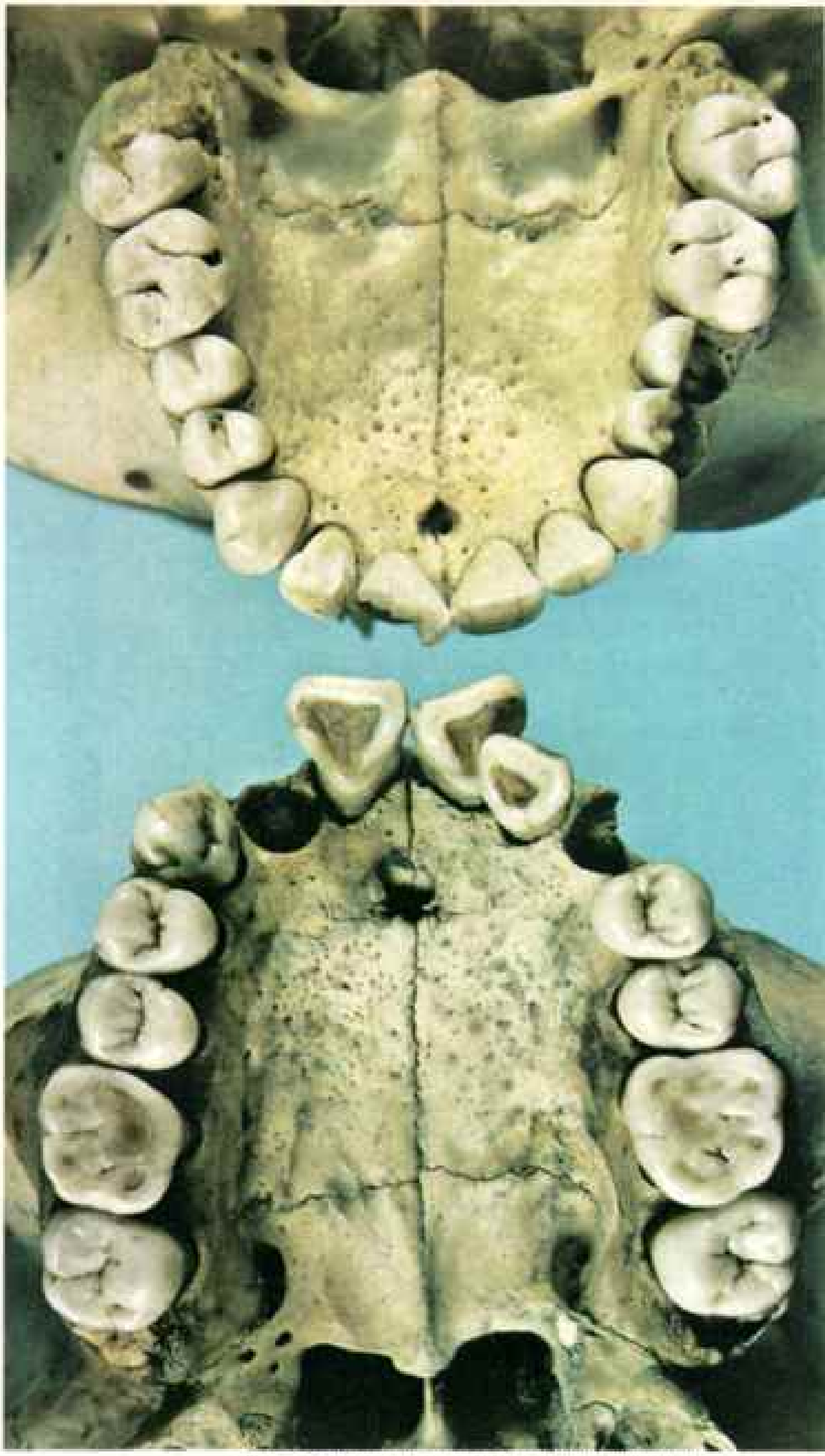
Every few days the hunters radiate out in search of game, staying away until they snare and spear as much as they can carry back to camp. Eventually animals grow scarce, and the nomads search for promising new game lands. One evening they return with news of abundant animals a few camps away to the eastward.

Now our entire band picks up and moves toward the rising sun. Burdened by our furnishings, slowed by the old and the very young, we make faltering headway.

Finally we pass over a low mountain range near the easternmost end of Beringia, in what is now the northern Yukon. Ahead

Dental detective work *is pursued by Christy G. Turner II of Arizona State University to trace early man's origins and age. Northern Asians and American Indians of both Ice Age and modern times share, to a considerable degree, certain traits of tooth formation. One is "shoveling" of the incisors, a scooped-out appearance of the forward biting teeth.*

Photographs on this page show comparisons of shoveling: ***(below)*** *3,000-year-old Chinese;* ***(right,*** *lower) modern American Indian. By contrast, incisors of European origin* ***(right,*** *upper) lack shoveling.*



COURTESY ACADEMIA SINICA, TAIPEI (LEFT); AMERICAN MUSEUM OF NATURAL HISTORY (BELOW); ALL BY CHRISTY G. TURNER II

Of two darkened teeth found in Chile and dated at 11,000 BP ***(right)****, the one at the right is a shovel incisor.*

According to Dr. Turner's research, a high frequency of shoveling evolved an estimated 40,000 years ago, and thus man probably did not enter America before that date.

lies a valley fastness known today as the Old Crow Basin. Here we halt. And here we emerge from the realm of speculation into archaeological acceptance—the earliest widely acknowledged occupation site in the New World, carbon-dated to at least 27,000 years ago.

The discovery of Old Crow in 1966 not only turned back the clock of man's presence in the Americas by thousands of years, it also revealed the inadequacy of the term "Stone" Age; this early man was also a skilled user of bone.

For hunters the 3,000-square-mile Old Crow Basin presented an arctic Eden, teeming with dozens of species of Ice Age game animals. Over time, skeletons of that long-ago menagerie were preserved beneath layers of sediments. Today, when spring melt swells the Old Crow River, its turbulent waters gouge these fossilized bones from the sediments and strew them by the thousands along the banks.

Many of these exhumed bones reveal signs of human alteration. Most were broken merely in butchering, but some were chipped to provide flakes for use as knives and scrapers. "We're looking at a technology almost entirely new to us," observes Dr. William N. Irving of the University of Toronto, who directs a major archaeological project in the basin.

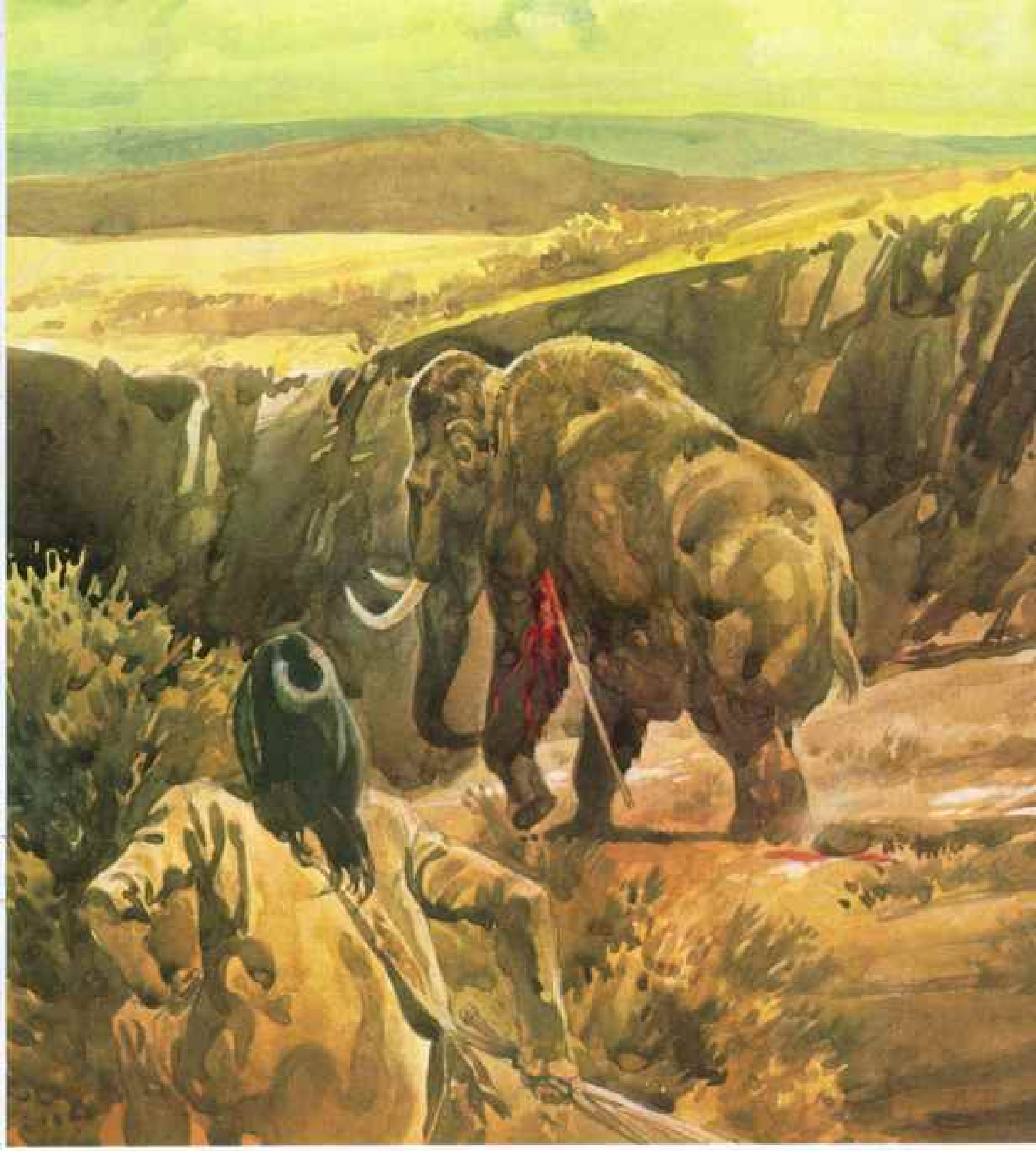
Appropriately the man who first opened this new chapter in American prehistory is an Indian, a member of the Yukon's Loucheaux tribe. An expert hunter and trapper, Peter Lord is a school janitor in the Loucheaux village of Old Crow. In the summer of 1966 he signed on as a field assistant to Canadian paleontologist C. R. Harington, who had been drawn to the basin's abundance of extinct-animal bones.

Five days out they stopped to survey a productive bend in the river. Peter Lord bent over, then straightened triumphantly with hand outstretched. In it he held an exquisitely carved caribou bone (page 336) whose serrated end gave it the look of a modern back scratcher. Suspecting the artifact's antiquity, Harington showed it to Dr. Irving, who was working nearby. Carbon-dating indicated the breathtaking age of 27,000 years.

Discovery of this flesher, used to scrape

Mammoth find *along the Yukon's Old Crow River demands patience and care from workers excavating a tusk* ***(above)****. No detail is too small to examine.*

*Archaeologist William N. Irving studies a stone chip (**facing page, below**) to assess whether it is an artifact of human manufacture or a "geofact" shaped solely by natural processes. As the river meanders through the Old Crow Basin (**below**), it uncovers evidence of what may be the continent's earliest inhabitants, a people expert in working bone.*



animal hides, launched two archaeological assaults on the basin. From Old Crow village, a helicopter whisked me in minutes to the riverside encampment of the Northern Yukon Research Programme, headed by Dr. Irving. The spring freshet had just receded, and Dr. Irving led me to a newly exposed sandbar strewn with thousands of bones being harvested by University of Toronto archaeologists. Posting himself nearby, Dr. Irving inspected the haul for signs of human alteration.

"Leg bone of a horse," he said, holding up a typically dark-stained specimen. "Obviously broken by human beings to get the marrow." A dozen more bones passed through his hands without comment before an angular chunk claimed his attention. "This is a fragment of mammoth bone—extremely hard stuff. You can see how they

chipped off flakes for cutting edges."

I followed the bones to their next stop—a canvas tent that served as a sorting depot for paleontologist Dr. Brenda F. Beebe.

"We've got a real zoo here," Dr. Beebe observed. Rummaging through a box of bones, she held up the scimitar fang of a huge cat, a mammoth tooth twice as large as a brick, the hooves of four horse species ranging in height from ponies to Percherons.

Cautious killers, *a hunting party in the Wyoming of 11,000 BP directs a wounded mammoth into a dead-end arroyo. Armed with stone-tipped lances and spear-throwers, even these most efficient predators would perhaps not rush into hand-to-tusk combat but wait until the animal was mortally exhausted. Evidence at the Colby site suggests that hunters cached surplus meat beneath stacks of bones.*

"Our most surprising discovery," she said, "is the jaws of several domesticated dogs, some of which appear to be at least 30,000 years old. This is almost 20,000 years older than any other known domesticated animal anywhere in the world."

Boating up the Old Crow, I encountered members of a second scientific team, the Yukon Refugium Project. Clinging to a bluff seventy feet above the water, they were trying to unravel the complex geology of the basin's 120-or-so feet of exposed sediments.

"Once we fully understand the geologic stratigraphy," explained Dr. Richard E. Morlan of the National Museums of Canada, head of the project, "we'll be able to date the bone artifacts that we and Bill Irving are finding." Some, he believes, come from levels that indicate ages twice those of the flesher—perhaps 60,000 years.

The problem of accurate dating casts a shadow across the dramatic discoveries at Old Crow.

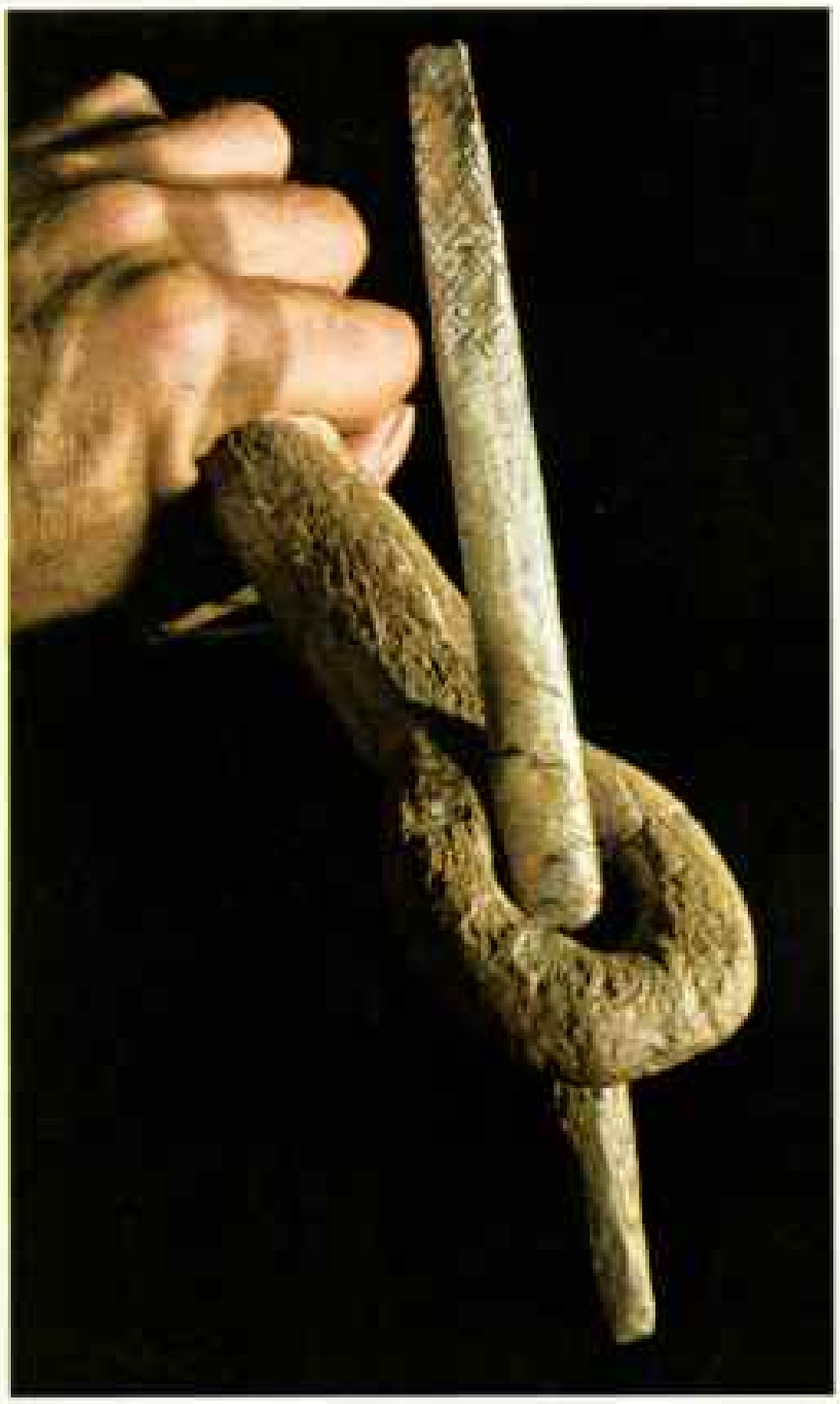
Archaeologists distrust radiocarbon dates of bone objects such as the flesher; also, no Old Crow artifacts have been found in association with datable human traces such as charcoal from hearths.

Another doubt—one now fast waning—hangs over the authenticity of Old Crow's bone "artifacts." Are they really the result of human alteration? Or could they have been broken by natural forces—the gnawing of animals, stresses of frost action, fracturing by landslides, the tread of wild animals?

Or, in the case of the flesher, where human alteration is unquestionable, could an artisan in more recent times have picked up a piece of already fossilized bone and carved the artifact?

Long familiar with implements of stone, archaeologists found themselves unequipped to answer questions about bone. Taking up the challenge, Dr. Robson Bonnichsen of the University of Maine, already a skilled flint knapper, undertook a massive study of bone modification. His analysis included more than 14,000 specimens found at Old Crow.

He concluded that only green, or fresh, bone can be flaked like stone into implements, and that the Old Crow bones fossilized *after* they were modified. His verdict: The artifacts are authentic.



BOTH BY DAVID L. ARNOLD, COURTESY ARIZONA STATE MUSEUM (ABOVE) AND ANDICK-HARRIS COLLECTION (FACING PAGE)

Equipped for eternity, *children were buried in Montana about 11,000 BP with the finest of tools (**facing page**). Among them are large and small stone knives and, in the left foreground, a dark Clovis point with characteristic fluted base. The three dowel-like objects are casts of spear foreshafts of bone. Points were hafted to the foreshafts, and they were socketed to the main shafts. While still pliable, foreshafts were straightened by an Ice Age wrench (**above**) also made of bone.*

POISED AT OLD CROW in Beringia, a human reservoir stood ready to trickle down the hemisphere. But ahead reared a seemingly insurmountable barrier, the continental ice sheet, spanning the continent from sea to sea, stretching a thousand miles southward.

Miraculously, however, a way lay open—a shifting, inhospitable pathway known as the ice-free corridor.

"In reality, two separate ice sheets blanketed the northern latitudes," explained

the Canadian geologist Dr. Nathaniel W. Rutter. "The larger, known as the Laurentide, covered most of Canada east of the Rocky Mountains. A smaller system, the Cordilleran, centered on the Rockies and spread to the Pacific Ocean.

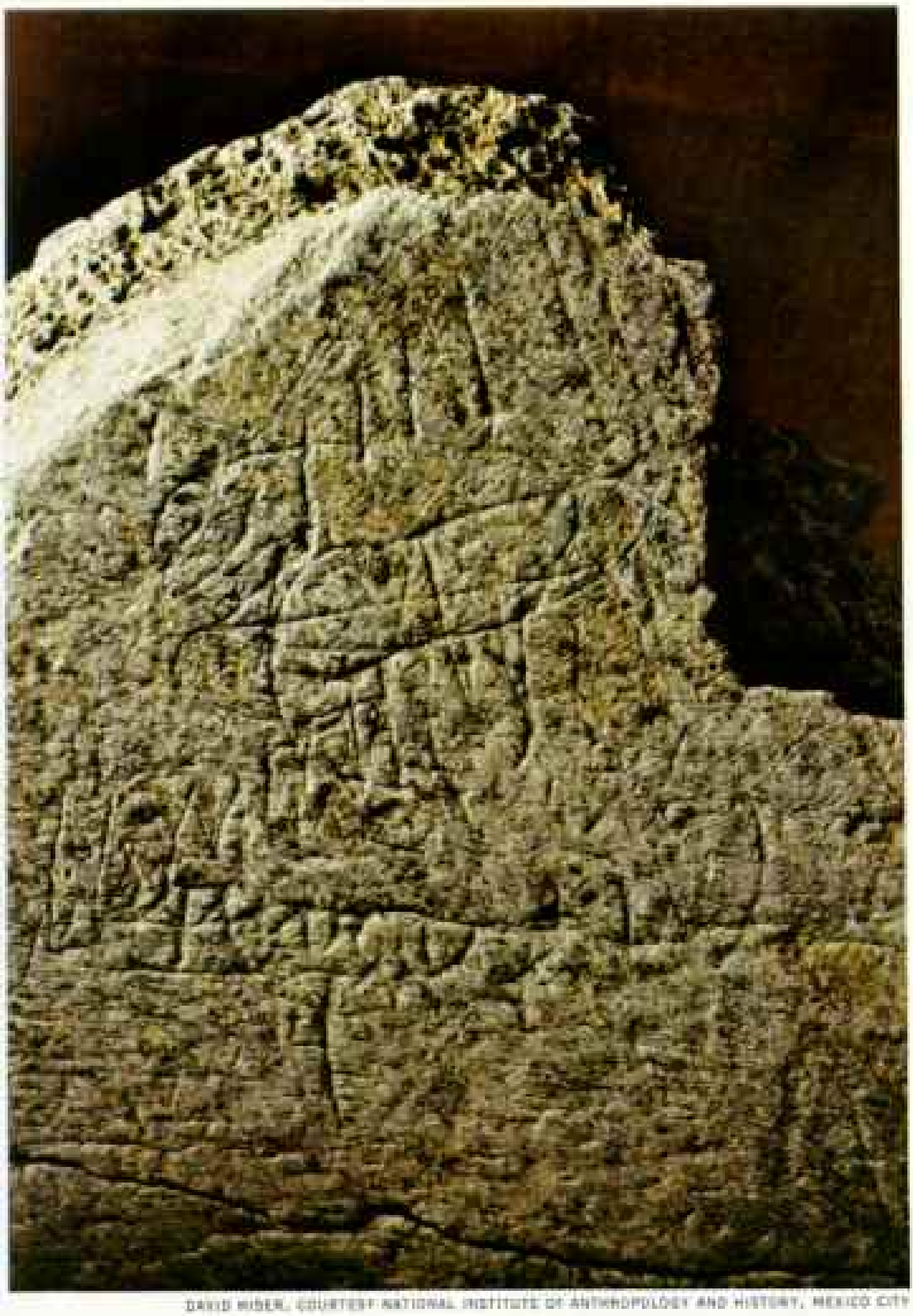
"At times the two sheets met and formed an ice barrier across the continent. But during most of the Ice Age they left a corridor along the eastern flank of the Rockies, often only fifty or a hundred miles wide."

Doubtless it was a formidable place, an ice-walled valley of frigid winds, fierce snows, and clinging fogs. "Man didn't travel it on the basis of a bag lunch," notes Dr. Morlan. Yet grazing animals would have entered, and behind them would have come a rivulet of human hunters.

No proof of early occupation occurs along the corridor, and some authorities believe man may have traveled another route—the coast of Alaska and British Columbia.

"Even at the height of glaciation," notes Dr. Knut R. Fladmark of British Columbia's Simon Fraser University, "ice-free pockets existed along the coast. Early immigrants could have leapfrogged from one to the next. Where ice shelved out over the sea, they would have needed boats, and we know these had been developed much earlier by colonizers of Australia."

South of the ice lay an immense horizon, but one surprisingly unobstructed. The mountain spines of both Americas run north-south. Except for a possible jungle barrier at the Isthmus of Panama, their flanks offer pathways along which hunters would be drawn by grazing animals.



DAVID HIDEN, COURTESY NATIONAL INSTITUTE OF ANTHROPOLOGY AND HISTORY, MEXICO CITY

A singular engraving *on a piece of mastodon bone* ***(left)****, found in Mexico and estimated to be 22,000 years old, apparently depicts a mastodon and a large cat* ***(above)****.*

While comparable art flourished in Ice Age Europe, nothing like this engraving has been found elsewhere in the Americas. Has the art of the Americas perished, having been done on wood, hide, or other impermanent materials? Or has it simply not yet been found? Did it even exist, except in isolated instances? Only more fieldwork can begin to give answers.

MAN'S EMERGENCE south of the ice marks the start of the real conquest of the hemisphere. It also marks the point at which opinions among early-man archaeologists most strongly diverge. I found that most, however, subscribe to one of three main theories about the settling of the Americas:

The "late arrival" viewpoint, whose chief spokesman is Dr. C. Vance Haynes of the University of Arizona, questions a significant human presence south of the ice before Clovis. Most sites purporting to be older than 12,000 years or so, Dr. Haynes believes, possess fatal flaws in dating or authenticity of artifacts. "If man was really here so long ago, a site will eventually prove it clearly, without the need for arguing over questionable aspects."

Dr. Haynes believes that big-game hunters entered Beringia already equipped with the stone and bone implements that make up the Clovis tool kit. Filtering down the ice-free corridor, they emerged on the Great Plains about 12,000 years ago, experienced rapid population growth in the virgin land, and rapidly expanded across the Americas, leaving a wake of fluted points.

The "middle entry" hypothesis, argued by authorities such as Dr. H. M. Wormington of Colorado College and Dr. Roger Powers of the University of Alaska, traces the genesis of the first Americans to an earlier culture in Siberia, where people living in a cold steppe environment made tools of bone. Spreading northeastward, they occupied Beringia about 30,000 years ago, leaving evidence of their bone-working technology at Old Crow. (Experts such as Dr. Mochanov, who believe these immigrants came from the Diuktai culture along the Aldan River, subscribe to this time schedule.)

Trickling through the corridor about 25,000 years ago, these Paleo-Indians in a few millennia reached sites in Mexico that many archaeologists believe to be the oldest evidence of occupation yet discovered south of the ice sheets. In time their descendants spread across both Americas. Few in number and making little impact on their environment, they left faint clues of their presence before the Clovis period.

This theory finds support in dentition studies pursued by Dr. Christy G. Turner II of Arizona State University. Comparing 11,000-year-old Paleo-Indian teeth found in Chile by Dr. Junius Bird with those of Old World peoples, Dr. Turner deduced that Paleo-Indians did not branch off from Asian stock more than 40,000 years ago.

THE "EARLY ARRIVAL" theory, advocated by Dr. Alan L. Bryan of the University of Alberta, accepts man's presence south of the ice sheets at least 40,000 years ago and argues for tens of thousands of years earlier. These very first Americans, Dr. Bryan believes, may have been members of *Homo erectus*, with subsequent evolutionary development taking place in the Americas.

He points to support in tantalizing but highly disputed clues:

- Visiting Brazil in 1970, Dr. Bryan photographed the skull of a beetle-browed hominid he believes to be a few rungs down the evolutionary ladder. Later he returned to continue his study, only to find that the skull had vanished without trace.
- The late anthropologist Louis S. B. Leakey believed that crudely fractured stones found in California's Calico Hills indicated an ancient human presence. Further investigation suggested shaping by natural forces; the investigation continues.
- Fire pits on California's Santa Rosa Island reveal stone tools and the bones of dwarf mammoths, convincing Dr. Rainer Berger of the University of California at Los Angeles that Paleo-Indians killed and cooked the horse-size elephants here more than 40,000 years ago.
- Along the California coastline, archaeologists have unearthed human bones that Dr. Jeffrey Bada of the University of California at San Diego finds to be 48,000 years old. But skepticism plagues his new dating technique, known as amino acid racemization and based on the chemical changes that take place in bones and shells over time.
- Surveying the ice-free corridor near Taber, Alberta, Canadian geologist Archie MacS. Stalker discovered the skeletal remains of a Paleo-Indian infant suggesting a probable age of 50,000 years. But some colleagues challenge the date of the "Taber child," and Dr. Stalker returns this summer to verify his find.

COURTESY SOVIET RESEARCH INSTITUTE (ABOVE); INSTITUTE OF ARCHAEOLOGY, LENINGRAD (FACING PAGE)

Bone and stone: *Both tool traditions of the New World have counterparts—and possibly prototypes—in Siberia. There the power of bone projectiles used about 14,000 BP in the Yenisey River area is manifest in a punctured bison scapula (**facing page**). Stone knives and points from Diuktai Cave (**above**) are flaked much as in the Americas. Soviet archaeologists watch (**top**) as an American colleague demonstrates Ice Age-style flint knapping.*

WHAT WAS THE LIKELY PACE of man's advance?

"Probably no one will clock the rate of spread archaeologically," asserts Dr. Richard S. MacNeish of the Peabody Foundation, whose 44-year career embraces 15 years of on-site work in both Americas. "I picture it taking place by the hurry-up-and-wait process.

"Within each broad ecological zone, movement would have been fairly fast—the hurry-up phase. But passing between zones, say the Panamanian jungle, meant stopping to evolve new adaptive patterns—the wait part. This might have taken centuries.

"We see this pattern in the much later Eskimo migration. Once they adapted to arctic North America about 4,000 years ago, the Eskimo swept from Alaska to Greenland so quickly their language remained virtually unchanged all across the top of the world."

This theory of rapid movement, implying little time in which to leave visible remains, may help explain the location of two sites that offer the oldest widely accepted evidence of man south of the ice sheets. They lie 2,500 miles south of the corridor near the sunbaked Mexican city of Puebla.

More than thirty years ago Mexican paleontologist Juan Armenta Camacho was drawn to a trove of extinct-animal bones in a riverine area known as Valsequillo. Among them Dr. Armenta has found crude stone artifacts, along with mastodon bones on which early artists scratched sketches of Ice Age animals (page 350).

In 1962 U. S. archaeologist Cynthia Irwin-Williams joined Dr. Armenta in mapping and excavating the fossil-rich sediments and their cache of artifacts. As the site's promise became apparent, Dr. Irwin-Williams brought in other experts: geologists, soil chemists, dating specialists.

Carving trenches into alluvial gravels, they encountered levels where hunters had slaughtered extinct animals further and further back in time. Almost a hundred feet down, at a level that indicated an age of 22,000 years, they found evidence of ancient butchers dismembering a mastodon. Meanwhile Dr. Armenta tallied a staggering profusion of Ice Age horses, bison, camels, mammoths, and mastodons.

Simultaneously, an archaeological team

led by Dr. José Luis Lorenzo found signs of human activity rivaling that of Valsequillo in age and probable authenticity. At the nearby site of Tlapacoya the bones of black bear and two kinds of deer appeared with 22,000-year-old hearths. A curved obsidian blade was found beneath a buried tree trunk that gave a similar date.

To some critics both sites pose questions of whether the artifacts are unquestionably associated with the animal and plant remains by which they were dated. But most experts agree that Valsequillo and Tlapacoya meet this test.

THEY STAND as lonely outposts, however. At least two thousand more years pass before evidence reestablishes man's presence.

In this period the Ice Age grinds toward its peak. The expanding Laurentide and Cordilleran ice masses collide, sealing off the corridor. For more than three thousand years this great valve blocks human and animal migration from Beringia to the ice-free south.

Falteringly, scattered handfuls of hunters and gatherers weave a few more threads into the gossamer tapestry of pre-Clovis culture. Two early haunts tell of Paleo-Indians felling mammoths, camels, horses, and bison on what are now the Colorado plains. Known as the Dutton and Selby sites, they occupy wind-scoured playas that once were Ice Age water holes.

When I visited the Dutton dig, it cupped a band of sun-scorched student archaeologists who toiled under the watchful eye of the Smithsonian's Dennis Stanford.

"We're getting four layers of cultural material here," explained the burly, bearded early-man specialist. "From Clovis on back to possibly 20,000 years ago. Except for the Clovis layer, all the artifacts are bone—not too different from the Old Crow material. The Selby site is much the same.

"Apparently the hunters hacked off the victim's head, tail, and feet and pulled the body away to butcher at their campsite. That's probably why we find so many skulls and foot bones compared with other parts."

Does Dr. Stanford regard these altered bones as proof positive of man on the plains thousands of years before Clovis?

"Certainly they are a strong indication," acknowledges the cautious archaeologist, "but not an airtight case. I suppose that these bone breaks *could* come about without human intervention, *if* the playa were undergoing a dry spell and *if* the bones were on the surface and *if* a herd of animals came charging over, trampling them with their hooves. But the broken mammoth leg bones we've found—*nothing* could do that except humans hurling rocks."

In this period of grinding cold a small group of early Pennsylvanians foraged almost at the foot of the great Laurentide ice mass. Many times their forays brought them to a sandstone outcrop forty miles southwest of Pittsburgh. Here at Meadowcroft Rockshelter the little band tarried to cook their game of rabbits and deer and sharpen tools for the next hunt. Their hearths establish a carbon-14 record tracing back at least 16,000 years.

One of Meadowcroft's hunters left behind a bifacial projectile point that may have profound significance.

"It's like a fluted point," attests Dr. James M. Adovasio of the University of Pittsburgh, "except that it has no fluting. It may be ancestral to the Clovis point." He sees similarities to a bifacial tool found by Dr. Ruth Gruhn at Idaho's Wilson Butte Cave that may be 14,500 years old.

To Dr. Adovasio, Meadowcroft's contribution to science is not only its antiquity but also the advanced technology employed in digesting the site's torrent of data.

I grasped his meaning as we entered the shelter, now tightly boarded against vandals. Inside the door stood an electronic device jarringly out of place in a cave. "A computer terminal," explained the intense archaeologist. "We've recovered nearly 3½ million objects here, from stone blades to tiny seed husks. Every detail about them went into the computer—size, shape, species, where found. Each object also went to an appropriate expert for analysis, and this too was fed into the computer. With a punch of a button we can get a readout of human activity and environmental conditions for any moment in the cave's history."

Before us opened a gaping hole, its walls showing occupation levels and hearth stains dating back 16 millennia. "We removed 230

metric tons of soil, digging with nothing larger than trowels," noted Dr. Adovasio as we stared down appreciatively. "Sometimes a living floor was thinner than a trowel; then we dug with razor blades.

"At one point in the cave's history, a huge section of the overhanging roof crashed down, and later occupants rolled a boulder aside to clear a place to work. Our archaeologists were able to trace those roll marks on the cave floor. That's careful digging."

Meadowcroft's abundant carbon dates and the care shown in excavating persuade most archaeologists that here, at last, lies unarguable proof of man's pre-Clovis presence. Yet I heard doubts from geochronologist Vance Haynes, who often assumes the role of devil's advocate in the ticklish area of site authenticity.

If occupation extends back so far, asks Dr. Haynes, why didn't the hunters leave bones of Ice Age animals that abounded in Pennsylvania? The carbon dates also arouse skepticism. Pointing to coal outcrops nearby, Dr. Haynes asks if rainwater could have brought in "dead" carbon dissolved from coal, thus distorting the measure of radioactive decay on which carbon dating is based.

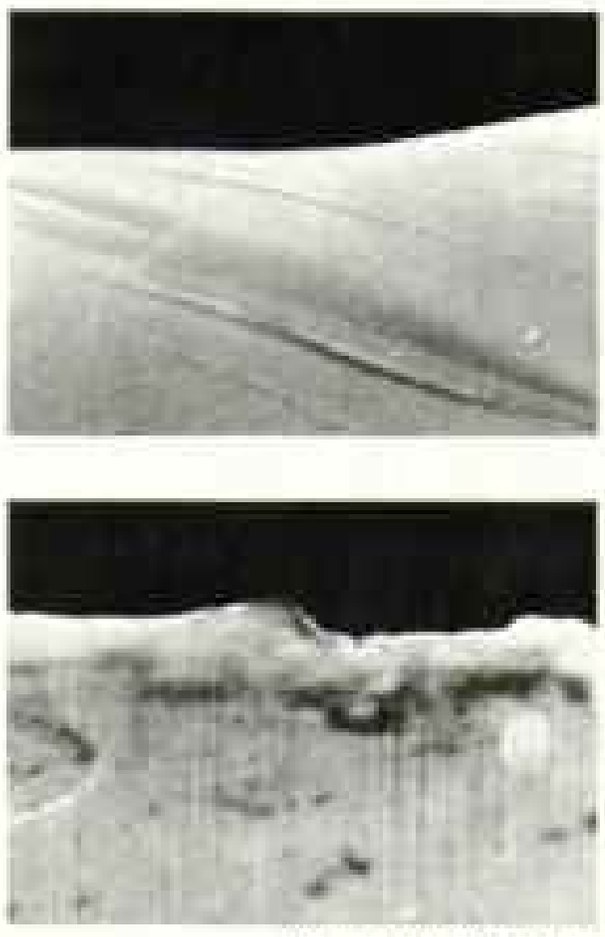
AT ABOUT THIS TIME early settlers signal their presence in South America. Their arena is a vaulting rock-shelter in Peru's scenic highlands with the unglamorous name Pikimachay—Flea Cave. Never mind. Six stories high and half a city block wide, it is the Ritz of caves. Little wonder that man and giant ground sloth may have vied to possess it.

"Evidence from bones and crude stone artifacts indicates that hunters surprised the elephant-size beasts in the shelter at least 14,000 years ago," asserts Dr. Richard MacNeish, who led the excavation. "They slaughtered them and stayed to eat their kill.

"Apparently hunting bands had used the shelter for thousands of years before that, perhaps as far back as 25,000 years ago. We found scores of artifacts, together with bones of extinct sloths, camels, horses, deer, and giant cats. From debris they left on the cave floor we identified activity areas—stations where they butchered animals and knapped flint and bone tools."

As is often the case with sites that claim

Stone craftsman *in the Virginia of 11,000 BP* ***(above)*** *left evidence not only of his work, but also, in the pattern of waste chips, of his seated, tucked-leg posture. His was no crude technology, as photomicrographs* ***(below left)*** *demonstrate. At 10,000-power magnification, the edge of a flaked obsidian blade (at top) is keen, while a modern steel scalpel (at bottom) appears rough and irregular. Duplicating the ancient skill* ***(below right)*** *takes patience and a hide pad to protect the hands from cuts.*



BOTH BY DAVID BENTLEY

***Firepower**—literally—may have been a weapon in the early Americans' arsenal. Finds at Tagua Tagua, Chile, suggest the scene at right. Horses, not yet domesticated and to become extinct in the hemisphere, are driven to slaughter before fires set upwind. Deliberately fractured and engraved with parallel strokes, a horse leg bone **(below)** was found in a natural trap, a swampy draw near the Chilean coast.*

DAVID L. ARNOLD

such antiquity, Dr. MacNeish's finds have their skeptics. Are the radiocarbon dates from bones reliable? Could his earliest stone artifacts be merely fragments fallen from the cave roof?

AS THE DEEP COLD of the Ice Age gradually lessens, signs of early settlers mushroom on both continents. One such sign appears at a desert water hole known as Taima-Taima only a few hundred yards from Venezuela's Caribbean coast.

I visited the kill site in the company of Professor José Cruxent, whose excavations have added uniquely to our knowledge of early man.

"I started digging *there*," said Dr. Cruxent, pointing to the edge of the water hole, "and soon I found the skeleton of a mastodon. Then I found another, and a third, and a fourth. Among the bones of one lay an El Jobo point—a bifacial spear tip of a type I had discovered earlier.

"The point was lodged in the mastodon's pelvic cavity, suggesting a thrust into the bladder in order to poison the animal—a technique still practiced today by African elephant hunters."

Dating his site from organic material in the soil, Dr. Cruxent came up with 13,000 years. But skepticism greeted his report. To support his findings, the Venezuelan invited the assistance of Professors Alan Bryan and Ruth Gruhn.

Joining Dr. Cruxent, the Canadians launched their own dig at the water hole and quickly uncovered the skeleton of a young mastodon. Carefully excavating, Dr. Gruhn also discovered an El Jobo spearpoint, lodged in the pelvic cavity. Chewed twigs presumed to be samples of stomach

contents produced a cluster of carbon dates around 13,000 years old.

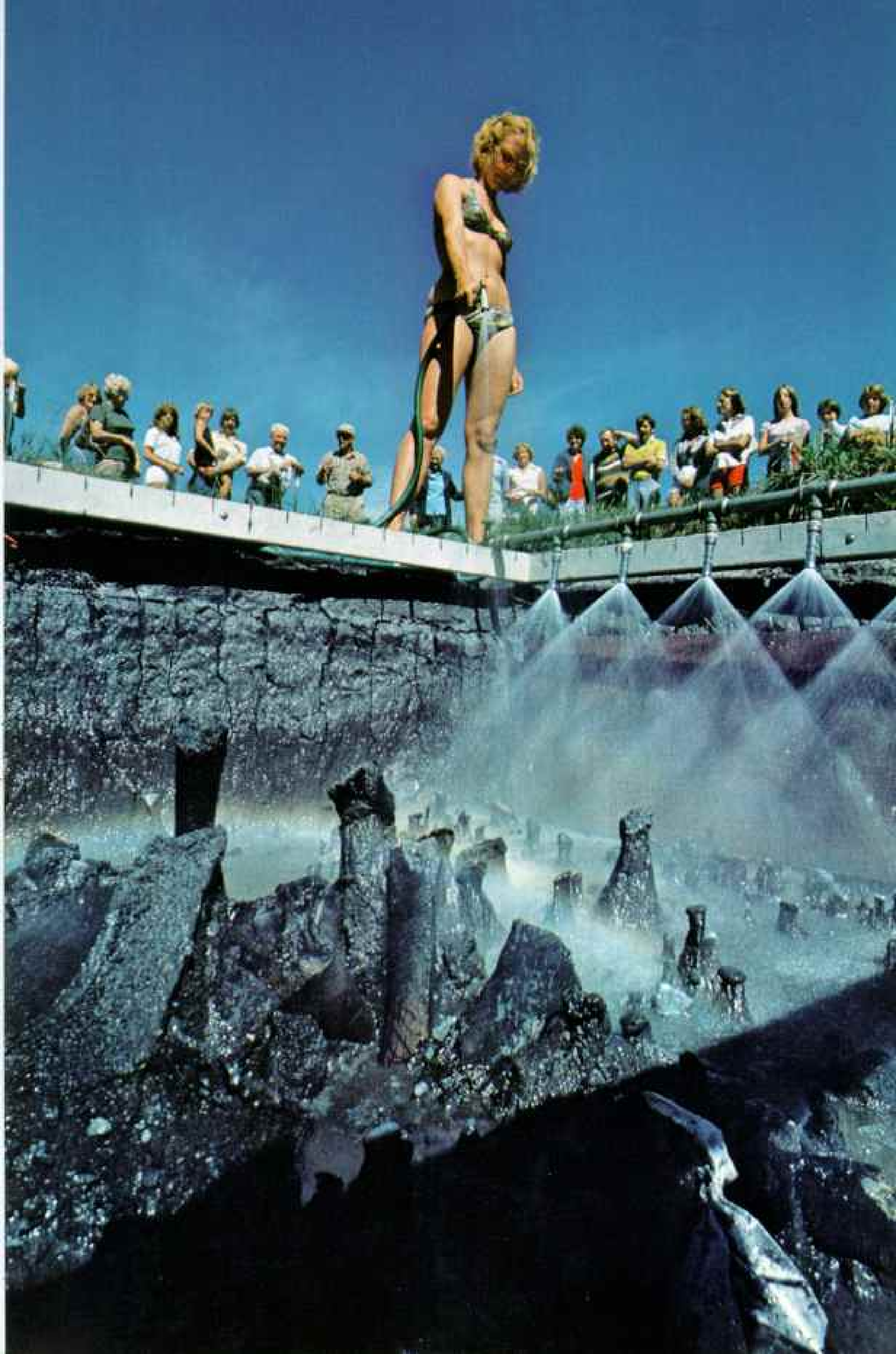
In light of their probable antiquity, El Jobo points hold profound implications. Like Clovis points, they were probably used with spear-throwers and bear evidence of pressure flaking—chipping performed by the pressure of a hand-held bone or antler—as well as percussion. Did this important advance in stone working originate in South America and diffuse northward to Clovis country? Or, as Dr. Bryan believes, did it spring up in both places independently, as happened in Old World locales?

IN THE TOPSY-TURVY ERA of the Ice Age, enormous sparkling lakes filled the bleak deserts that mark today's Great Basin between the Rockies and the Sierra Nevada (maps, pages 339-41). Lakeside marshes provided superb habitat for animals—and possibly early man.

Along shorelines of these fossil lakes, archaeologists find bifacial tools known as Lake Mojave points. These, like Clovis and El Jobo points, show signs of pressure flaking. Most have been found on the surface, and dating them is difficult. But some experts believe that if Clovis points prove to have a New World antecedent, it will be found among Lake Mojave artifacts.

In contrast to the watery Great Basin, much of Ice Age Florida was semidesert. There a venturesome underwater archaeologist has revealed a strange drama that unfolded 12,000 years ago in a goblet-shaped sinkhole southeast of present-day Sarasota (pages 362-3).

"At that time the water level in Little Salt Spring was almost ninety feet lower than today," explained Carl Clausen of General Development Foundation as we wriggled



into scuba gear at the edge of the sinkhole.

"Apparently a Paleo-Indian fell in, and was able to scramble up to a ledge a few inches above the waterline. Stranded, he evidently caught a giant land tortoise that had fallen in, impaled it with a stake, and managed to cook it on the ledge.

"When we excavated the ledge, now 87 feet beneath the surface, we found the stake thrust between the tortoise's shells, which in turn rested on fire-baked clay. The stake was carbon-dated at 12,000 years old."

Suited up, Mr. Clausen and I descended into the darkening cenote. Soon his flashlight played on the ledge, revealing a trench holding tortoise bones and segments of the carapace. From the trench wall projected other bones—remains of an extinct sloth. Silently we explored the sinkhole, surveying yard after yard of unexcavated ledge.

"A lot of history's still buried down there," remarked Mr. Clausen after we surfaced. "I think someday we'll find human remains—maybe those of the tortoise cook."

THE HAND of our archaeological clock passes 12,000 years ago and sweeps toward 11,000. Now, from Alaska to Tierra del Fuego, the New World seethes with human activity.

Most conspicuous are the Clovis mammoth hunters, whose trademark of kill sites and fluted points boldly punctuates western North America.

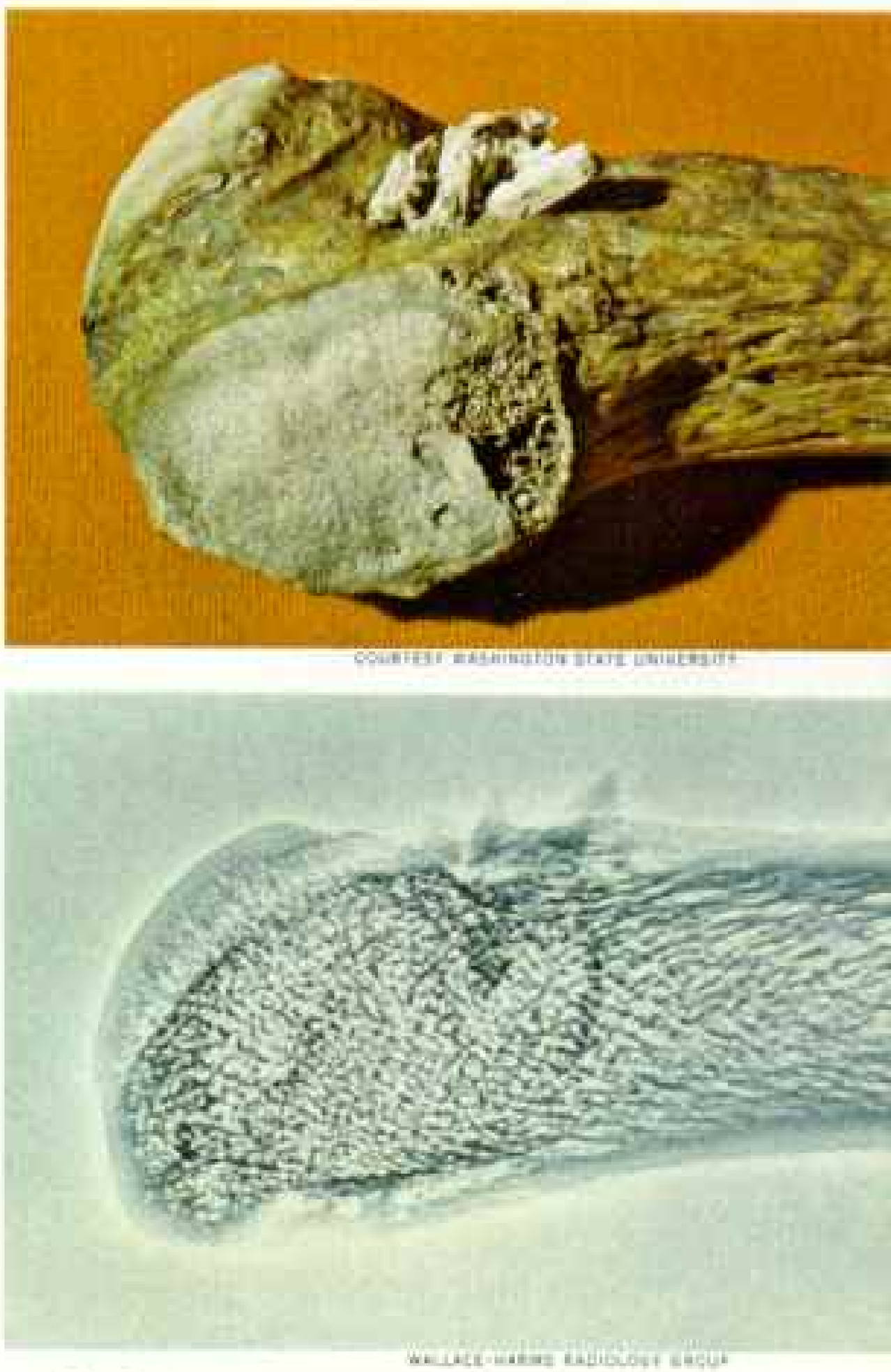
Simultaneously vague figures scatter fluted points across the continent, most densely in states of the Midwest and South. The points concentrate along major river systems, a pattern paralleling that of hundreds of mammoth- and mastodon-skeleton discoveries. Yet except for a kill site on Washington's Olympic Peninsula and another in Missouri, evidence does not link man with mastodon north of central Mexico. North American hunters seem to have shied away from the burly beasts.

One explanation offered for this is that mastodons may have fed on spruce twigs, and this resinous browse could have given their meat an unpalatable flavor.

Despite the abundance of fluted points, no remains east of the Mississippi River tell of early hunters pursuing Ice Age animals. Yet Paleo-Indians left their mark.

At the sprawling Debert campsite in Nova Scotia, a fluted-point people left 3,200 stone tools, along with hearths dating from 10,600 years ago. In Virginia's Shenandoah Valley, flint knappers quarried rich outcrops of jasper to make Clovis spearpoints, and left traces of having planted upright posts—the earliest evidence of New World structures.

Scattered discoveries of fluted points speak of human stirrings southward through Mexico and Central America and into South America. But evidence of man's activity has been difficult to find.



COURTESY WASHINGTON STATE UNIVERSITY

WALLACE-HARMS RADIOLOGY GROUP

By hosing down *the site of an ancient pond formed by glacial meltwater, bones are freed from soil (**facing page**). At this Washington State University site dated at about 12,000 BP, a mastodon rib was found pierced by a bone point (**top**). A radiograph (**above**) shows healing of the wound, indicating it was not lethal.*

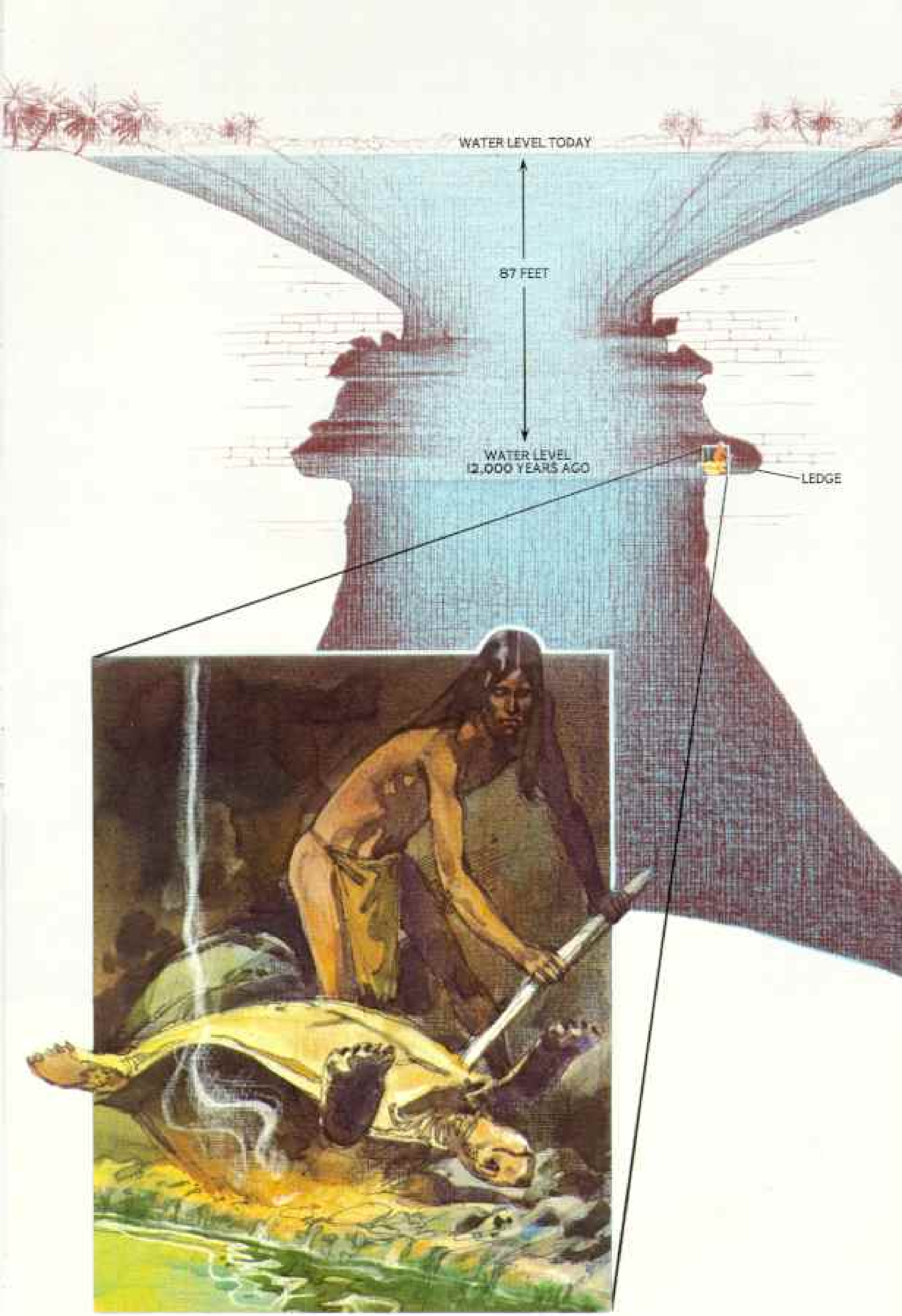
"There's little doubt that Paleo-Indians lived here at least 11,000 years ago," Chilean archaeologist Lautaro Nuñez said as we visited two likely mastodon kill sites near Santiago. "But in South America we have problems locating their remains. Most archaeological sites are found by luck—by builders digging basements, farmers dredging irrigation ditches. We are less mechanized here; we find fewer sites by chance."

Like beacons marking the end of the longest journey, intriguing caves speak vibrantly of the human presence at the tip of South America. These earliest Patagonians appear to have lived 12,600 years ago in Los Toldos Cave in Argentina, where they hunted the guanaco, or wild llama. By 11,000 BP they occupied Fell's Cave in Chile, making fluted points with distinctive fishtail bases and stalking guanacos and horses. Like

their distant ancestors in Old Crow, at the other end of the earth, they may have had domesticated dogs.

THIS FATEFUL MILLENNIUM, during which early man indelibly stamps his presence on the Americas, sees another epochal event. The great scythe of extinction erases the Ice Age megafauna, sweeping widest in North America.

***A good day's work**—a hunter with snared rabbits, gatherers returning with baskets of berries, other band members smoking meat—ends at the Meadowcroft Rockshelter in Pennsylvania. Scholars from the University of Pittsburgh have meticulously excavated the site and cataloged finds dating from 16,000 BP to the 18th century A.D.*


WATER LEVEL TODAY
87 FEET
WATER LEVEL
12,000 YEARS AGO
LEDGE

Four species of mammoth vanish from the Americas; three types of mastodons and camels, as well as ground sloths, lions, bears, tapirs, peccaries, sabertooths, and horses. Darwin marveled at the abrupt transition from "monsters" to "pigmies."

Did the sudden flowering of Paleo-Indian hunters bring about the exterminations? The question stirs almost as much controversy as that of early man himself.

Experts agree that the waning Ice Age saw violent fluctuations in temperatures and moisture patterns, which in turn wrought radical changes in the vegetation and even animal behavior. These climatic shock waves, many believe, could have wiped out the megafauna without human intervention.

Other authorities see man and nature conspiring. Shrinking ecological niches, they believe, concentrated and weakened the animals, so that they fell easy prey to man.

Still others believe that human hunters alone, with devastating spear-throwers and stone projectile points, could have snuffed out the megafauna, unaided by natural forces. "Man was the most terrible tiger," asserts Venezuela's Dr. Cruxent.

The concept of human-caused extinctions finds elegant expression in the "overkill theory" propounded by Professor Paul S. Martin of the University of Arizona. Contending that Clovis hunters were the first Americans to arrive south of the ice sheets, Dr. Martin sees them rapidly sweeping the length of the hemisphere exterminating Ice Age animals.

"Assume that a band of a hundred hunters emerges from the ice-free corridor near Edmonton about 11,500 years ago," suggested Dr. Martin at his breezy desert office outside Tucson. "Assume too that the Ice Age animals, having never been hunted, have few defenses against this new and thoroughly superior predator.

"The hunters advance perhaps ten miles a year in an ever widening front, doubling their numbers every generation. In only 300 years they swell to 300,000 people and reach the Gulf of Mexico, taking a toll of maybe 100 million large animals as they advance. A slight lag occurs at the Panamanian bottleneck, but soon the wave sweeps on into South America. By 10,500 years ago, only a thousand years after arriving in Edmonton, they have Tierra del Fuego in view."

Every year, archaeologists tighten the dragnet, in the most sweeping manhunt ever staged. The academic posses constantly discover promising new sites in both Old World and New. Given time, they will close in on those first shadowy pioneers who silently settled the immense frontier so many thousands of years ahead of America's European "discoverers." □

A desperate end, *with no way out, seems to have been the shared fate of a Paleo-Indian and a land tortoise who both fell into Little Salt Spring, Florida, about 12,000 BP. In the dry conditions of the time, the spring's water level was much lower (diagram,* ***left****). Archaeologist Carl Clausen (****right****), having investigated the site now underwater, reconstructs this scenario: The man was able to find shelter on a ledge and impale and cook the tortoise.*

But when the tortoise meat gave out, what could he do? The overhang prevented his climbing out. He could only shout, and wait, and hope.

JAMES A. CRAIG

OSHKOSH

America's Biggest Air Show

By MICHAEL E. LONG
NATIONAL GEOGRAPHIC SENIOR STAFF

Photographs by
JAMES A. SUGAR
and the author

LIKE BEES RETURNING to the hive, aviation buffs swarm each summer at Oshkosh, Wisconsin, for the country's premier air show. During last year's eight-day convention of the Experimental Aircraft Association, 12,000 airplanes arrived, including 1,492 built by association members.

A California doctor landed in a small, sleek biplane that he and his family had built at home, partly in the kitchen. A young woman flew in from Illinois in a flawless 1942 Stearman, a former hulk that she had spent two years restoring. One man motorcycled nearly 1,000 miles from Pensacola, Florida, just to look at all the airplanes.

Hundreds came from abroad by commercial jetliners, including a Japanese who deplaned wearing a sign, Take Me to Oshkosh, Wisconsin, U.S.A.

The man behind all this is Paul Poberezny, who at the age of 5 "built a little shop" in his father's chicken coop behind their house in Milwaukee to make model airplanes. "I've never stopped thinking about airplanes since," says Poberezny, now 57, who has 23,000 flying hours in 363 types of aircraft—including 12 of his own design.

After returning from duty as a fighter pilot in Korea, he began to build an airplane —*The Little Poopdeck*—and was amazed at the interest local fliers displayed. "If a guy could ever harness that," he mused then, "it might do aviation a lot of good." So Poberezny founded the Experimental Aircraft Association (EAA) in 1953.

"Experimental," a category that the Federal Aviation Administration assigns to home-built aircraft, is a bit of a misnomer. Association members typically choose designs with proven safety records, and are cautioned against modifications.

With headquarters in Hales Corners, a Milwaukee suburb, the EAA now counts 75,000 members, and Paul Poberezny marvels at the number of people who convene at Oshkosh each year—155,000 in 1978.

Each afternoon of the show there's a barnstorming and aerobatic display by expert pilots like the Red Devils, here performing (***facing page***) in their home-built Pitts Specials at a show near Atlantic City, New Jersey. From bottom: Paul's son, Tom, Charlie Hillard, and Gene Soucy.

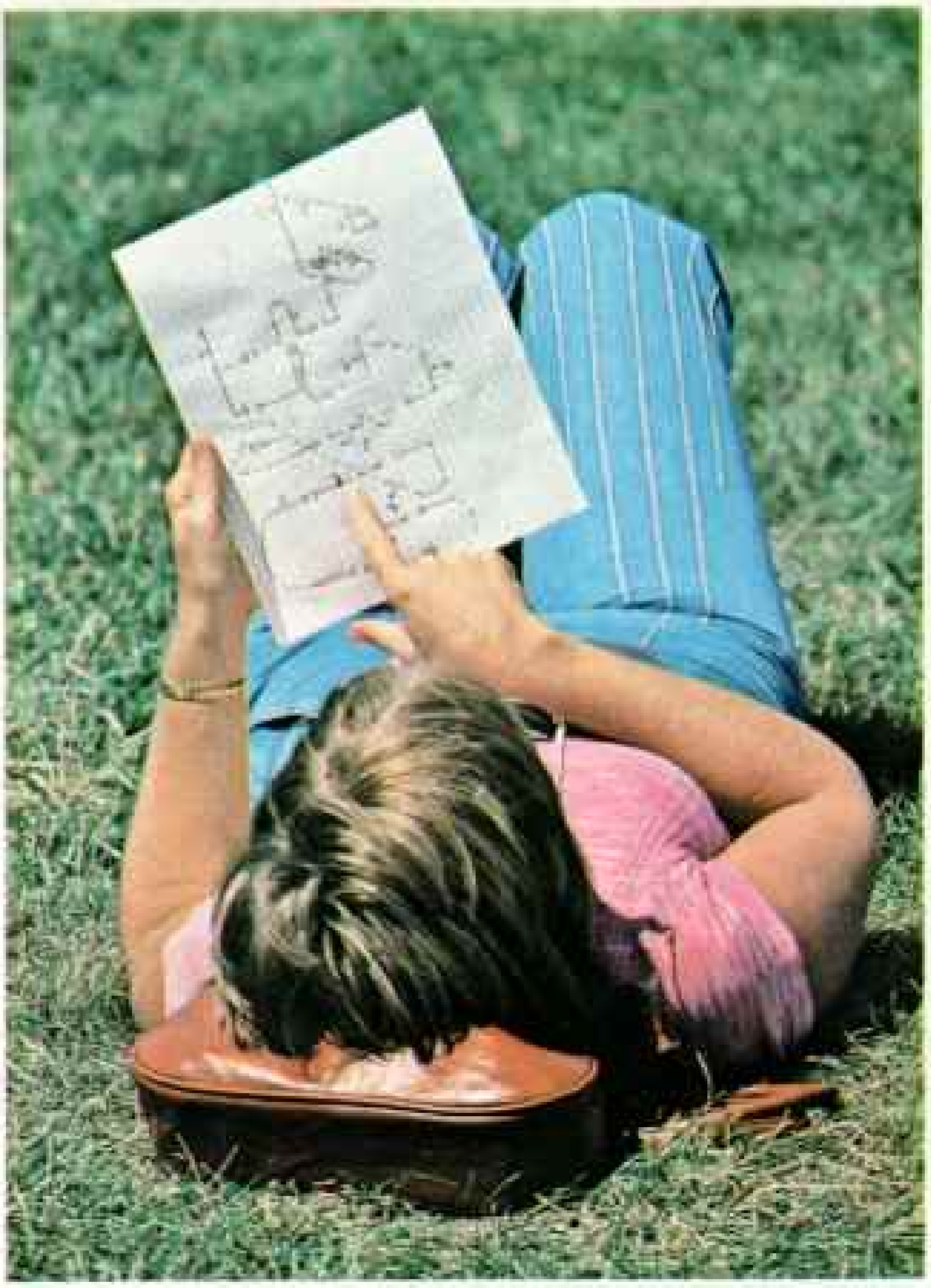
ALL BY JAMES A. SUGAR

THE RED BARON—alias John Eberle of Pittsburgh, Pennsylvania—flies again near Oshkosh's Wittman Field at day's end (***above***). Eberle labored 3,500 hours and fashioned 17,137 pieces of wood to build a reproduction of the Fokker Dr I flown by German ace Baron Manfred von Richthofen in World War I.

On the ground (***left***) John Parish of Tullahoma, Tennessee, polishes his 1952 Beech D 18 to a see-your-face shine. Like many EAA members, he also brought his family and friends along.

Come morning, the fliers will be eager for the air. Each convention day the small field on the shore of Lake Winnebago hums to some 9,000 takeoffs and landings. That's more than four times the amount of traffic at Chicago's O'Hare, normally the world's busiest airport.

An EAA volunteer directs aircraft to the runways (***top***). Many members cheerfully take vacation time to help things run smoothly, including staying up all night to staff a campground that houses 30,000 people. Why do they do it? "Well, I get free lemonade and a foam cup with my name on it," says one, tongue in cheek.



SMOKE TRAILS outline the Red Devils' spectacular bomb-burst maneuver (***right***). Many aerobatic pilots, both men and women, later adjourned to nearby Fond du Lac to compete in an annual contest sponsored by the International Aerobatic Club, a division of the EAA. Their ranks included an astronomer, a psychiatrist, a teacher, a railroad engineer, and a former prisoner of war in Viet Nam.

Businessman Brian Zeederberg of South Africa (***above***) gets a word of advice from an official before flying a demanding series of maneuvers that lasts only five minutes but can leave a pilot wet with perspiration. A fan follows a contestant through a sequence, written in diagram form (***above left***).

Bill Thomas of Miami, a former aerobatics champion himself, uses a special glass (***left***) to judge the precision of a competitor's flying. The circle indicates the track of a perfect loop.

ALL BY MICHAEL S. LEWIS

"LIKE USING A HURRICANE for a hair dryer," says Marie Stivers of Marietta, Georgia, to describe the experience of being anchored to a biplane's wing (***above***); turn the picture upside down to read the pilot's name. Wing rider Stivers, who once studied to be a classical pianist, unbuckles a safety harness (***left***) after enduring loops and barrel rolls at 160 miles an hour in front of the Oshkosh crowd.

Deployed in a bean patch (***right***) five miles southwest of the field, Federal Aviation Administration personnel control aircraft flying a prescribed entry route to Oshkosh. Scores of FAA air-traffic controllers vie to work at the show. Those accepted get no extra pay, just the satisfaction of a job well done.

JAMES A. SUGAR (FACING PAGE AND TOP); MICHAEL E. LONG

Restored to World War II fighting trim, a Curtiss P-40E wearing the Flying

DAVID A. GUSTAFSON

Tigers insignia and a General Motors FM-2 Wildcat patrol the skies.

MICHAEL C. LONG (ABOVE); OTHERS BY JAMES A. SUGAR

MOVE OVER, birds. Here comes Ed Sweeney of Reno, Nevada, in a Manta Fledgling II, a hang glider powered by two chain-saw engines (***above***). Cruising at 30 miles an hour, Sweeney says he feels "like a tourist of the earth." The Hummer (***left, top***) moseys along at about the same speed—"So slow," says designer Klaus Hill of Morgan, Utah, "that you don't even need goggles." The aircraft weighs only 170 pounds. Its fuselage is an aluminum irrigation pipe, five inches in diameter.

Flying from Baker, Oregon, to Oshkosh, Irv Mahugh got his reproduction of the 1931 Ramsey Flying Bathtub (***left, center***) up to 75 miles an hour. He and his 10-year-old son took six days for the trip, dropping in on friends en route.

The Quickie (***left, bottom***), flown by designer Burt Rutan of Mojave, California, won the EAA award for outstanding new design in 1978. Like the Wright brothers' Flyer, the Quickie lacks a horizontal tail. It's actually up front in the form of an airfoil called a canard, which here also houses the landing gear. With its 18-horsepower engine throttled back, the svelte aircraft flies at 80 miles an hour and gets 104 miles to a gallon. It is so stable that a test pilot was unable to provoke a spin. □

LOUISIANA'S ATCHAFALAYA

Trouble in Bayou Country

By JACK AND ANNE RUDLOE

Photographs by
C. C. LOCKWOOD

WINDROWS OF FROGS leaped out of our way, and the ground periodically dissolved into fluid muck. Sometimes we sank to our thighs, desperately clutching cypress knees. Fat brown cottonmouths slithered away from us into gardens of lavender-flowering water hyacinths. Cypress oil burst into iridescent constellations around the green seedpods soaking in the amber water, and as the morning sun rose higher, the chorus of whistles and chirps became louder.

But our goal, an egret rookery in southern Louisiana's Atchafalaya swamp, was worth every mosquito bite. Before us were hundreds of dazzling white egrets. Every few minutes adult birds alighted to regurgitate catches of crawfish and minnows into the mouths of their excited young, which seemed to swallow their parents' heads.

We continued deep into the forest, where golden rays of sunlight shafted through the leafy dim light. C. C. Lockwood, photographer and staunch defender of the controversial Atchafalaya swamp, spotted a line of festive red ribbons trailing into the bushes. "Probably bullfrog hunters," he said,

***Life-soaked wilderness** of the Atchafalaya —the continent's largest river-basin swamp—lures sportsmen, trappers, oilmen, loggers, farmers, and crawfishermen, here maneuvering pirogues to their traps.*

grinning. "They use the ribbons to mark their way into the swamp. The old-timers didn't need them—but they're gone. It's easy to get lost; somehow the swamp always looks different."

Most people see the Atchafalaya (uh-chaff-uh-LIE-uh) as they drive over the four-lane Interstate 10 bridge that stretches for 18 miles between Lafayette and Baton Rouge (map, page 385). Yet the vast swamp engulfs and dwarfs the highway with all its roaring trucks and speeding cars. Hardwood forests, pastures, and soybean fields in the better-drained northern end of the Atchafalaya Basin give way to cypress-tupelo swamps and willow-covered, newly formed lands. South of Morgan City, freshwater marshlands extend for miles toward the Gulf of Mexico.

North America's largest river-basin swamp is nourished by the Atchafalaya River after it breaks away from the Mississippi north of Baton Rouge to wind for 135 miles to the Gulf. The U. S. Army Corps of Engineers enclosed the central part of the basin for use as a floodway. Under normal conditions a gigantic water-control structure near Simmesport funnels water from the Mississippi into the Atchafalaya River. During serious floods the Morganza facility also can be utilized. The corps is prepared to dynamite the fuse-plug levee west of Simmesport in an extreme case. The three control points together can divert into the basin half of the biggest Mississippi flood anticipated.

Rich Swamp Breeds Discord

But the Atchafalaya Basin Floodway—the lower floodway—remains awash with controversy. Fielding Lewis, a member of the Louisiana Landowners Association, says it was "built to destroy itself by silting." Environmentalists see it as a productive wetlands, possibly the last refuge for the ivory-billed woodpecker. To New Orleans, Baton Rouge, Lafayette, and Morgan City the watery wilderness serves as a refuge from the asphalt and neon.

"This place is like no other," declared Adron Ebarb, a Lafayette resident and ardent bass fisherman as he proudly displayed his day's catch of largemouth. "Just look at what the Atchafalaya produces! I come out here to get away from the city, to revive my mind. Everywhere else you go it's crowded, but it's not crowded here."

Yet POSTED—NO TRESPASSING! signs are nailed to cypress trees, warning visitors to stay in their boats. Virginia Kyle Hine, whose family owns substantial acreage in the lower floodway, sees increasing public access as a threat. "These newcomers are going to wreck this basin with their garbage. We have nurtured the land, preserved it all these years, and now we're the ones wearing the black hats!"

In Mrs. Hine's home in New Iberia a servant brought us lemonade as she told us how her grandfather lumbered the swamp's magnificent forests of virgin cypress.

Long before the last prime cypress was taken, oil and gas wells were drilled, and landowners grew wealthier. Some wells bring hundreds of dollars a day in royalties.

Oil and gas development, with the wide canals dredged for crew boats, drilling rigs, and pipelines, poses a long-term threat to the swamp's fishing industry.

For the moment, however, the fishermen are doing fine. During crawfish season, which runs from late January to June, crawfishing is so lucrative that many men leave their jobs in the oil fields, pile their traps into boats, and head for the swamp. "Back during the 1973 flood I was taking in more than $500 a day," one fisherman in Henderson boasted to us, and seeing our tape recorder added hastily, "but don't quote me, I don't want Internal Revenue after me."

Everywhere in southern Louisiana, restaurants and markets feature crawfish. As much as 36 million pounds of the succulent crustaceans are trapped out of the Atchafalaya backswamps each year. The success of crawfishing is directly tied to the water level in the swamp. *(Continued on page 382)*

Peace, quiet, and fresh eggs *helped Gwen Carpenter decide to shelve a teaching career for a life deep in Bayou Sorrel, surrounded by 575,000 acres of semiwilderness. The nearest telephone, a mechanism Gwen abhors, is half an hour away by boat. "I just never did get any good news over a telephone," she explains.*

Misty bayou morning *greets Gwen at the "shotgun on a barge"* ***(top)*** *she built with Calvin Voisin. After a flood destroyed their former home in 1973, they paid $450 for the remains of an old plantation house and reassembled it as a shotgun—a dwelling with all the rooms in a row—on a barge they bought for $900.*

They get by very happily on very little. Crawfishing brings a modest income. Catfish from Calvin's hoop nets ***(above)*** *add a few dollars more, if the catch doesn't end up fried on the table* ***(left)*** *with crab gumbo, corn, squash, beans, tomatoes, and a jalapeño-cayenne hot sauce—all homegrown or fresh-caught.*

As the water rises during the winter and spring months, young crawfish spawned the previous fall seek shelter and food in the shallows. They grow rapidly, and fishermen have a good season. But in a dry year, when the water stays low, the crawfish are few and small.

Wilton Hebert, Jr., a stocky young man from Pierre Part, agreed to show us his favorite crawfishing spot even though the season was over and he hadn't been there for several months. We drove to nearby Belle River, launched his aluminum boat, and sped to Bayou Long, one of the few places we traveled where the watercourse had not been straightened and channelized by the Corps of Engineers. It was wild and twisted as a bayou should be. When we stopped to explore, pugnacious red crawfish, six-inch giants of the mud, reared up, their claws outstretched.

We sped on, with mullet and shad leaping before our boat. Big sluggish alligator gars gulped air. Everywhere there was life; even the mud was cobbled with freshwater clams and mussels. Biologists had told us that the Atchafalaya is more productive than the Everglades. Here before us was the impressive evidence.

As our boat slowly churned through floating mats of hyacinths, we were amazed at the abundance of freshwater shrimp, insects, and fingernail-size baby crawfish hanging to the clumped roots. This aquatic life supports an incredible amount of terrestrial wildlife—mink, otter, egrets, ibises, and great flocks of overwintering ducks.

Annual Cycle Nourishes Life

All this productivity is the gift of the annual flooding and draining cycle of the basin. Every year rain and melting snow from far up the Mississippi, Ohio, Red, and Missouri Rivers flow down into the big swamp, bringing nutrients that help feed the system. Throughout the cycle, leaf litter breaks down, pumping more food into the swamp.

"This is my home away from home during crawfish season," said Wilton happily as we traveled through the cathedral of moss-draped cypress trees. Then we came to one of the many canals slashed through the trees. OIL AND GAS PIPELINE. DO NOT ANCHOR OR DREDGE said a sign. The basin is crisscrossed by hundreds of canals. Many were dug to float out the virgin cypress trees, others for wells, pipelines, and navigation.

"Sometimes these canals do good and make the fishing better," Wilton said, "but what hurts so bad is when these oil companies come in here, dig their canals, throw up dirt banks, and keep the water from spreading out over the swamp. With low water it gets sour back there. When it rains, the water comes flushing out, and it stinks like a septic tank. I've seen it so bad the crawfish crawl out on the cypress knees to breathe and sometimes they'll die right in the traps."

The problem is being tackled by requiring drainage openings in the banks.

Moving around the winding watercourse, we were suddenly confronted by a hundred-foot-wide, half-mile-long, freshly dredged canal. Two immense oil-drilling barges and a flotilla of barges and crew boats contrasted sharply with the peaceful surroundings. Wilton was shocked.

He stared dumbfounded at the mounds of roots, the fresh black earth thrown up in unbroken spoil banks. The cypresses were cut down and scattered like matchsticks. "I never saw this before," he stammered. "None of this was here three months ago when I took my traps. They ruined my best crawfishing place." His voice was weary. "I know the country needs oil, but this don't make no sense to mess up the swamp so."

Wilton's roots go far down into the Atchafalaya. Although few of his people—known as Cajuns—still live deep in the swamp, many descendants of the early swamp dwellers live around the margin of the floodway, next to the levees, and trailer their boats to the launching ramps. The outboard motor changed their lives, making it possible to enjoy the comforts of town and to commute to their fishing grounds. Like their parents before them, they live by fishing and trapping, bringing out nutria, mink, raccoon, and otter pelts. Huge stacks of wire crawfish traps, gill nets, and hoop nets lie in nearly every yard in communities such as Belle River and Henderson.

These people are predominantly French-speaking Acadians. Driven from Nova Scotia by the British in 1755, the Acadians began to arrive in the Atchafalaya in the early 1800's. They settled in already established

towns such as Plaquemine and St. Martinville, where, some say, Evangeline really ended her long quest for her lover, Gabriel.

Longfellow's epic embellished the facts. Gary Hebert, editor of the Plaquemine *Post,* told us another story. "Their real names were Emmeline Labiche and Louis Arceneaux. They were betrothed but separated during their exile from Acadia. Evangeline didn't meet Gabriel on his deathbed at an almshouse in Philadelphia, as Longfellow wrote. When she finally arrived in St. Martinville after crossing the Atchafalaya by boat, she found that he had married someone else, and she died, as the story goes, of grief." Today "Evangeline" lies buried in the St. Martinville churchyard near the massive live oak that bears her name.

He Overcomes Chicken-head Hexes

As English-speaking settlers, mainly from Virginia and the Carolinas, bought up fertile high ground around the edges of the basin for sugar plantations, the Acadians tuned their lives to the swamp: trapping, fishing, subsistence farming. Some lived in settlements like the now nearly abandoned town of Bayou Chene, while others stayed on camp boats deep in the bayous. Merchant boats came to buy pelts and sell or trade what couldn't be had from the swamp. The sick were healed by *traiteurs,* or folk doctors, who treated snakebite, illness, and spells with herbal and occult remedies.

At Red's Levee Bar near Catahoula Lake we found Lloyd D. "Red" Higginbotham shelling pecans. A member of the Police Jury, or county commission, of St. Martin Parish, he is also one of several traiteurs who still practice. We sat in the cool darkness of his barnlike bar. Kittens and chickens wandered in as he described his profession.

"People that has visited me . . . they find a snake skin or chicken head in their pillow, crossed nails or crossed matches. I have certain prayers I say for their success to overcome the evil that follows them. I overshadow whatever that person walked in . . . that's what I am—a traiteur."

Across the basin, Pierre Part, a bastion of Acadian culture, is a colorful collection of wooden houses scattered along a boat-cluttered bayou. There we met Claude Metrejean, a dignified man with a fine pointed mustache, running a busy fish house. A steady stream of fishermen arrived at his dock to sell catches and to buy bait. Claude, speaking interchangeably in English and French, hurried about, buying snapping turtles, supervising workers skinning gar and boiling crawfish bright red in great steaming vats.

"In business you can hardly be small any more," Claude observed. "Even though you're small, you've got to act big. We had a real good crawfish season in 1977; I bought as much as 38,000 pounds in one day."

Catfish fillets are among his biggest sellers. Load after load of blue cats were brought in, and after weighing them, Claude counted out dollars from his bulging billfold to pay his fishermen. A prominent sign next to the scales read: IF YOU SELL YOUR FISH HERE . . . YOU BUY YOUR CHEESE HERE. Spoiled cheese and cottonseed cake are stuffed into the hoop nets for catfish bait.

As we watched Claude's men scooping wriggling fish into vats of crushed ice, two boys tied a pirogue to the dock and unloaded their catch: a tightly tied burlap sack filled with pulsing, hopping bullfrogs. Claude tracked the needle on his hanging scale and handed them $15. "Those are not for food," he told us. "A man comes from a laboratory twice a week to buy them live for a study."

No sooner were the frogs in Claude's cooler than a blue pickup truck with the name EAGLE lettered on its hood backed up to the icehouse. Robert Hebert, Wilton's brother, jumped out and began to shovel crushed ice into washtubs filled with yellow-tailed shad, much too small to eat.

"It's for our turtles," Robert explained. "It makes them grow better and lay more eggs."

Several houses away his father had a turtle farm, raising red-eared sliders, the little turtles of the pet industry. We asked to see the operation, but Robert was hesitant. "You can't see the turtles before 11 a.m. Come back when the sun is high in the sky. They're busy laying now."

After lunch we returned and toured two large fenced ponds that literally boiled with 15,000 adult turtles greedily eating the shad. Wilton Sr. and his four sons, daughter, and two small grandchildren scrutinized the hard-packed mud, digging out dozens of inch-long, *(Continued on page 389)*

Both man and nature *threaten the swamp, for decades an important floodway for the Mississippi River. The immediate enemy: sediment. Each year about 135 million tons of America's heartland pour from the Mississippi into its major distributary, the Atchafalaya River; much of it overflows into the swamp, choking it. In the northern end of the floodway, about 30 percent of the vast hardwood forests have been bulldozed for pasture and soybeans (**top**).*

*To determine the fate of the remaining wetlands, with their delicate ecological balance, ten plans are under study by the U. S. Army Corps of Engineers, Department of the Interior, Environmental Protection Agency, and state of Louisiana. Perhaps the most controversial proposals would allow the corps to buy 443,000 acres of private land between Krotz Springs and Morgan City to prevent development and encourage recreational use. Many visitors now see the swamp from the 18-mile Interstate 10 bridge (**middle**) that spans the Atchafalaya River and the entire floodway.*

*Overshadowing all is the will of "Old Man River" as it steadily attempts to change its course to that of the Atchafalaya River. To stave off the disaster that event would bring to area industries and cities like New Orleans, which depend on the big river for fresh water and transportation, the Old River Control Structure (**bottom**) allows less than a third of the Mississippi, at top, to enter the Atchafalaya.*

Atchafalaya Basin

Safety valve for doomsday, the Atchafalaya Basin Floodway System, enclosed by levees in the center of the natural basin, is designed to receive half of the worst flood that could sweep down the Mississippi.

Levee

Oil field

KILOMETERS 10

STATUTE MILES 10

DRAWN BY IKKANDAR BIDAY
COMPILED BY PATRICIA J. HARRISON
NATIONAL GEOGRAPHIC ART DIVISION

More than 60,000 acres of trees have been cleared for farmland in the West Atchafalaya Floodway, course for an emergency discharge from the Mississippi and Red Rivers.

Sedimentation is raising the land inside protection levees, and the levees themselves are subsiding. Thus, they must be continually heightened.

Agriculture thrives, but permanent dwellings are banned in the Morganza Floodway, another major route for floodwaters.

Serious flooding threatens Morgan City and other communities on the southeast edge of the floodway, where normal drainage patterns are often blocked.

Red River

Old R.

OLD RIVER CONTROL STRUCTURE

MISSISSIPPI LOUISIANA

FUSE-PLUG LEVEE

LOCK

Simmesport

Atchafalaya River

WEST ATCHAFALAYA FLOODWAY

WEST PROTECTION LEVEE

MORGANZA FLOODWAY

MORGANZA CONTROL STRUCTURE

Mississippi

Morganza

New Roads

Opelousas

Krotz Springs

Little Alabama Bayou

Maringouin

Baton Rouge

Ramah

EAST PROTECTION LEVEE

Henderson

Plaquemine

ATCHAFALAYA BASIN FLOODWAY

Breaux Bridge

Lafayette

Catahoula

Catahoula Lake

St. Martinville

Bayou Cheneo

Bayou Sorrel

Bayou Sorrel

Pigeon

New Iberia

Lake Fausse Pointe

Bayou Teche

Jeanerette

Little Bayou Pigeon

Pierre Part

Bayou Long

Belle River

Lake Verret

Intracoastal Waterway

Franklin

Grand Lake

Six Mile Lake

Lake Palourde

Morgan City

Vermilion Bay

West Cote Blanche Bay

Wax Lake Outlet

Marsh Island

East Cote Blanche Bay

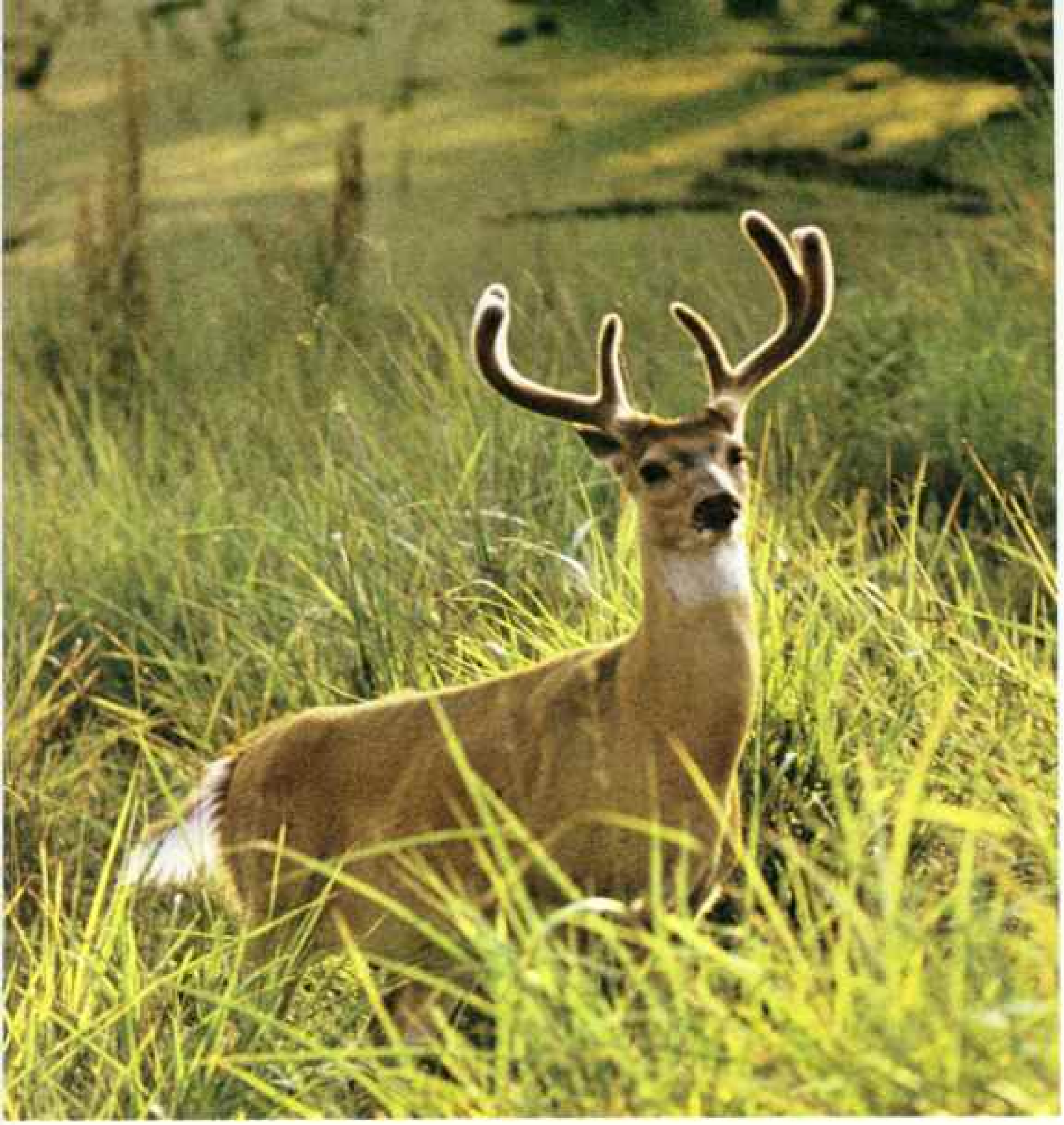
Lower Atchafalaya River

Gulf of Mexico

Atchafalaya Bay

Adrift in a ghost forest, *anglers cast for bass in the shadows of huge cypress stumps* ***(above)****. By the early 1930's, loggers had cleared the swamp of virtually all its first-growth bald cypresses, behemoths that often towered above a hundred feet. Called the "wood eternal," cypress heartwood infused durability into everything from cabins to coffins.*

Bare-handing a more offbeat swamp resource, Kelly Falcon prepares to bag a nonpoisonous water snake ***(left)****. He sells such reptiles to both a roadside tourist zoo and to a laboratory for study. A part-time electrician as well as a filmmaker, Kelly shares the many-hatted life-style that is typical of the Atchafalaya's sizable community of Cajuns. They are the descendants of French settlers who were ousted from British Canada in 1755 and trickled into what is now southern Louisiana.*



Where the water still flows, *life teems. King of the Atchafalaya swamp is the crawfish* ***(above)****, a delicious freshwater cousin of the lobster. Last year commercial crawfishermen trapped a record crop: 36 million pounds. Another delicacy, crappie* ***(below)****, locally called sacalait, may be caught only as a game fish. In season, hunters stalk wild turkey, woodcock, squirrel, rabbit, and especially the large population of white-tailed deer* ***(left)****. Trappers report earnings totaling more than $300,000 a year from the pelts of mink, nutria, and raccoon* ***(lower left)****.*

(Continued from page 383) pinkish white eggs. The day's harvest was taken to the warm hatchery building on the bayou, where the eggs were washed and neatly stacked in trays to await hatching. The Heberts produce about a hundred thousand turtles annually.

Since their product was banned from U. S. markets in 1975 following an outbreak of salmonella, turtle farmers in Louisiana have been legally exporting turtles to pet wholesalers overseas. However, scientists at Louisiana State University (LSU) have recently developed a process to ensure that pet turtles are free of salmonella, and turtle farmers are gearing up to possible reopening of the more lucrative domestic market.

Outside the hatchery was a ten-foot mound of Spanish moss. "Some of this moss we use to catch the shad," Robert said. "Early in the morning when the sun comes up, we drop the moss in the water and fish come to spawn in it. Then I catch them up in my net. The rest of the moss we sell to a buyer in Labadieville," 25 miles east of Pierre Part.

Spanish-moss gathering was an Atchafalaya industry for generations of swamp dwellers, but Lawrence Duet, the last buyer in the area, had only a few piles in his yard when we visited him.

"I pretty much retired two months ago," he said. "There's not enough moss now. There used to be a lot of it in the Atchafalaya Basin; it was about the best producing area in the state." He lifted some in his big work-worn hands. "This little bit comes from northern Louisiana."

Although moss was once a major source of furniture stuffing, its use is now limited. "The minnow hatcheries, they use moss for shiners to spawn in. They'll be in trouble next season," Duet said sadly. "I don't see where I can get any more. I often wonder what has destroyed the moss. As far as I can tell, it's from the air; the air is polluted."

Whether the Spanish moss died of air pollution or a fungus, only wisps of the greenish gray air plant now drape the cypress branches, not enough to warrant a commercial harvest.

"It was a different swamp fifty years ago," reminisced Max Greig, owner of the little restaurant La Maison Cadien in St. Martinville. "When I was a boy, we had all the

quail, all the deer we wanted, all kinds of game. Our streams weren't polluted, weren't sanded up. They didn't have no—what you call those guys that plug up every stream? Corps of Engineers."

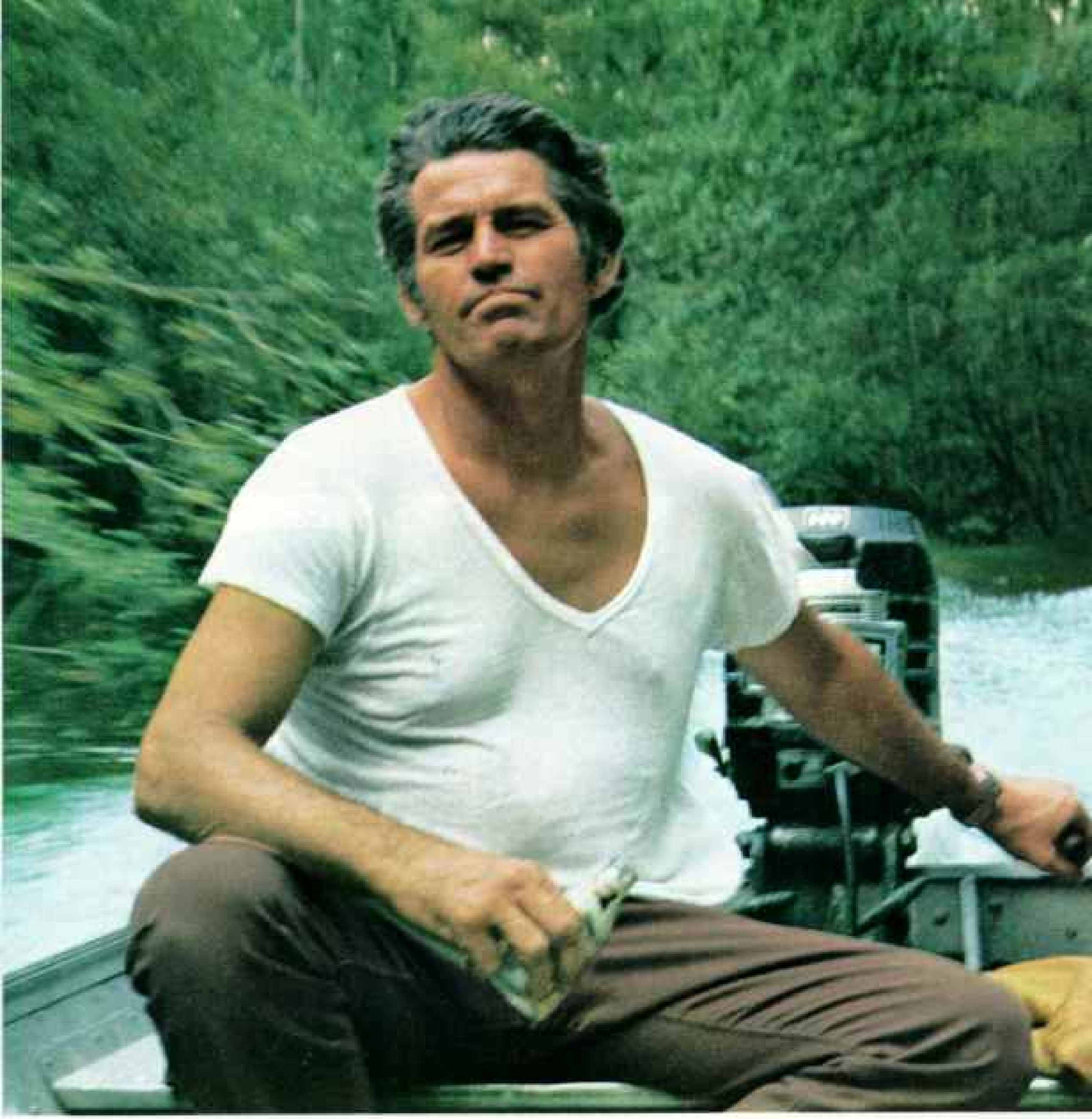
Alcide Verret agreed. One of the few who never left the swamp, at 78 he lives on Bayou Sorrel catching catfish and shooting squirrels for breakfast. "Lord, how this swamp has changed! Years back I could stand on the shore of Grand Lake and barely see across to the other shore. Just open water. Why that lake was so big they had to have lights to guide the boats. Now it ain't nothing but willer bars and silt. All these young people are crying, 'Save the Atchafalaya.' Hell, ain't nothing left to save!"

After the 1927 flood that took more than two hundred lives and left thousands homeless in the Mississippi Valley, the Corps of Engineers took the swamp in hand. Colossal dredges moved down the Atchafalaya River, deepening it. Midway down the basin, where the main channel fragmented, they created one, deep and relatively straight, to carry more water to the Gulf. In the process they pumped sand into the backswamps, blocking drainage into 22 bayous. Today much of the swamp is contained by massive levees built by the corps that run north and south through the center of the basin.

As the mud-laden river water inundates the swamp year after year and then drains off, it leaves behind silt and soils eroded from the farmlands of middle America. The floor of the swamp becomes a little higher each year.

As we drove along the top of the levee near Catahoula, the problem was obvious. To

Cyclic flood *is the swamp's lifeblood. Fall brings low water to a slough (***top***), when crawfish burrow to hatch their young and vegetation withers. In winter and spring (***middle***) the slough overflows. Billions of young crawfish and other fry emerge to feed on detritus. They, in turn, nourish larger fish like bass and catfish, water birds, and mammals that follow them into the shallows as the water retreats in summer (***bottom***). Weeds and grasses flourish to begin the cycle anew. Here, pioneering willows have replaced cypress and tupelo trees killed by sediment onslaught.*




TIGRES
TIGRES
TIGRES

Neither rain, *nor heat, nor gloom of night can keep Lubin Jewell (***above***), postmaster of Maringouin, from enjoying the swamp. Lubin belongs to a hunting club that leases 12,000 acres near Little Alabama Bayou. Though he fears the encroaching soybean fields, he also fears the proposal to buy private land for public use. "Amateur hunters will wipe out our game. It's happened before," he avows. In a deer-hunting camp near his own, the Torres family labels their hounds (***left***), which often stray during the chase.*

the west lay swamp that had not been encompassed by the corps' levees. It was much lower and swampier than the willow-covered dry lands inside the floodway. Alcide's words came back to us, "If the levee ever breaks, head for the floodway. It's the highest ground around."

Russell Ruiz, 67, who once ran a merchant boat and later built a store at the edge of the levee, was bitter: "Us—they have ruined our way of life as fishermen in the basin. My grandchildren won't see it. The corps moved in here in the 1930's and began work. It was very easy to do anything they wanted because people were frightened. They didn't want a repetition of the flood." His voice rose with indignation. "No one at the time could visualize the destruction that was going to come of it. I'm almost ashamed to be a part of a society that would allow this to happen."

Corps' Early Efforts Hailed

Years ago when the Corps of Engineers began the basin flood-control project, the drying up of the backswamps from channelization was not seen as an ecological disaster. However, some arable land in the lower floodway was lost when the water level was raised, although the prime farmland of the northern floodway didn't suffer.

We flew over large sections of magnificent hardwoods that were being bulldozed for soybean fields. Carroll Olivier, who lives near Opelousas and farms 1,300 acres inside the floodway, boasted: "This is some of the best, if not the best, land in the state. This silt everybody's crying about brings the topsoil of America. We do very little fertilizing. You've got a lot of people who want to retain the basin exactly as it was. I can't go along with that! No matter what you do, it's going to change on its own."

As we traveled far out in the Atchafalaya Bay with Joey Dykes, a corps planner, the effects of the siltation were everywhere. Huge landmasses choked with willow scrub rose from the open water.

"None of that land was here before the 1973 flood," Joey explained. "Probably no geologic change has taken place as fast as the building of this delta, except maybe earthquakes and volcanoes. The Center for Wetland Resources at LSU agrees with the

corps' prediction that by the year 2020 this entire bay will be filled in.

"But the Mississippi is the real problem," Joey continued, smashing a mosquito on his arm. "It changes channels every thousand years or so, cutting new riverbeds and abandoning old ones. Because the Atchafalaya provides a shorter route to the sea, the entire Mississippi is trying to divert and come through the basin. That's why we had to build the control structure near Simmesport, to try and hold it back."

Because of rapid sedimentation and sinking levees, the lower floodway is fast losing its control capacity. Natural swamps tend to absorb water like giant green sponges, but not when they are altered extensively by dredging and are filled in by each year's silt-laden flood. The floodway is now able to move 900,000 cubic feet of water per second. Floods carrying almost twice that much are likely about every hundred years.

The corps controls the flow of the Mississippi into the swamp; the water level, in turn, controls land use. Environmentalists want the corps to keep the swamp seasonally wet to ensure an abundance of fish and wildlife. Landowners want a short wet season to boost timber growth.

A long-range water-management plan is now being developed, amid controversy, through the efforts of federal and state agencies. Its goal is to provide improved flood control while ensuring that enough water flows into the backswamps for biological productivity. Engineering technology will be used to try to control the silt, but oil and gas development and other current uses of the basin will not be restricted. Among the alternatives envisioned by the plan: permanent control of the land by the corps, either through ownership or easements.

Landowners generally oppose the plan, conservationists favor it. Charles Fryling,

Swamp casualties: *Cypresses and live oaks fell to clear a bayou so that a section of the world's tallest offshore-drilling platform could be floated from Morgan City to the Gulf. Canals that have been dredged through fifty producing oil and gas fields often improve fishing, but may block water flow to backswamps.*

a professor of landscape architecture at LSU who serves on an advisory committee to the corps, commented: "To do nothing would play into the hands of the farmers and developers. The floodway would silt in, the wetlands would dry up and be converted to soybeans. The old plan was to dredge a channel through the swamp to speed the water to the Gulf. The new plan will be better. And it may mark the first time environmentalists work to get a corps project approved. It's going to take the same tools that ruined the swamp in the first place—dredges and bulldozers—to restore it."

"It may take years to solve these problems," said Joey Dykes. "Trying to control the water in the Atchafalaya is like punching a marshmallow. You push it at one place, and it breaks out somewhere else."

Thriving Swamp Species: Scientists

In an effort to develop a plan that encompasses all the conflicting interests, dozens of scientists have invaded the basin to study the dynamics of the changing swamp.

"The only way to manage the swamp for fish and wildlife is to keep the water moving," Dr. Fred Bryan of the U. S. Fish and Wildlife Service said emphatically, as we traveled the swamp. "If you impound it, the swamp gets a sour belly; less oxygen gets into the water and you have fish kills."

"Studies!" cried Morgan City Mayor Russell "Doc" Brownell. "All they do is studies. We need to get on with the dredging and get the water out into the Gulf."

Near the southern end of the basin, Morgan City lies in the path of the floodwaters that are diverted by the corps from the Mississippi River down the Atchafalaya floodway to the Gulf of Mexico. The town is protected by ring levees, but just barely.

During the 1973 flood, volunteers worked desperately, laying sandbags and plugging leaks as the dikes were nearly overcome. "You could look up and see tugboats passing above your head," Bob Cox, a bearded LSU student recalled. "Every day levees became softer. I moved my family out to higher ground."

"These environmentalists care more about wildlife than they do about the safety of people," Fielding Lewis, an opponent of the water-management plan, complained in Franklin. "We landowners will do anything for flood control, but we do not intend to give up our property to satisfy the whims of environmental elitists and pinhead bureaucrats. This is nothing but a land grab!"

Retorts Dr. Bryan: "Environmentalists are against taxpayers subsidizing flood protection for people who build in floodplains, where they have no business being in the first place."

Obviously, the hand of man lies heavy upon this vast swampland. But, for all the abuses, the pipeline corridors, canals, wells, and levees, the Atchafalaya is still productive. Old-timers say there isn't the wildlife there used to be, but it's hard to see how there could be more. Saving the swamp will clearly require all the biological and engineering skills we possess, a resolution of the political controversies, years of effort, and perhaps hundreds of millions of dollars.

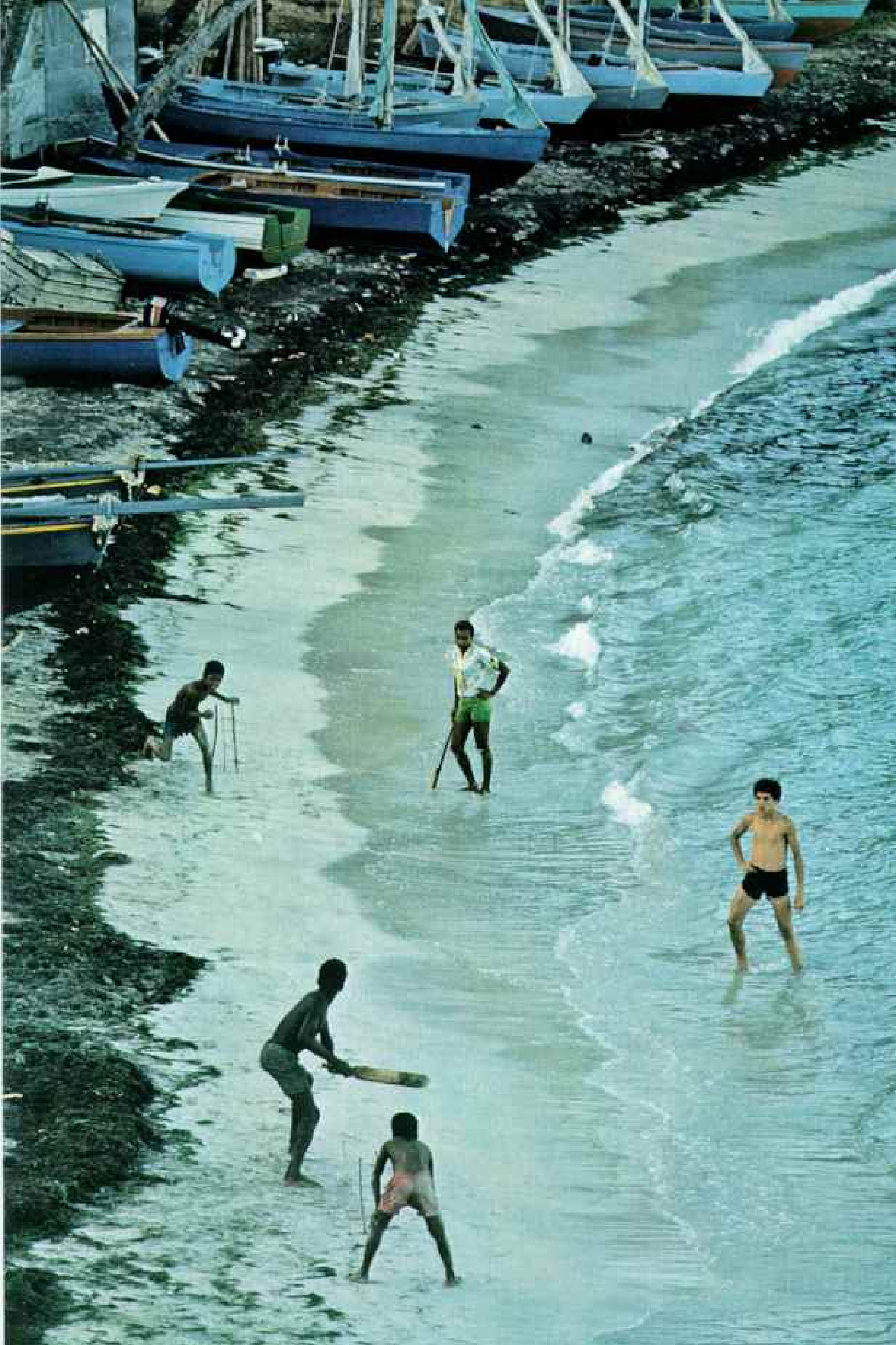
Mighty Mississippi Holds Swamp's Fate

But even then the Mississippi may ultimately decide the fate of the Atchafalaya. The corps has long recognized that the Mississippi is trying to change course. They projected that, unless something was done, the Atchafalaya would capture the flow of the Mississippi by 1975, leaving Baton Rouge and New Orleans as backwaters. Now, by congressional mandate, only 30 percent of the waters from the Mississippi and Red Rivers are normally permitted to flow into the Atchafalaya River.

But in 1973, floodwaters roaring down the Mississippi scoured away the concrete floor of the floodgates and nearly destroyed the entire structure. Had it been lost, the Atchafalaya would probably have captured the Mississippi.

Another big flood and it may succeed. □

Anthem to day's end, *the silhouette of a great egret rises above a rookery. The floodway harbors more than 300 species of birds. Some ornithologists believe that the ivory-billed woodpecker, widely considered extinct, may yet survive in a hidden pocket of the Atchafalaya—thus underscoring how rare and valuable a swamp can be.*



ST. VINCENT, THE GRENADINES, AND GRENADA

Taking It as It Comes

By ETHEL A. STARBIRD
NATIONAL GEOGRAPHIC SENIOR STAFF

Photographs by COTTON COULSON

CLOSE to the southern tip of the West Indies, where trade winds temper the heat of near-equatorial latitudes, a short, slender thread of sun-drenched islands stitches the surging Atlantic to a quieter Caribbean Sea.

Tied on the north to St. Vincent, on the south to Grenada, these are the Grenadines, where the tempo of life, in local terms, is largely "now for now." Take what today brings; as for tomorrow, "jes hol' strain"—relax.

Relaxing here hasn't been all that easy lately. On March 13 Grenada erupted politically in a mini-revolution that overthrew the despotic rule of Prime Minister Sir Eric Gairy. Not to be outdone, St. Vincent's Soufrière volcano erupted physically a month later to the day—on April 13—dumping crop-killing ash over much of that island's north end and further depressing a deficit economy. As tremors continued, thousands from the countryside took uneasy refuge in and around the capital city of Kingstown, trying to "hol' strain."

Strung out between these larger neighbors,

It's cricket *to play surfside in these islands, where local necessity improvises on British tradition. Here the weather is as fine as the economy is poor. And this year volcanic and political eruptions have added to burdens long borne with cheerful fatalism.*

Soothing trade winds *cool four-mile-long Canouan* ***(right)****, one of a string of small Caribbean islands known as the Grenadines. Together with those north of Carriacou* ***(map, preceding page)****, Canouan owes allegiance to St. Vincent, an Associated State of Great Britain. The rest belong to Grenada, an independent nation. Both entities have a combined population of about 220,000, half under the age of 20.*

Although Columbus sailed in nearby waters in 1498, he did not confront the cannibalistic Carib Indians ashore. The long struggle for empire gave the islands English language and law and a sprinkling of French place-names; a plantation economy peopled them with African slaves.

Part of the Windward Islands chain, the Grenadines ride a curving volcanic ridge, formed as two tectonic plates of the earth's crust came together.

the Grenadines themselves bead what seasoned yachtsmen consider some of the most spectacular cruising waters in the world. How many islands there are depends on who's counting what. Some say sixty; others, six hundred—which would have to include every rock, reef, or roving whale ever to poke above the tide.

Now politically divided between the British Associated State of St. Vincent and independent Grenada, the Grenadines share with them a common heritage—of volcanic origins, early settlement by Carib Indians from South America, and a later seesaw history of French and British domination.

Also alike in many ways are those who occupy the entire island group—Vincentians, Grenadians, and citizens of ten inhabited Grenadines. As the natives say, "Whether we doin' well or catchin' hell, we's all one."

Most descend from African slaves imported during the 18th and early 19th centuries to work the cane fields of a white plantocracy. Midway through the 1800's, after slavery ended and sugar slumped, majority power and property began shifting from European colonials with vast estates to smallholders, most of black ancestry.

Among British influences that endure: Nearly everyone speaks English, allowing for a few liberties and a certain free-form style. Like saying "what is to is what is" to express the inevitable. Or inviting guests to a "wash yo' foot and come."

Leniency with the language has little to do with lack of educational opportunities for

the population of about 220,000, almost equally divided between St. Vincent and Grenada. School attendance is compulsory, although economic necessity sometimes forces older children into reluctant truancy.

In an agricultural economy that yields few surpluses, a principal export, along with bananas and nutmegs, is people. For years hundreds—many among the most promising—have migrated to England, the United States, and Canada with steady work in mind. As for stay-at-homes, an estimated 50 percent are jobless or underemployed.

An old man named Sal explained the going theory of supply and demand:

"No one he'p ageables down here less'n it's chilrun. Not all turn out good so bes' have plenty. My girls go way; say come, come New York—I go, they pay. Allatime send a li'l somethin'. Boys go too, but they no care. So, wha'op'n me if I only got boys?"

Another widely syndicated belief is that a tourist boom will soon rescue Grenada and St. Vincent from bankruptcy now held at bay by outside aid. Perhaps. But in six of ten places I stayed in peak season, I was the only guest. "Developers come, mom, but de worm ain' wrigglin'."

Even before Soufrière began acting up, visitors from charter boats and cruise ships increased but slowly, and few lingered long enough to give much lift to the economy. Or to see what goes on in back of the beaches, a beat I chose to cover on a leisurely, downwind course.

Watered by frequent rains and some

rivers that never run dry, St. Vincent—the big brother and mountainous "mainland" for its seven lived-on Grenadines—has the furrowed look of a brain coral. Here plant life, in normal years, flourishes in a climate and rich soil where even fence posts sprout. Yet poverty is so great that the island is sometimes referred to as the "Third World's third world."

Hundreds Fell to Volcano's Might

Much of the island's fertility—as well as some current problems—exploded from the depths of Soufrière. The 4,048-foot peak last erupted violently on May 7, 1902, just a day before the disastrous blowup of Mont Pelée on nearby Martinique. An 11-month series of outbursts followed, leaving some 1,600 dead, including many of St. Vincent's dwindling Carib population.

Busy as a honeycreeper, native-born Dr. Earl Kirby, a retired veterinarian, now works at uncovering signs of early cultures. Switching from animal care to amateur archaeology was, he admits in his Edinburgh-educated accent, something of an accident.

"Chap called me to tend this sick cow about 18 miles back in the hills. Well, you know these roads. By the time I got there, the butcher had left; my patient was in the stewpot. So I worked off me mad by poking around an old sugar-mill ruin. Found a few artifacts, and that got me going.

"The Caribs weren't a very cordial lot. They followed their old enemies, the Arawaks, from South America to the islands—and finally displaced them. They also resisted the later Europeans."

The French, who came in 1626, and the English, who arrived a year later, got along together no better here than at home. By the end of the 18th century, when England won the final bout, St. Vincent had changed hands three times in its short colonial career.

An afterthought of this revolving-door period, imposing Fort Charlotte saddles a lofty promontory overlooking Kingstown, the principal port as well as the capital. Today inmates, not invaders, are the fort's chief concern.

Superintendent of Prisons Frank Mason, a genial ebony giant, took a sharp salute from a guard inside and reassured me: "You don't have to *(Continued on page 408)*

Custom sets a table *of gracious living at Orange Hill Estates on St. Vincent, where Hazel Barnard takes tea with her grand-*

children. Largest of several estates remaining from British colonial days, Orange Hill encompasses some 3,000 acres of citrus, banana, and coconut groves. To keep it going, owner Cyril Barnard and other family members work alongside a staff of 500.

Soufrière's monumental fury *roiled the skies when the volcano erupted on St. Vincent last April 13, blasting clouds of ash, gas, and steam to heights of 60,000 feet* ***(right)****. About 20,000 islanders scurried south to safety, abandoning north-end towns such as Fancy* ***(below)****. Fortunately no one was killed. Soufrière continued to fume and rumble, and not even experts could predict its next outburst.*

RICHARD S. FISAR (RIGHT)

Shrouded in ash *from Soufrière, coconut palms at Orange Hill Estates* ***(right)*** *stand like a grove of ghosts. The ash also coated and damaged bananas and citrus fruits, well tended and sprayed in greener days* ***(above)****; the eruption destroyed more than a third of the island's predicted 32,000-ton banana crop. "But if we can save the coconuts, we'll make it," said Cyril Barnard. "With the government aid we're hoping for, it should work out."*

The thousands of people who fled the volcano's wrath had all returned within two months. To them it seemed cruel consolation at best that the ash, high in nutrients, would eventually enrich their soil.

A crop reborn: *No longer raised primarily as starch for baby food and bland diets, pulpy arrowroot* (**below**) *has found a new market as an ingredient in computer paper. Rebirth for the religious is a river baptism on St. Vincent* (**facing page**). *In these islands, however, witchcraft survives despite strong Christian beliefs.*

worry about these prisoners; they're just short-termers we truck up from our downtown jail to bake bread. The old wood-fired ovens in the cookhouse were standing around idle, so we decided it would save money to use them."

The state of the state's finances makes cutting corners a necessity. But a decade ago St. Vincent splurged on one acquisition that Frank showed me with a certain pride. "I'm not sure why it took so long to get our own. Before, we borrowed one from Grenada."

Among these islands, transporting anything—man, beast, or baggage—involves almost certain uncertainties. And especially, I should think, a gadabout gallows.

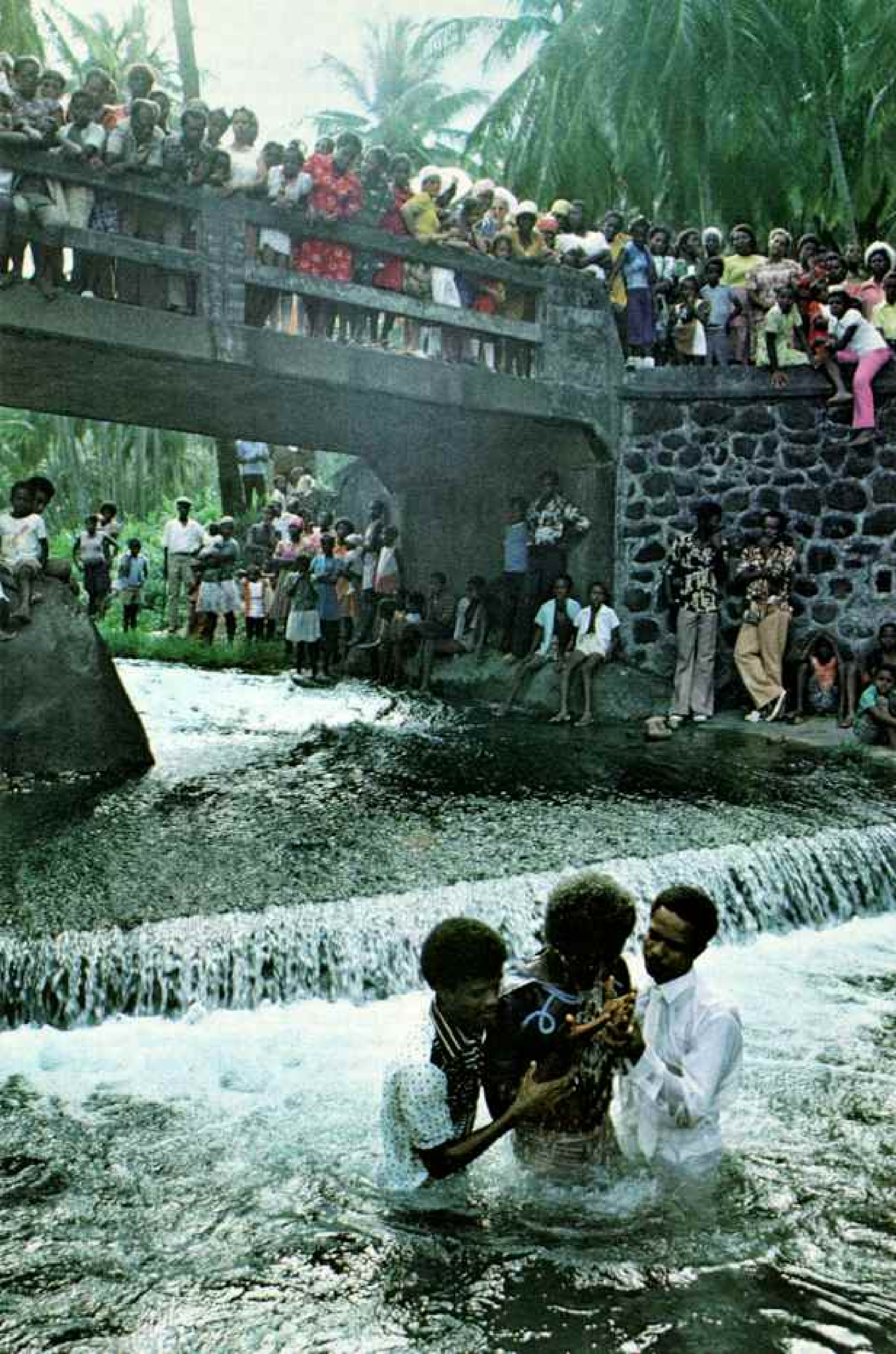
Some Bread Grows on Trees

Freer spirits than Fort Charlotte's convict cooks avoid breadmaking by shaking a similar staple from the nearest breadfruit tree. Tahiti's gift to the Americas might have arrived sooner if mutinous crewmen of H.M.S. *Bounty* hadn't jettisoned the ship's cargo of Caribbees-bound saplings when they set their captain, William Bligh, adrift in the South Pacific.

The captain survived to sail again, and a direct descendant of the first trees he finally delivered to the New World in 1793 thrives today in Kingstown's Botanic Gardens. An obliging fellow named Rudolph fielded a falling fruit almost the size of a soccer ball and urged me to try it for supper. It *was* supper—soup, corned-beef hash, vegetable, and potato salad—all from a single offshoot of Bligh's most enduring bounty.

Even greater variety patterns the neat hanging gardens of East Indians and "Bajans" (a contraction for Barbadians) who have resided for generations among the ridgetops of Kingstown's pleated outskirts. When emancipation emptied the fields in the late 1830's, estate owners restaffed by importing indentured labor from the Portuguese islands and India. After Cromwell, a number of Scots left home in a hurry, settling first in Barbados. Later they moved to the St. Vincent highlands, where they've mingled with and married mainly their own.

"In me young days, nod at a black girl, me father knock me silly." Alfonso Olton doesn't mind seeing these old ways die. "It's not very exciting courtin' one of your kin."



Plagued by lameness and a troublesome eye, Alfonso has no difficulty driving even when a little rum further blurs his vision. Thanks to his patient donkey, Jean.

"I can walk a leetle when the divil don't get me foot. But mos'ly ol' Jean, she hauls me. Only transport I know runs on guinea grass that don't cost a cent for a fill-up."

Ash Buries Arrowroot Crop

Hemming the Bajan stronghold of Dorsetshire Hill, the main highway serpentines up the windward coast, keeping company with sand beaches black as Caspian caviar. This striking sight strikes out with tourists, who prefer to sun on lighter strands.

On sheer-sided heights beyond Georgetown, field hands of both genders and all ages plant and harvest arrowroot. Even surefooted goats prefer leveler land.

"It botha some, clummin' up. But betta leanin' into yo work than down below, bowin' to yo feet all day."

Arrowroot's end product, an easily digestible starch once grown almost exclusively on St. Vincent, has lost much of its major market—the United States—to more plentiful substitutes. This year even consistent users may have to switch. As I flew around the island during Soufrière's flare-up, arrowroot fields normally teeming with workers were laden with ash and deserted.

Ownership of the island's 20,000 cultivated acres divides three ways: the state, small farmers, and a few large landholders. Cyril Barnard, a spar-straight squire whose British forebears helped colonize the Caribbean, runs the most expansive, imaginative spread of them all (pages 402-3). His Orange Hill Estates cover some 3,000 windward acres of former Carib country, producing and processing a long list of exportables—from passion fruit to patchouli oil, the ingredient that sets the scent in perfume.

"Mainly what we grow are continuing crops—bananas, coconuts for copra, limes, and cattle. But if one market begins to sag, we try to develop another. Like making buttons from coconut shells or using waste husk fibers for twine and insulation.

"My father bought this place from a man who couldn't face starting over again after Soufrière's 1902 eruption. Now I've seen what that mountain can do, and I know how he felt. We've already lost thousands of tons of bananas, and further activity could wipe out our cattle and coconuts."

As it surfaces, Soufrière's lava tends to explode into clouds of gas and scorching particles that can avalanche downhill at 60 miles an hour and broil everything that happens to be in its way.

North of Orange Hill the roadway winds a few more miles to end in a cluster of windswept shacks fancifully called Fancy.

On the Caribbean side the major route out of Kingstown, a real cliff-hanger, geargrinds to a halt just above Chateaubelair, leaving all the craggy northwest coast and much of St. Vincent's corrugated interior inaccessible to almost everyone. Yet leeward fishermen once round-tripped across it daily to sell their catch in Georgetown.

South of Chateaubelair a few hardy souls still pursue the blackfish, or pilot whale, in open boats. Shuffling around his living room, Griffith Arrindell, 86 and ailing, ferreted out photographs and clippings of his heyday as blackfish king of Barrouallie.

"Dat fish's head hol' bes' dom machine oil ever is. So I come home from States in 1931 'spectin' to sell plenty. One watchmaker buy a li'l—then nobody. Thirteen boat catchin' big then so even meat bring only penny a pound. Now only three boat left."

The king settled, like a fallen soufflé, into his chair and sighed. "Doctor say I no live long. Same with blackfish fishing. But we both take our time about dying."

It was a poignant moment—both for me and the old man of the sea.

"Already you use up lot that time I got left. So, maybe you he'p this po' mon make his las' days happy."

Now for now.

A visitor to the St. Vincent sphere soon learns that favors granted often involve requests for payment. But expectations of the aging baron of Barrouallie proved modest compared to those of a handful of whalers sailing longboats out of Friendship Bay on the windward coast of Bequia.

Northernmost of the populated Grenadines, Bequia prospers more than the others from layover yachtsmen, occasional boatbuilding, and a sizable input of part-time residents from abroad.

Getting there across a choppy, six-mile

Underwater reveries *materialize for a young couple in the coral-studded Tobago Cays* ***(above)****. Steady winds and transparent seas make the Grenadines a delightful landfall, but the hoped-for tourist boom has not yet come. Low occupancy has forced some hotels to close.*

A working diver ***(right)*** *plucks conchs from a sandy bottom to sell as a delicacy at local markets. A tug of the lifeline signals that he's weighted with conchs and ready for hoisting.*

channel can be a tipsy experience, even on the vintage 65-foot, all-purpose schooner photographer Cotton Coulson and I chose for the trip. A dockside lounger eased my mind: "Don' you worry none, mom. She no sink long's de worms keep holdin' hands."

Bequia buzzed with big news when we landed two hours later: The first humpback whale in two years had been harpooned off Canouan; flensing would start on Petit Nevis Island at dawn.

Fleecing attempts began on our arrival there when one of Petit Nevis's owners tried to collect $500 U. S.—about $1,200 in East Caribbean currency—from Cotton for the privilege of uncapping his lens. That's *real* now for now.

After hearing the whalers harangue about the daily dangers of their trade, I found them later beneath a palm-frond shelter on nearby Mustique, hunting their prey with binoculars and beer.

Seven miles southeast of Bequia, Mustique offers the ultimate in luxury living, thanks to a Scottish millionaire named Colin Tennant, who bought all 1,400 acres in 1959 for around $100,000. Today, a house and lot there can cost five times that sum. Not the least of Mustique's mystique is the part-time presence of England's Princess Margaret, one of the first of its 42 homeowners.

In converting the island from long-staple cotton to long-stable investors, 52-year-old Colin, a fashion-plate peer who prefers caftans to kilts, cannily preserved much of the islanders' established life-style.

"When I arrived, about twenty families were cultivating a little of the land for very little of its profits. I hired them all; now there's never any unemployment here.

"When the old ones said, 'We favor de hoe, suh,' I gave up developing by modern methods. Consequently, these people have moved gradually into the present with little upset and almost no desire to leave."

Job opportunities there attracted Vincentian Winston King. Taller than six feet and topping 215 pounds, he acts—without appointment or argument—as local arbiter.

" 'Nother fella top me by two inches. But, in here," he tapped his chest, "I bigger mon. Any trouble, I talk calm and p'lite and ev'thin' go quiet agin."

Four years ago, keeping calm saved Winston's life. The overloaded schooner he had boarded for a Christmas trip to St. Vincent ran aground and rasped to pieces in the swells. Winston skinned to his skivvies and swam to safety, which nine other passengers never reached.

Lacking: Water and Tourists

Visitors may float or fly to Canouan, where residents—about 700 of them—don't care how they arrive as long as some do. So far, few have. In the meantime major income derives, as on most of these islands, from the ones who moved away.

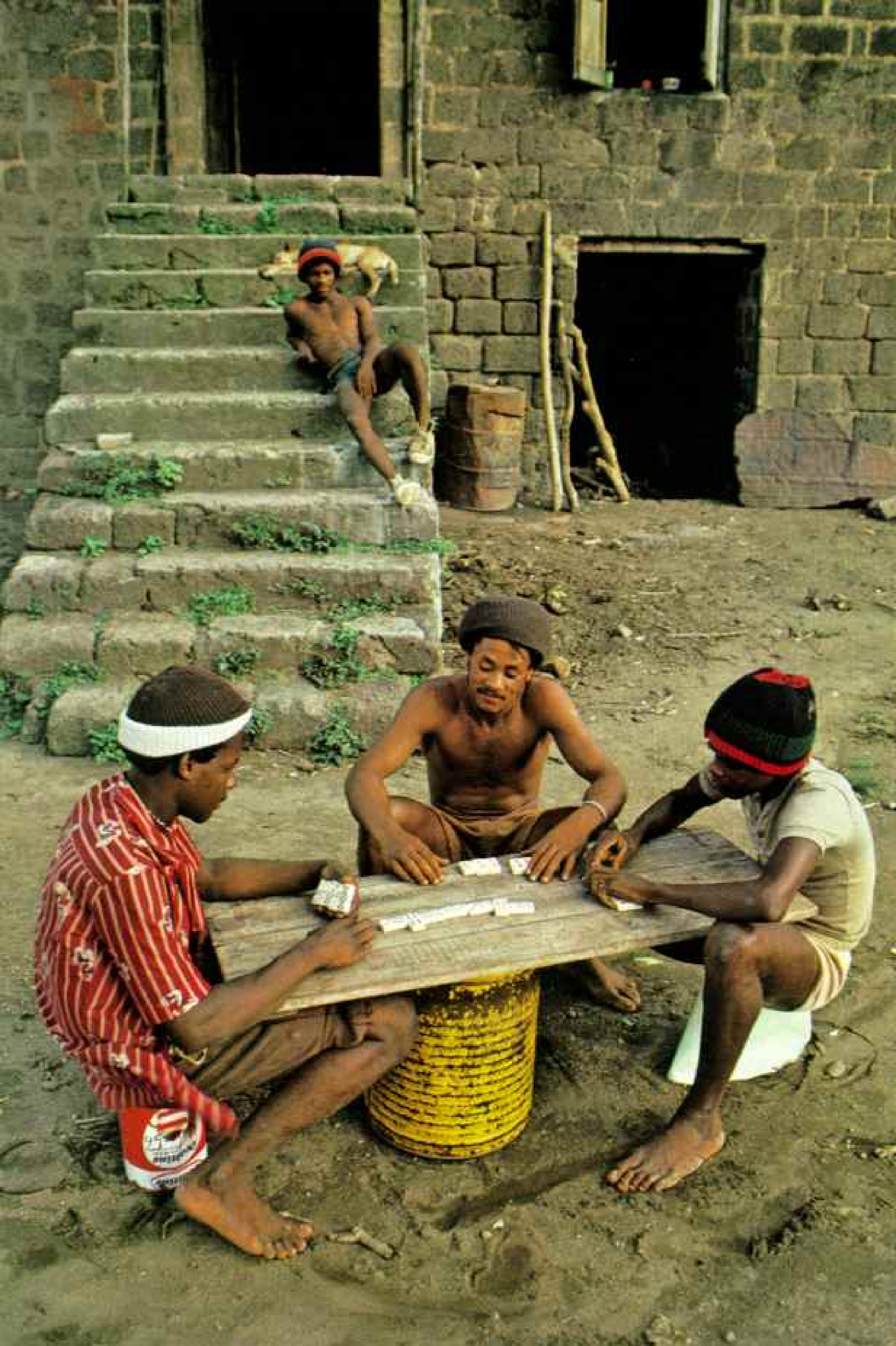
To those bound there by bucking mail boat, sights pass slowly enough to savor thoroughly. Shadowed waves make shark fins in the sea; flying fish carom, like well-skipped stones, across the whitecaps. A returning islander reaches into foot-deep water in the lifeboat's bilge to rescue his hobbled "picked-neck" chicken, a sorry-looking species already half-plucked at birth. "Dom bird t'ink he's a duck."

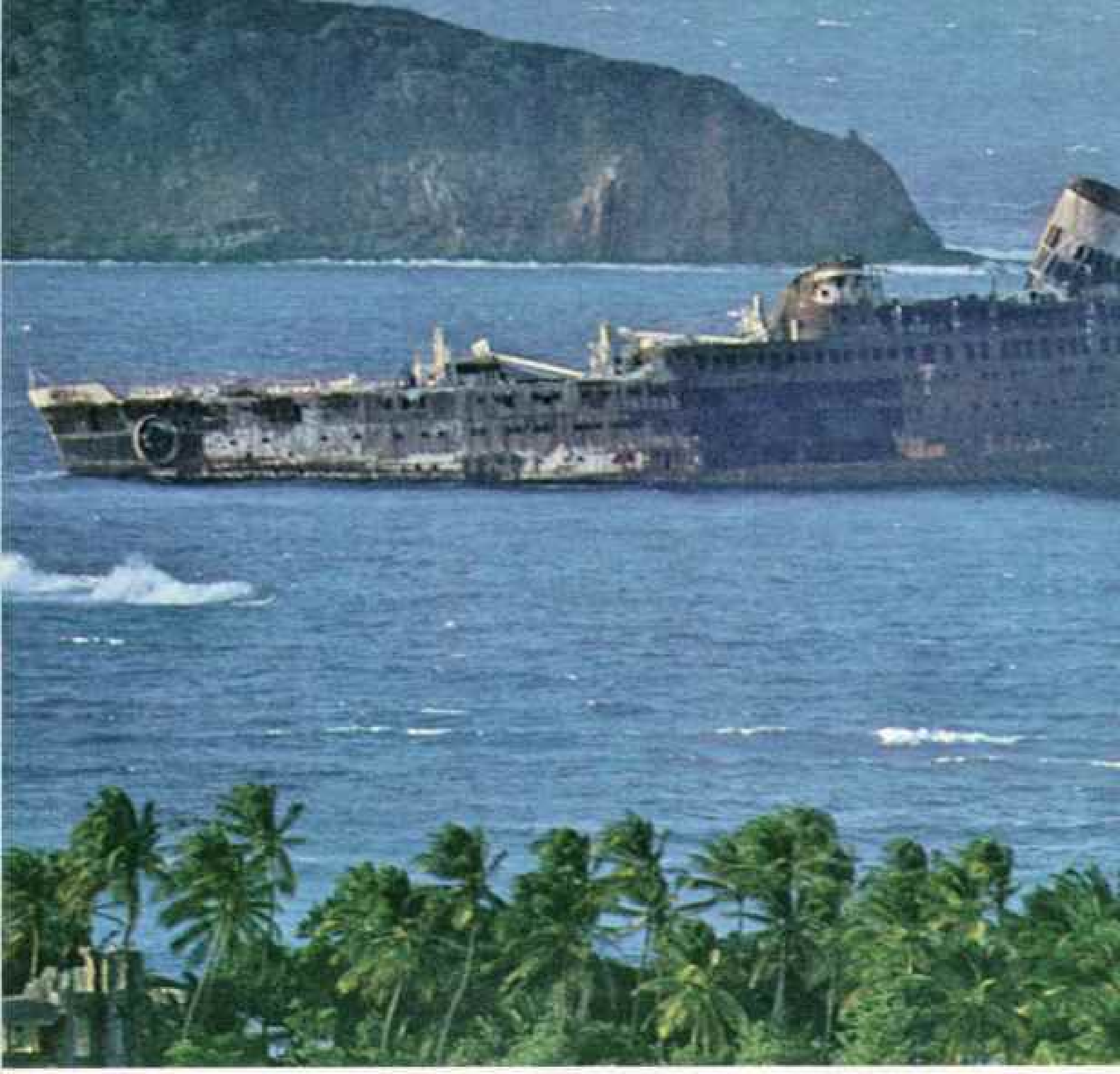
Engines idled while Grenadine gondoliers ferried ashore passengers, produce, and beverages. With rains still three months away, Canouan's water supplies were drying up. The island, optimistically designated by the state for full tourist development, has yet to provide a steady, year-round reserve even for those who live there.

A year out of school with no prospects for future work or study, teenager Katherine Snagg elected herself my escort. "Big buildin' up there, she our Perseverance Friendly Society. Ev'y month we go sign book and leave what bes' we can. When anyone go sicky or die, money come from book to take care. That way, po' people he'p each other."

Circling this three-car island afoot, Kathy introduced me to its gleaming bracelet of

Life deals a harsh hand *on St. Vincent, where youths play dominos and loaf around an abandoned stone house. High unemployment hamstrings an economy that barely scratches out a per capita annual income of $300. Many people—often the brightest—emigrate to England, the United States, and Canada and send support to relatives.*





Snagged by reefs *in 1971, the French liner* Antilles *lies broken and rusting off Mustique. A less spectacular problem, scarcity of fresh water, limits tourism*

beaches and rocky haunts where she hunts the seabirds' eggs. On eastern moors, goats grazed through stunted, laid-back scrub, their only nourishment in these parched days. "Dat bush dere, we call it 'sticking book.' Pods got glue inside good for pastin' t'ings." Canouans may not have much, but they know how to use what they have.

Kathy reappeared at the dock next day to see us safely on our way to Union Island aboard a fifty-year-old "engine boat." Making the most of his opportunities, the skipper charged an extra fee for fresh air space on the upper deck.

Things are going rather well these days for twin-peaked Union, a crossroads community of 2,000 people. Its busy little airport handles a dozen planes a day. And more and more charter yachts refuel and resupply at Clifton, one of two villages, where the post office insists on modesty in the mail room.

"Anyone comes in here gotta be dressed from knee to neck. Bareboating means no paid crew, not walking around half naked."

Two competing Frenchmen further fueled the mini-boom by bidding up the price of fish, thus sending a lot of long-idle boats back to sea. Exporting the catch of

on many of the smaller islands. "On Petit St. Vincent water is more precious than rum," a sign in a hotel reminds. "Please use only what you need."

almost everything to Martinique, which a disapproving government seems helpless to prevent, has made fish scarce for Grenadiners. But who's to argue when the buyer then on Union's waterfront kept a moatful of sharks between him and the public.

Some of the younger Union fishermen prefer to dive, with or without tanks, for premium-priced lobster, turtle, and "lambie"—conch.

Thomas, who at 40 still scouts the seafloor at seven fathoms on a single gulp of air, made room on his open 16-footer for me. And two helpers. Oars. Bamboo mast and boom. Several hundred pounds of ballast stone. Underwater gear. And a great deal of "t'ing an' t'ing"—and so forth.

Yet the little craft proved as buoyant and indestructible as a plastic jug when we skimmed under patched canvas toward the enchanting Tobago Cays, where transparent waters and animated reefs create a snorkeler's wonderworld (page 411).

Belting himself with a long rope, Thomas crossed himself and dropped over the side of the boat. "Lambies, dey like sandy bottom and movin' roun' a lot. So findin' sometime take mo' time than gettin'." He dived, his

Sails eased to bag the wind, workboats crafted in the islands

swim fins rising like flukes behind him.

A tug on the lifeline and young Moses reeled Thomas back to the surface with repeated armloads of lambies while I watched the freeboard shrink. As the gunwales were about to go under, he called it a day. "Shark come nosin' roun' lookin' kinda vex so I say, 'Shark, mon, I jes leavin'.' "

Ten speedboat minutes farther southwest, American John Caldwell and Mary, his Australian wife, have added some smart new wrinkles to an island once called Prune. Generously landscaping its 110 sandy acres with flowering shrub, casuarina, cedar, and palm—the name the island now bears—they produced a garden resort of rental cottages and private homes beside broad, bright beaches.

Before pegging their fortunes to Palm Island in 1966, the couple ran a charter boat

race in a regatta off Carriacou.

out of Antigua. Lover of both trees and seas, Caldwell enriched many a bare island with palm plantings—five thousand in his travels. To grateful Grenadiners now benefiting from a bonus in food and shade, he's known fondly as "Johnny Coconut."

Almost next door, another one-resort island—Petit St. Vincent—marks the southern limit of St. Vincent's Grenadines. Like millions of others, Willis Nichols, a robust, 68-year-old papermaker from Cincinnati, Ohio, always wanted to own an island. The difference is, he does. But the government, trying to make the tourist dream come true, wouldn't let him purchase 113-acre "PSV" unless he developed it.

"We put in the only desalination plant in the Grenadines, figuring its solar still would supply us forever. When it began breaking down seven years later, there weren't any proper replacement parts anywhere. So now we're shipping fresh water in from St. Vincent just like Mustique has had to do."

Plumbing still gushes and flushes more reliably on these two islands than any of the others in the group. (That sort of comparison has a way of creeping into your thinking in the Grenadines.)

A Speakeasy Island?

Less than a mile away, Petite Martinique has a reputation for importing more potent potables that bypass customs on their way to customers. Whether true or not, this rock-strewn isle of sparse vegetation and 700 independent-minded souls has amassed, according to some estimates, the greatest per capita wealth in the entire West Indies.

I was sure I had made contact for a "down de chute" sale when I fell into step with a little woman toting a large liquor bottle.

"Nice day."

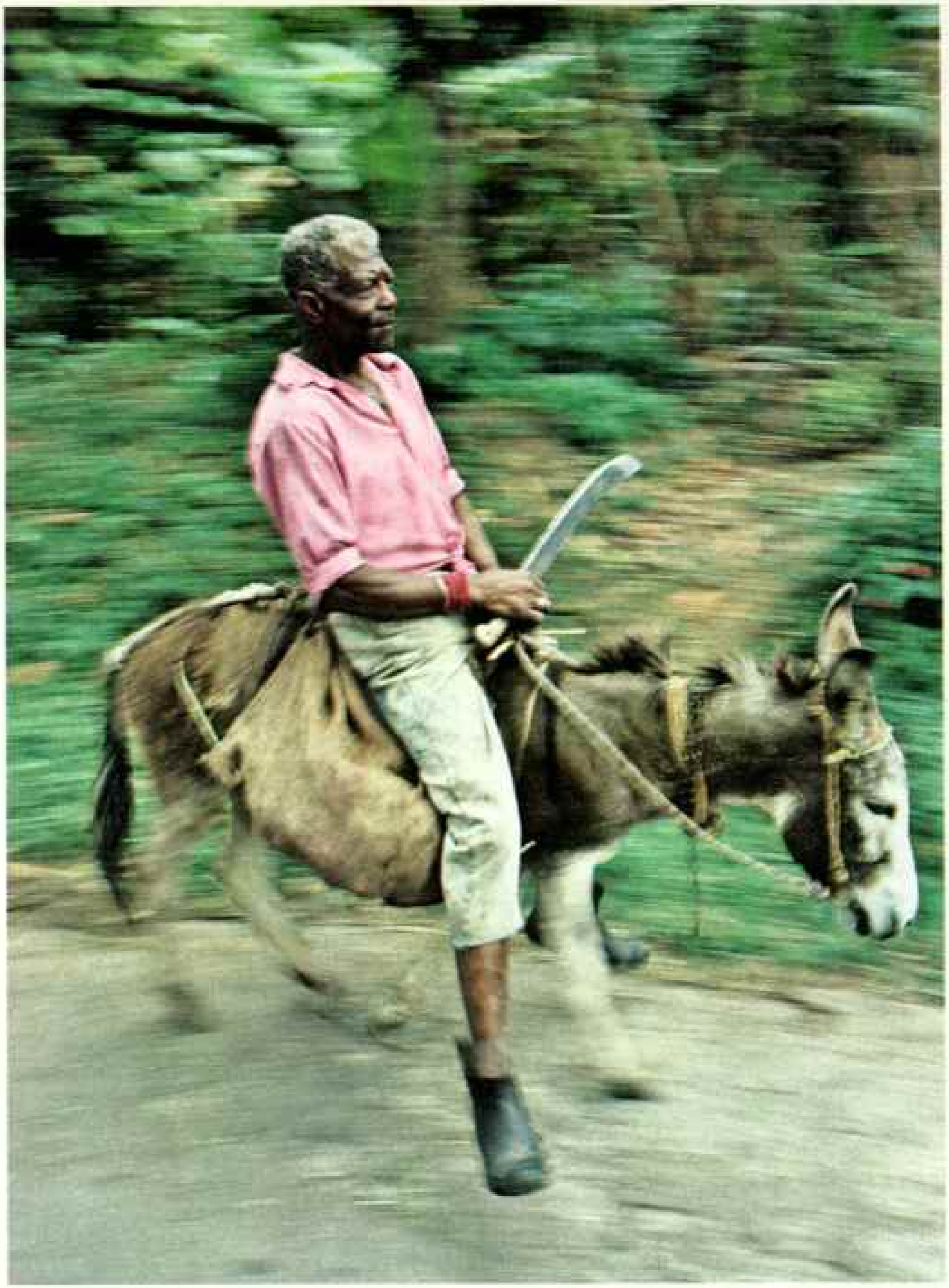
"Na fo' my son; he bad sick with backaneck." (Which can mean any achy ailment from flu to dengue fever.) She held up her jug of milky-looking elixir. "So I fix him med'cin fum jumbie ben root, gravel senne, ar'root. With a li'l jack iron fo' flavor."

Laced with this local, quick-kick rum, bush cures maintain a faithful following.

Among its more visible accomplishments, Petite Martinique raises fine seamen—many now crewing bulk carriers in foreign waters—and highly skilled boatbuilders. So, too, does near-neighbor Carriacou, largest of the Grenadines.

Shaped something like a smallmouth bass rising to the lure of Palm Island, Carriacou covers approximately 13 square miles and counts among its roughly 7,000 citizens some of the pleasantest, most uncomplaining people on earth.

"Bad breeze never blow; every disapp'intment bring a blessing."



Grenada's economy rides *on the fortunes of its farmers—work-hardened men like this landholder* ***(above)****. They rely on donkeys, hoes, and machetes to cultivate and harvest plots of less than two acres. Even so, agriculture yields 15 million dollars in exports yearly. Bananas* ***(right, above)****, plastic-bagged on the tree to discourage bruising and insects, rank third behind cacao and nutmeg* ***(right)****, Grenada's largest cash crops. The red fibers coating the nut are sold as mace, another valuable spice.*

"God send rain in His own good time; He never give us more than we can bear."

Bearing up well is Zepherin McLaren of Windward village. Measuring by eye, sawing and shaping solely with hand tools, he turns out everything from eight-foot dinghies to eighty-foot cargo schooners that have a way of outclassing all challengers.

"Ribs of white cedar, Guyana greenheart for keel, Canadian pitch pine and spruce we plank on without steaming; they're all tough to work but make tough workboats."

Shunning the sea, Gregory "Pa-Glean" Joseph, 93, has dug up more of the world than most men.

"Back in 1914 it's de Panama Canal. Colonel Goethals, he pay ten cents an hour fo' ten-hour day. In Brazil I he'p make de railroad. Then I go minin' coal in Canada, an' hoe cane in Cuba. Mos' from here den go to Brooklyn, makin' tunnels fo' de subway."

Pa-Glean asked where I came from the island way: "Who you belong?" Brooklyn, of course, I said; after all, I had once gone to school there.

"You nice lady. Mebbe ten years, you come back. I ready for a new wife by then."

He took up his shovel and followed me outside. To dig again. In his garden.

Drought Puts Emphasis on Livestock

With the pigeon peas harvested and unpicked cotton "makin' flag," "leggo season" had come. To save them from deepening drought, livestock had been released to forage as they could.

Ed Kent shooed away two cows chewing contentedly on the plastic roof of his Moke, a midget car. "Craigston here is the last of Carriacou's old plantations. My father bought it fifty years ago. When I took over in 1968, no one knew the island was headed into a five-year drought. Lime juice, our main export, dropped almost overnight from 70,000 gallons to 200 gallons a year; we couldn't make up the tree loss in a lifetime.

"So I began switching to cattle and blackbelly sheep. When natural grazing dries up, I fatten them on cottonseed and lime pulp—probably the only meat around being tenderized on the hoof.

"We'll probably have other droughts. But my wife, Jean, and I intend to stay and keep trying. Carriacouans have a special quality

A delirium of color *whirls in dances drawn from the African heritage of islanders at Carnival rehearsal on Carriacou (**right**).*

*With less frenzy, revolution swept Grenada last March when a coup deposed Prime Minister Sir Eric Gairy and installed Maurice Bishop (**below,** at right). Gairy, a flamboyant figure in the Grenadian government for two decades, attributed his political longevity to his "relationship with the Divine." Opponents pointed, instead, to rigged elections and bribery.*

Bishop announced a program of moderate socialist reform and promised Grenadians a new constitution and restoration of human rights.

and spirit we admire; they're civil without being servile. We think there's no happier place in any of these islands."

When the mail boat to Grenada decided to skip a trip for no apparent reason (which is reason enough here), Ed lightered me out to a down-island cattle boat along with some of his sheep. "You get your choice of A or B decks—aft or bow."

I tried the fantail first, with its diesel fumes, seasick passengers, and a crewman cleaning a ratlike manicou—an opossum—for cooking. Finally deserting my stern surroundings, I found the ark end of falling and bawling animals a slight improvement.

Carriacou to Grenada is no run for the queasy. Here the Atlantic, lathered by untamed winds blowing all the way from Africa, tries to dump its load of wash on every passerby. It succeeds remarkably well.

Favored with calmer waters, Grenada's port and capital of St. George's lives up to its rave reviews. Bisected by a long ridge, it cants steeply from two seaside sections—Bay Town and the Carenage—to spill splashes of color across an amphitheater of hills. Buildings of mellowed brick—English Georgian and French provincial—preserve the flavor of its colonial past.

Here, as on St. Vincent, claims that a tourist boom is in the making appear somewhat premature, although the island

did welcome nearly 150,000 visitors in 1978.

Many similarities link Grenada and St. Vincent. Both are roughly elliptic and similar in size (Grenada 120 square miles and St. Vincent 133). Alike, too, are their crumpled midlands, "agro-proletariat" majorities, economic imbalances, and reliance on emigrant incomes. Water and crop conditions pose few problems in either place.

In terms of inner turmoil, though, Grenada holds a decided edge. In 1651 Grenada's Caribs chose to leap from a cliff at Sauteurs rather than surrender to the French. In 1795 a French-provoked peasants' revolt annihilated most of the resident British; reprisals virtually eliminated the insurgents. Five years ago winds of violence swept the island into pre-independence strife.

This year a handful of dissidents, with popular support, overthrew the long dictatorship of Sir Eric Gairy in a near bloodless revolt that lasted only a few hours.

Patient and peaceable by nature, Grenadians had endured—in a now-for-now sort of way—years of rule that many considered tyrannical. It was, at the least, marked by favoritism and corruption.

An avid advocate of UFO's and other spatial phenomena, Gairy claimed spiritual guidance from on high and wisdom born of mystic insight. His earthly practices, however, ranged from voodooism to violent

reprisals against real and imagined enemies. On March 12, globe-trotting "Uncle Eric," off to New York, left home once too often.

The next day a small task force led by socialist Maurice Bishop seized control of the country in a predawn blitz that caught all but its participants by surprise. Before noon Grenada's 300-man army had surrendered and most of Gairy's close supporters were in custody.

Visiting the prison shortly after the takeover, I found former army commander Winston Masanto being detained there, but cheerful about his sudden change of station: "Heck," he said, "I trained half the fellows now guarding me."

The 34-year-old Bishop, a London-schooled barrister, took over as prime minister. At the same time, his People's Revolutionary Government suspended the existing constitution, parliament, and court system; reinstated some long-ignored democratic rights; and pledged early free elections.

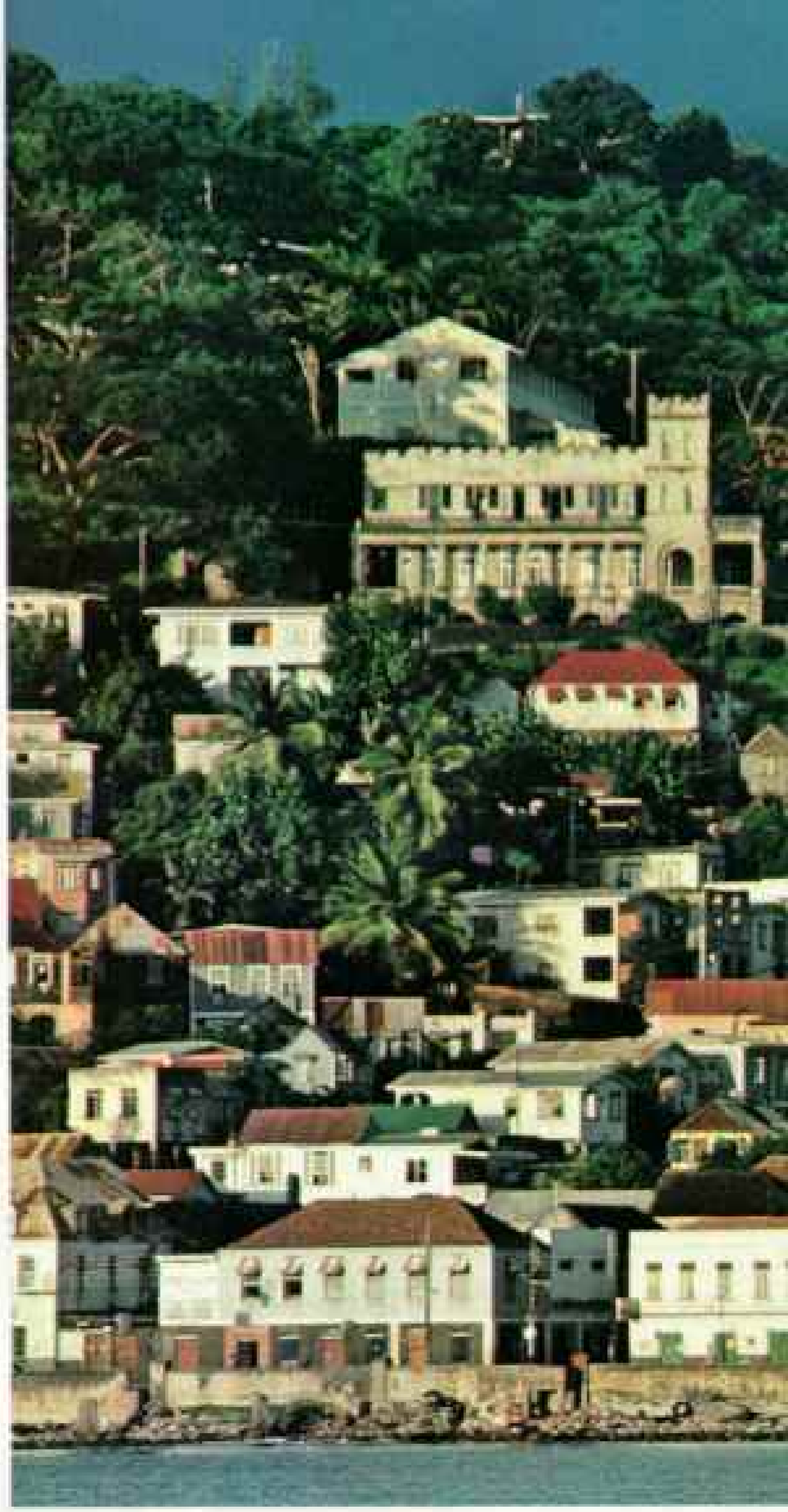
Ten days into the new order, Prime Minister Bishop stated his priorities to me: "An end to corruption, rapid reconstruction, and an all-out effort to increase national production. This means getting a lot of idle land and people back to work. For us, economics is a simple thing: If you don't put in, you can't take out."

Back in 1955, what island farmers put in, Hurricane Janet took out. Grenville's L. L. Ramdhanny, heavyset grandson of an indentured East Indian, remembers the day.

"The storm made an unexpected turn on its way to St. Vincent and wiped out most of our main crops—cacao and nutmeg. I don't know how this house stood up unless the Almighty thought it was still the convent it once was. Everything else around was flattened. So, I thought, was the future for my ten children. But the Lord and the land wouldn't let me give up that easily.

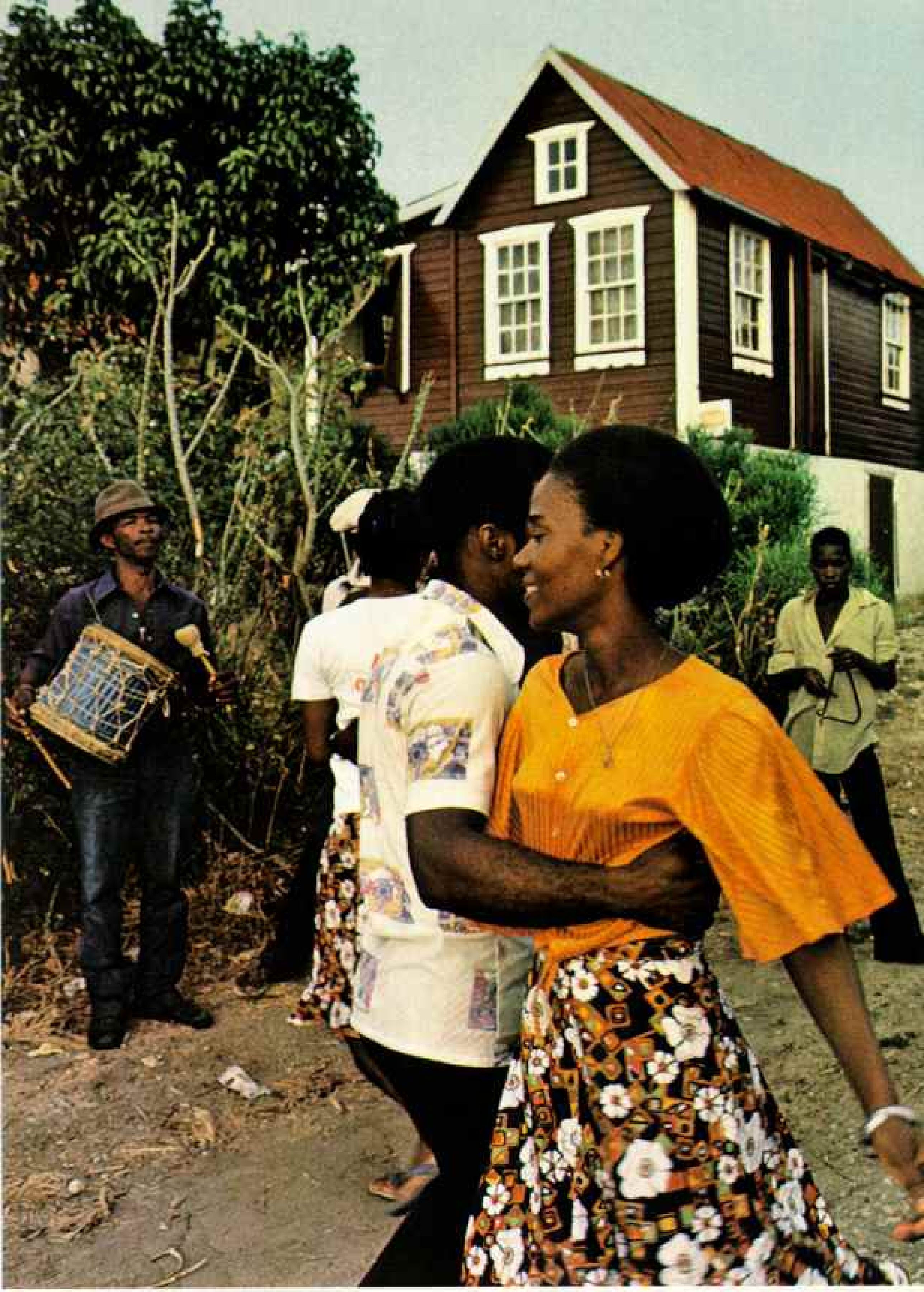
"To speed recovery, we farmers began planting bananas. They not only bear in seven months but shade young nutmeg and cacao trees that take years to mature.

Grenada's newly minted "green gold" forests blotted out the sun as I crossed the island from Grenville to Gouyave (Charlotte Town) on a road that's barely there. One of the most productive stretches of land belongs to two Branch brothers—John and



Endless summer *bleaches the jumble of French provincial and Georgian colonial buildings in St. George's, Grenada's capital and chief port* ***(above)****. Smallest nation in the Western Hemisphere and a recent member of the United Nations, Grenada packs one of the densest populations in the Caribbean into an area only twice the size of Washington, D. C.*

Summer's end means school's start for students of St. Andrew's Anglican Secondary School in Grenville ***(right)****. Most schools are church related but receive government aid; attendance is compulsory.*



St. Vincent, the Grenadines, and Grenada

Sir William—who with another brother, Dutton, cultivate some 700 acres of fruits and spices on their Dougaldston Estate.

As usual, all were working on a weekend; even Lady Thelma Branch had joined the Sunday shift, peeling lacelike mace away from the nutmeg's inner shell (page 419).

Outside, a wispy woman of advanced years did a lively, barefoot shuffle through trays of drying cacao beans, turning them to the sun. I asked her age, knowing few here can ever afford to retire. "I no know, mom. Me mudder die befo' she tell me."

"For us," said Sir William, "the only place to die is in Grenada. Other places, only family and friends come to the funeral. But here, everybody's welcome."

Large attendance also lightens many a load for the living. On a beach near Halifax Harbour, a dark-skinned crowd waged a tug-of-war with a bulging net of jack. Captivated by this early morning tableau, I pitched in to help land several hundred pounds of the small silvery fish.

"You pull plenty good for an old head," said one of my teammates. Whipping off my hat, he filled it with fish. "You he'p, you earn dem."

Not wanting to seem ungrateful, I carried my gift, flashing and flipping, around the the next bend and gave it back to the sea.

Many Welcome New Era

Of Grenada's many alien owners, most gravitate to the north around Levera and Sauteurs or to Lance aux Épines and Westerhall on the far-southern side. The recent change of government has brought relief to most of them. Gairy was accused of expropriating private property and deporting those who met with his disfavor.

At land's end, in the posh community of Westerhall Point, I asked an English resident if the events of the past few years didn't make him a little uneasy.

"Not really," he replied. "We almost settled in Cyprus." □

Music of the moment *sets Carriacouan dancers swinging and underscores a free-wheeling rhythm of life. A willingness to share work and sorrow helps islanders weather choppy times.*

Swollen with plundered blood *and doubled in weight, a mosquito flies clumsily off the finger of a human host. Fast-beating wings create its shrill whine. Only females seek blood, using the protein to produce eggs. With more than 3,000 species and subspecies,*

EQUILETTIDIA PERTURBANS: DWIGHT R. KUHN

the mosquito is the world's most deadly insect, annually claiming countless lives by spreading disease.

Mosquitoes, the Mighty Killers

By LEWIS T. NIELSEN
PROFESSOR OF BIOLOGY, UNIVERSITY OF UTAH

HIGH IN UTAH'S WASATCH mountains, I was standing with a student assistant in an alpine meadow thick with wild flowers. Natural beauty surrounded us, but we were not enjoying the scenery. Hundreds of hungry, dive-bombing mosquitoes were attacking us.

We were studying the nectar-feeding habits of mosquitoes. Many people think of all mosquitoes as vicious bloodsuckers. The truth is that only the females bite. However, both males and females of most species require the nectar of flowers or the juice of fruits as one source of food. The males need it their entire lives, the skin-puncturing females for at least a portion of theirs. Some species never take blood.

Our slapping and muttered complaints were interrupted when John Stireman, one of my graduate students from the University of Utah, pointed to mosquitoes clinging to a cluster of mountain bluebells.

"Those mosquitoes are collecting nectar through holes that bees made," John exclaimed. At the bases of the flowers we saw punctures drilled by worker bees—their tongues couldn't reach the nectar from the front of the long-tubed blossoms. Large numbers of both male and female mosquitoes were busily taking nectar from the bee holes (following page).

Mosquitoes ordinarily gather nectar by direct approach through the face of the blossom. I have often collected mosquitoes dusted with golden grains of pollen. Because of their thirst for nectar,

mosquitoes surely must serve as plant pollinators, especially of wild flowers too small to interest bees. In the Canadian Arctic mosquitoes certainly are major pollinators of bog orchids.

That mosquitoes do some good after all may come as a surprise. As carriers of pandemic diseases like malaria and yellow fever, they have probably killed more humans than all the wars in history. Yet this justifiably unpopular insect, in addition to its role as a plant pollinator, provides food for birds, fish, and many other organisms. In fact, some nectar-feeding mosquitoes produce larvae that feast on the larvae of blood-sucking mosquitoes (pages 432-3).

But whatever can be said in defense of the mosquito will never outweigh its devastating effect on humankind. With the possible exception of man himself, it bears responsibility for more death and discomfort than any other single form of animal life on our planet. At least a million people still die each year from mosquito-borne malaria, and millions more are stricken.

AEDES HEXODONTUS; JOHN STREHAN

Sipping nectar *from a blossoming bluebell in the Wasatch mountains of Utah, a mosquito slakes its thirst through a hole drilled by a worker bee. Males dine exclusively on plant and fruit juices; in most species, females also need nectar, but blood dramatically boosts their egg output. Scientists now believe mosquitoes pollinate some plants, especially the small wild flowers that bees often bypass.*

Blood Hunger Gives Female Its Sting

It's the blood need of the female that makes her humming a dirge of death. The female of most species must bite to get blood for the protein needed to produce eggs. That bite can carry deadly infection.

The female mosquito draws blood through an intricate network of piercing and pumping parts that would be the despair of any micro-engineer. We hear but don't feel an attacking female mosquito because her wings hum at 200 to 500 beats a second while her average unfed weight tots up to a mere 1/10,000 of an ounce. Flying off with two or three times her own weight in blood (often more than five milligrams), she is loaded with enough nutrition to produce 75 to 500 eggs, depending on the species. A female, if she survives, may go through several cycles of mating, feeding, and egg laying.

My research on these extraordinary insects has taken me all over the United States and into Canada, Mexico, Panama, Puerto Rico, and Scandinavia. Recently I talked with mosquito expert Dr. Kenneth L. Knight of North Carolina State University. He is senior author of a recent book that catalogs the mosquitoes known to science—more than 3,000 species and subspecies.

"At least three-fourths of the species live in the tropics or subtropics," Dr. Knight told me. "Most of the others are found in warm temperate regions. As one goes north, the number of species declines sharply. About 160 are known from North America, north of Mexico. Some seventy of these inhabit Canada. Each of our 50 states counts between forty and sixty native kinds."

Every mosquito species occupies a specialized niche, where it can survive most successfully with minimum competition from other species. Mosquitoes must lay their eggs in water or in a place that water

will overflow, and they exploit every imaginable occurrence of standing water. While the larvae of most species—familiar as wrigglers that thrash their way through the water—favor relatively fresh waters, some prefer highly polluted environments. Others invade brackish-water habitats.

Favorite mosquitoes of mine—favorite because of the attractive wild terrain they inhabit—are the Ice Age left-behinds, the high-mountain snow mosquitoes of the western United States. Their larvae, more than a dozen species of the genus *Aedes*, appear once each year in pools formed by melting snow. Northern in origin, snow mosquitoes were pushed south as far as Arizona and New Mexico by advancing glaciers during the Pleistocene epoch. Adapted to a harsh, cold climate, they were forced by postglacial warming to move up into the mountains. Today, isolated in the high elevations, they are the principal pest species of the coniferous forests of western North America.

Despite the paucity of species in northern latitudes, mosquitoes occur in greatest numbers in arctic and subarctic regions. Thousands of square miles of flooded tundra every year hatch mosquitoes in hordes that darken the sun and make life unbearable for both man and animals.

Such bloodsucking mosquito swarms probably can survive on plant juices alone if they are unable to obtain a blood meal. Countless millions must fail to find animal victims. In at least two arctic species, blood-deprived females can produce fertile eggs if nectar is available, but only a fraction of the number they would deposit if protein nourished. Some females, when restricted to plant food, produce only a single egg.

Blood Loss Could Prove Fatal

It's a question whether anyone is alive today who has not been bitten by a mosquito. Hospitalization from mosquito bites is not uncommon, and cases of temporary insanity induced by mosquito blitzkrieg have been documented. Investigators in the Canadian Arctic have measured attack rates as high as 9,000 bites a minute. For an unprotected person, this would result in the loss of half the blood supply in two hours—an amount more than enough to cause death!

Mosquitoes seem to have evolved in the tropics at least two hundred million years ago. From there they colonized virtually all parts of the world.

Often man helped out. One of the most pernicious mosquito pests—the vector, or carrier, of several diseases—is *Culex quinquefasciatus*, a cosmopolitan species that favors water in cans, broken pots, old tires, and uncovered sewage near human domiciles. From its origin in the tropics, this southern house mosquito, as it is often called, is believed to have colonized the rest of the world by hitching rides in water barrels aboard 18th- and 19th-century sailing vessels.

Oceanic islands once blessed with freedom from these pests have been invaded. Mosquitoes were unknown in Hawaii prior to 1827, the year in which an island doctor was called on to treat a new itch, inflicted by a new kind of fly described as "singing in the ear." *Culex quinquefasciatus* had arrived. Three other mosquito species have since taken up residence in Hawaii. One, *Aedes aegypti*, the common carrier of yellow fever, has been mainly responsible for several outbreaks of dengue fever among the islanders.

Fighting a Scourge of Mankind

Whatever other harm mosquitoes may do, none of it can compare to the devastation caused by the diseases they have inflicted on mankind and other animals. And remember that disease transmission usually requires at least two bites—one to pick up the organism and another to infect the victim.

Malaria, filariasis, dog heartworm, and more than eighty virus diseases including yellow fever, dengue, and encephalitis can be blamed on mosquito carriers. The *Anopheles* mosquito has made malaria one of the greatest killers the world has ever known, bringing death to hundreds of millions. Most of the 370 or so species of anopheline mosquitoes have the potential of transmitting malaria, but probably fewer than fifty are major vectors of human malaria.

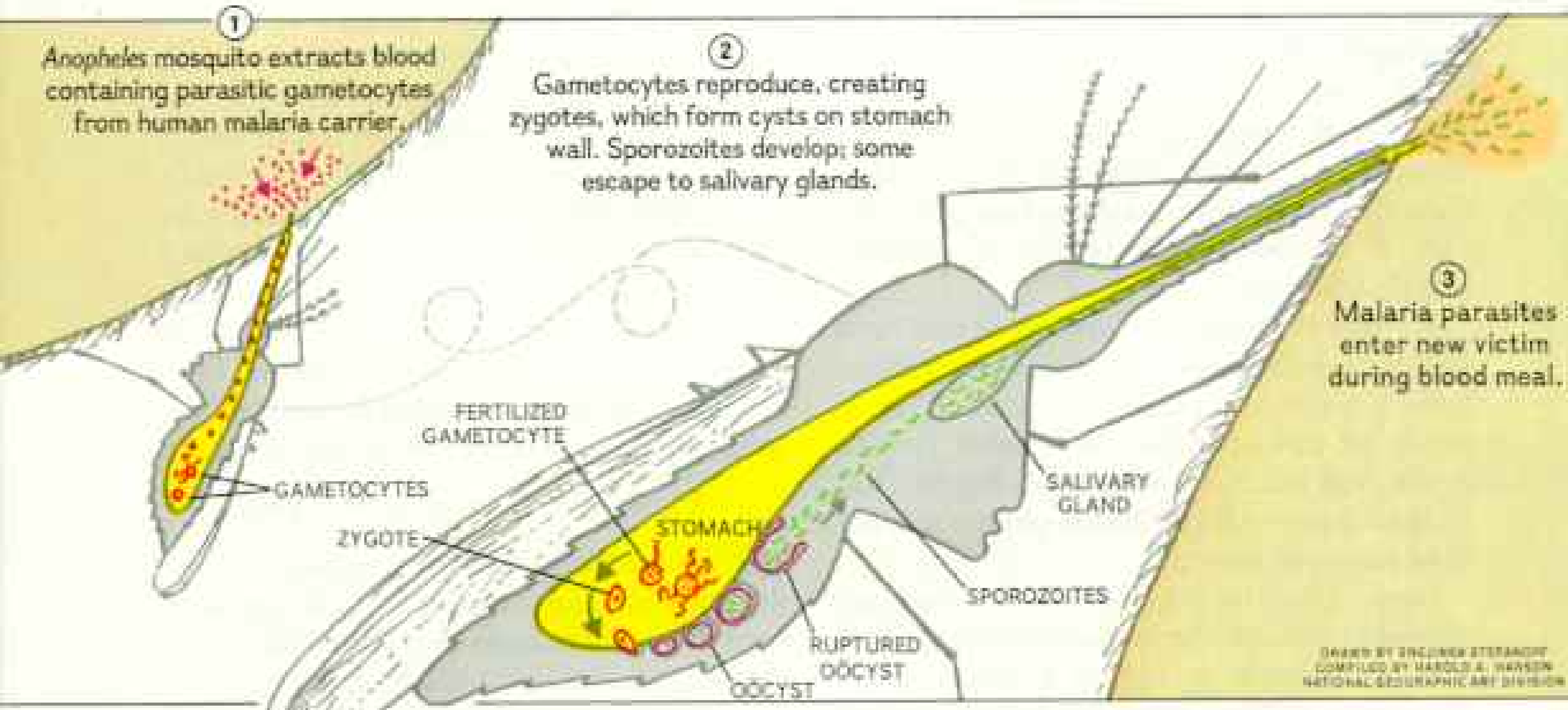
In the United States as recently as the mid-thirties, the average yearly toll from malaria was four million cases. The virtual eradication of native malaria in this country by the early '50's was probably due to a combination of *(Continued on page 436)*

Dread disease carriers

A GRIM ARRAY of diseases follows in the wake of the mosquito's bite: malaria, yellow fever, filariasis, and dengue—often called breakbone fever.

Once believed to be nearly eradicated, malaria is again on the increase, as pesticide-resistant mosquitoes adapt to man's chemical onslaught. India reported six million cases in 1976, up from 40,000 only a decade earlier. In the tropics of the New World, a major carrier is the species Anopheles albimanus *(**left**).*

*A vital link in the malaria cycle is a parasite, here seen (**right**) in its gametocyte stage. If picked up by a mosquito,*



MALARIA
Eradicated in the U. S. since the 1950's, malaria persists in much of the world. At its peak thirty years ago, the disease took a human life every ten seconds.

YELLOW FEVER
Originating in Africa, yellow fever ravaged the Americas until Maj. Walter Reed proved that the mosquito was its carrier. Eliminated in cities, it lingers in rural areas.

DENGUE FEVER
Although rarely fatal, this disease causes acute pain and fever, with recovery often taking months. It is most prevalent in Southeast Asia and the Caribbean.

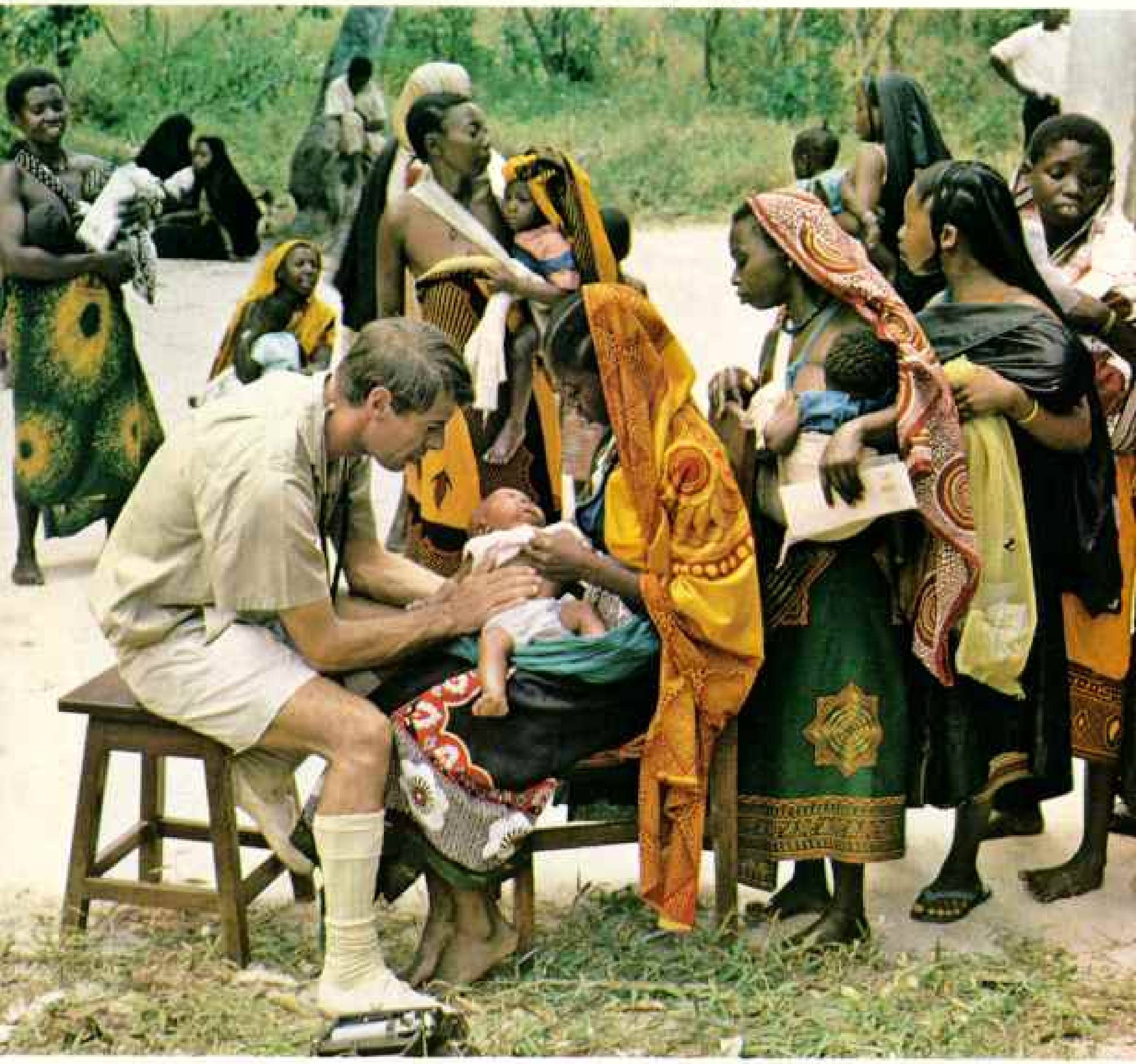
FILARIASIS
A small parasitic worm, carried by mosquitoes, is the cause. In the body the worms can block a victim's lymph passages, resulting in elephantiasis.

gametocytes reproduce within the gut of the insect. Their progeny then migrate to the salivary glands. When the mosquito bites, the malaria parasites are injected into the victim.

Through history malaria probably has taken more human lives than any other disease. In Africa it still infects millions of people

MAGNIFIED 9,400 TIMES: LAWRENCE KAEG AND PAUL CARSON, AMERICAN JOURNAL OF TROPICAL MEDICINE AND HYGIENE

*annually. A Tanzanian official told the World Health Assembly last year that malaria "daily erodes our economic health and kills our children." At the Tanzanian village of Kisiju, mothers bring their children to a rural doctor (**below**), who feels their sides for enlarged spleens, a telltale malaria symptom.*



EUGENE J. GERBERG

Birth of a mosquito

WITH PROW UPTURNED, a cluster of mosquito eggs floats on water like a raft (**below**). *When a female draws blood, her swelling gut presses a nerve that triggers a series of hormonal secretions, prompting the eggs to mature. Mosquitoes deposit their eggs in water, which the females detect either visually or by sensing water vapor in the air. Since most mosquitoes prefer fresh water, they also test salinity with the hairs on their legs. Although many lay egg rafts, others drop them singly like bombs. Eggs of some species have ballast tanks to keep them afloat. Others are highly durable, remaining viable for months even if they become dehydrated.*

After the embryo has consumed the egg yolk, a sharp spine on its head splits the shell and the larva emerges. Larvae of some species hatch in installments, possibly a defense against inbreeding. These larvae may release a chemical that temporarily inhibits the hatching of other eggs.

Once they emerge, the larvae begin feeding immediately, consuming bacteria, pollen, and microscopic plants. The larvae of a non-biting African species (**facing page, lower left**) *prey on other larvae, offering promise as control agents.*

In its last molt, the larva becomes a pupa (**facing page, lower right**). *Then, after a few days, the adult mosquito emerges* (**right**), *but until its wings dry and harden, it is highly vulnerable to fish, spiders, and other predators.*

EDGAR & RUTH KRAMER

CLAUDE NURIDSANY AND MARIE PERENNOU

CULEX PIPIENS (ABOVE AND BELOW, RIGHT AND FAR LEFT); EUCHRYSCHIRUS BREVIVALVIS AND AEDES AEGYPTI (BELOW, CENTER)

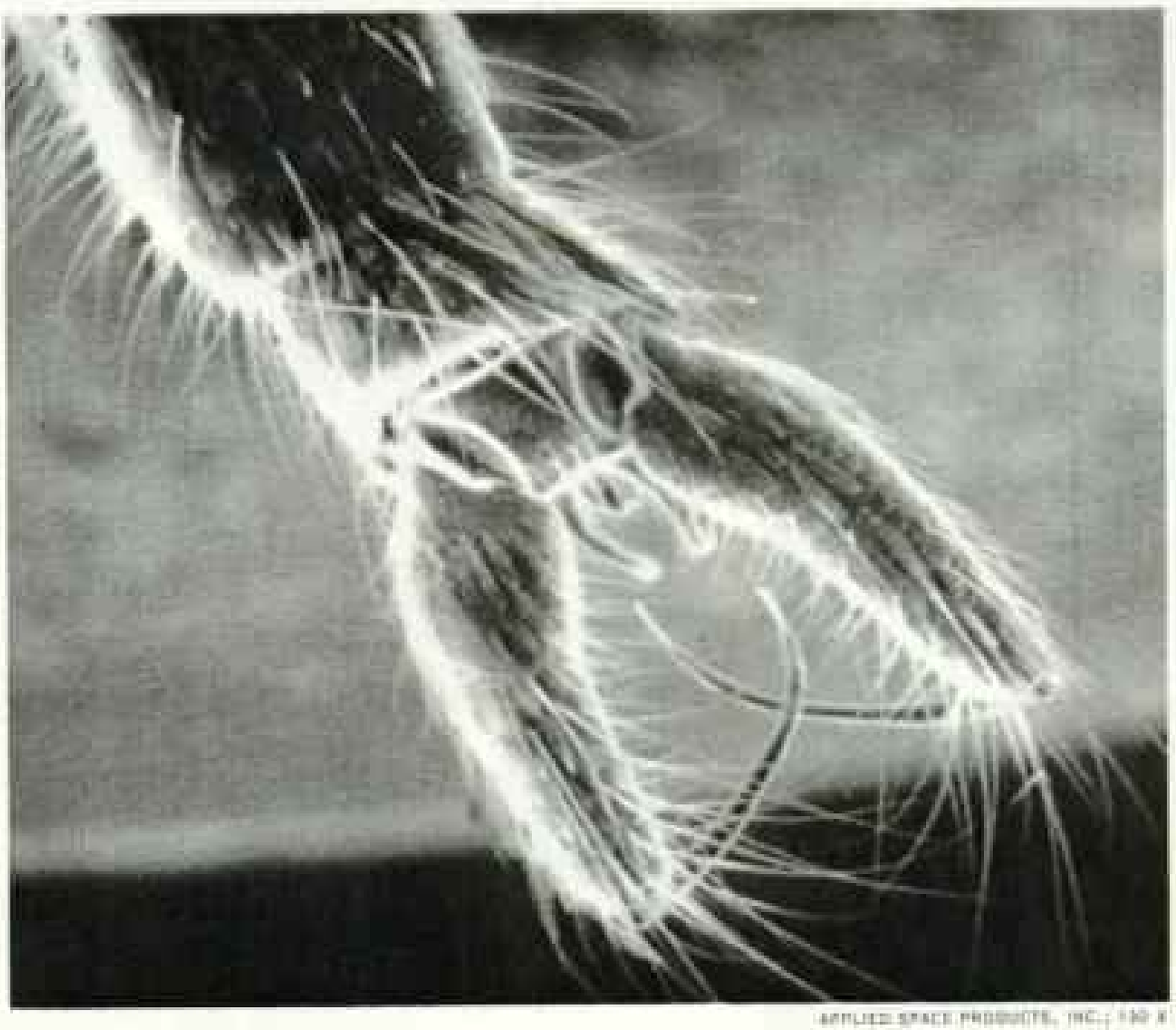
NATIONAL GEOGRAPHIC PHOTOGRAPHER ROBERT F. SISSON (LEFT); JOHN A. L. COOKE, OXFORD SCIENTIFIC FILMS

Anatomy of a mosquito

*THE THORNY TIP of the mouthparts of a female (**left**) conceals a stylus of surgical precision (**left, middle**), revealed by a scanning electron microscope. After alighting on a victim, she unsheathes the stylus, whose fine sawteeth neatly slice skin tissue. When she pierces a capillary, two powerful pumps in her head draw blood.*

*Males in search of a mate are attracted by the buzzing of the females' wings. The proper frequency (200 to 500 wingbeats per second) registers on a male's antennae, luring him close. Claspers on his body (**below**) fasten to the female during mating.*

*Mosquitoes need their acute sensory apparatus, for despite eyes covered with hundreds of lenses (**right**), they probably cannot see clearly beyond a few inches.*



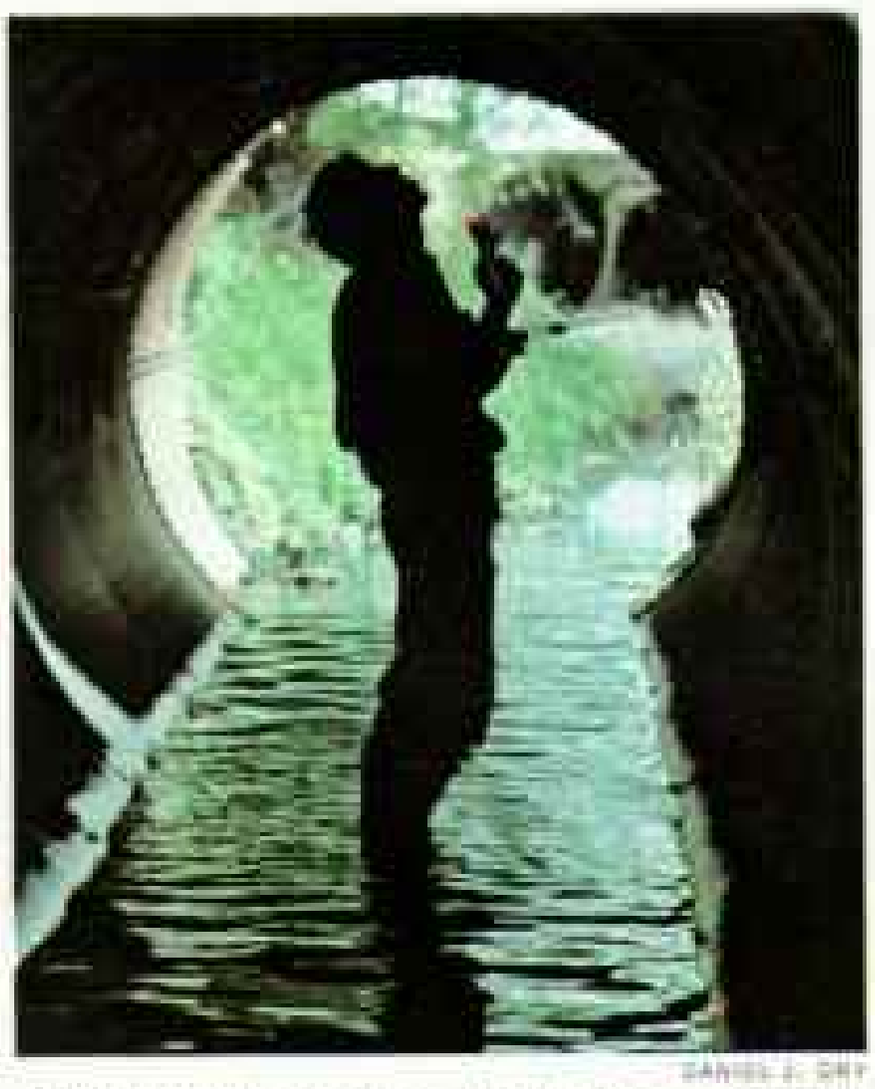
CULEX TARSALIS; ROBERT F. SIBSON

(Continued from page 429) effective mosquito control, better medical treatment, and an improved standard of living.

Unfortunately, malaria remained rampant in other parts of the world. The global incidence of malaria during the 1940's and early '50's was estimated at 300 million cases annually, with at least three million deaths (one death every ten seconds).

The World Health Organization mounted an international malaria-eradication campaign beginning in 1956. The walls of millions of houses were sprayed with DDT. Over several years the program proved highly successful. Some countries virtually wiped out malaria. It has now been reduced to an estimated 120 million cases annually—a hundred million of them in Africa—and a million deaths.

But the mosquito is not capitulating. Southern Asia and parts of Central and South America have experienced a resurgence of malaria. Partly this results from lack of funds and shortages in insecticides and antimalarial drugs. Mostly it reflects the incredible adaptability of the mosquito.



CARL E. ORY

***A flashlight** spots encephalitis carriers during a 1975 outbreak in Chicago.*

"More than 83,000 malaria cases were reported in El Salvador in 1976," Thomas D. Mulhern, former executive director of the American Mosquito Control Association, told me. "High resistance to house sprays has developed in *Anopheles albimanus*, the primary vector.

"Interestingly, though," he added, "the greatest resistance in El Salvador resulted from a combination of household spraying and continual exposure of *A. albimanus* to DDT and other chemicals used in controlling agricultural insect pests."

Worldwide malaria eradication may be impossible. More realistic is malaria control around the globe—where every available weapon will be needed simply to maintain gains already made.

Next to malaria, yellow fever has been mankind's most feared mosquito-borne disease. Both the disease and its principal vector, *Aedes aegypti*, probably came to the New World in vessels trading between Africa and South America during the 17th and 18th centuries. Once established, yellow fever raised havoc throughout the Americas. Urban mortality rates of victims sometimes reached 50 percent. In 1793 a great epidemic in Philadelphia resulted in the death of 10 percent of the population. Between 1793 and 1900 at least half a million cases were recorded in the United States.

The trouble was that no one knew what caused the disease. Rigid quarantines, disinfection of freight and mail were of no avail. In 1900 a U. S. Army commission headed by Maj. Walter Reed investigated an outbreak of yellow fever among American troops in Cuba. *Aedes aegypti* was established as the vector of yellow fever—confirming the theory of a Cuban physician, Dr. Carlos Finlay, who in 1881 had proposed a mosquito vector for the disease and had even implicated *Aedes aegypti*.

French efforts from 1881 to 1889 to build the Panama Canal had been stalled repeatedly by the terrible ravages of malaria and yellow fever. Only when mosquito-control programs, directed by Dr. William Gorgas, freed the isthmus from these two diseases was the United States able to complete the vital waterway between the Atlantic and Pacific. Today, although yellow fever still is a major threat in parts of Africa, the disease has been practically eradicated in urban areas of the New World.

Another mosquito-borne tropical disease, infecting an estimated 250 million humans, is filariasis, which is caused by a parasitic nematode worm. A mosquito acquires the worms with a meal of blood, then transmits them to a human at the site of a bite. The swarming parasites can block the victim's lymphatic trunks. The result may be a

CHARLES HERRON, U. S. DEPARTMENT OF AGRICULTURE

A dying colt lies in a Texas field, *victim of a severe outbreak of Venezuelan equine encephalomyelitis. Identified in South America in 1938, the mosquito-borne virus reached the United States in 1971, causing an epidemic that claimed 1,500 animals. In Mexico, where farmers depend heavily on horses, the toll was much higher.*

grotesque swelling of the limbs or other parts of the body called elephantiasis.

At least 19 filarial worm parasites affect humans and other animals. Most are mosquito borne. One of these, dog heartworm, is a major problem in the United States. Medication may be effective, but in severe cases heart surgery can be the only recourse.

Dengue fever, a mosquito-borne virus disease common in the tropics and warm temperate regions, produces intense pain in muscles and joints. Dengue is one of the most prevalent mosquito-borne diseases. Recent epidemics in Puerto Rico raised concern that the disease may become re-established in the southern United States, where the vector *Aedes aegypti* is common.

All the human diseases I've mentioned have now been virtually wiped out in temperate North America. But a serious threat for the United States still exists in the group of mosquito-borne virus illnesses known as the encephalitides. Each year they strike humans and horses with illness and death. In 1975 more than 2,000 people contracted the diseases, and 150 died.

Control Requires Global War

Because mosquitoes abound wherever humans live, mosquito control has become a necessity. Scores of countries around the world support mosquito-control programs; more than five hundred agencies function in the United States and Canada alone.

I recently served as president of the American Mosquito Control Association, which provides professional assistance to mosquito-control agencies worldwide. The association has 2,500 members in 91 countries. Our integrated approach focuses on elimination of environmental conditions favorable to the insect and the use of chemicals and natural biological controls.

Pesticides remain the number one weapon. Chemical sprays regularly decimate mosquito populations, but the surviving insects sometimes develop resistance. Pesticides do offer a potential threat to the environment. They may accumulate in food chains and present a hazard to man and animals. Resistance of mosquitoes and other insects to chemicals, as well as environmental pollution, forces a continuing search for safer and more effective pesticides.

J. T. BARBER, C. B. FASE III, AND L. F. YATSU

Potent new weapons *may stock future control arsenals, since many mosquitoes have stiffened their resistance to once effective pesticides.*

Seeds of the mustard family become sticky in water and can be used to trap

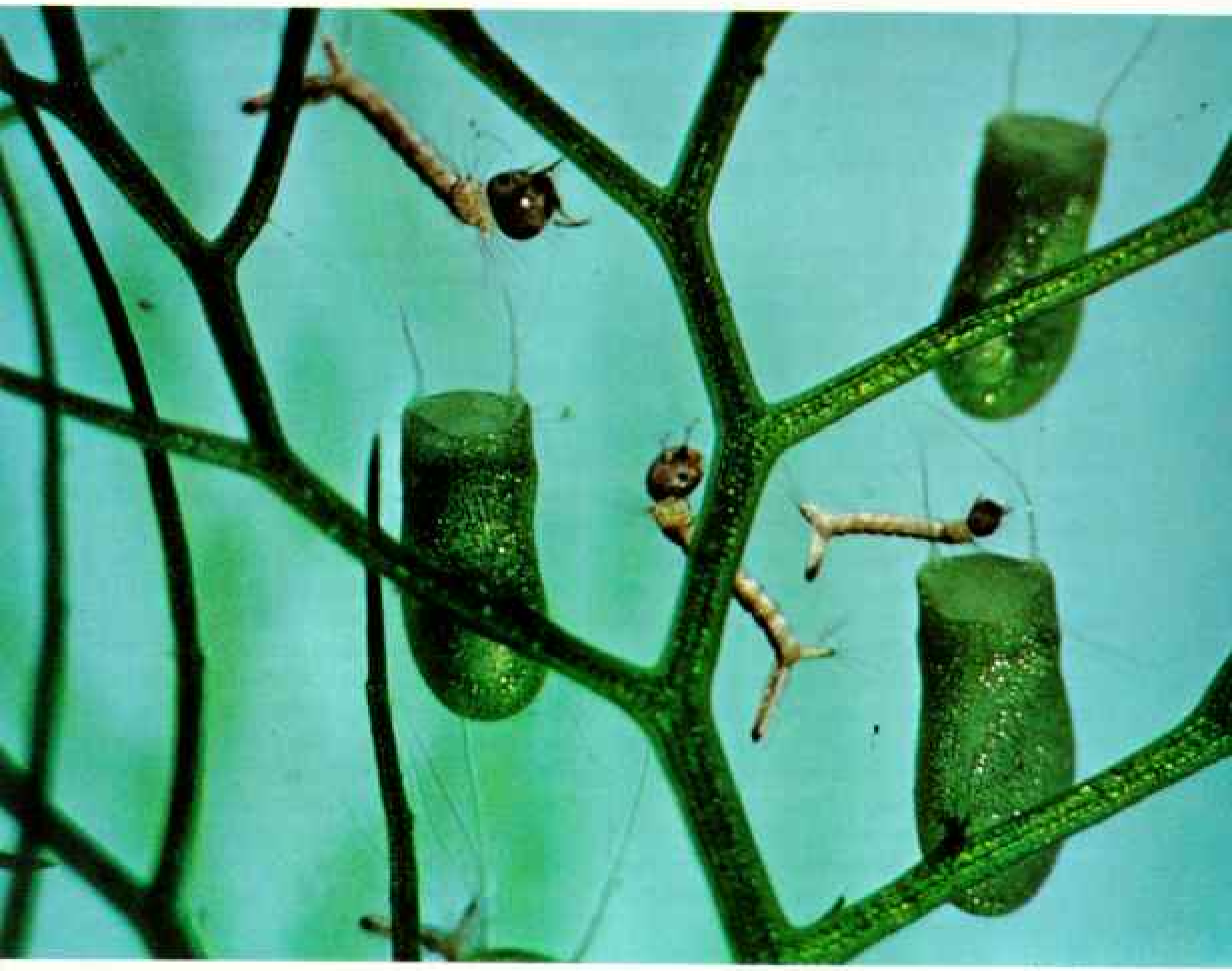
JOHN STEDMAN

TREAT DAVIDSON

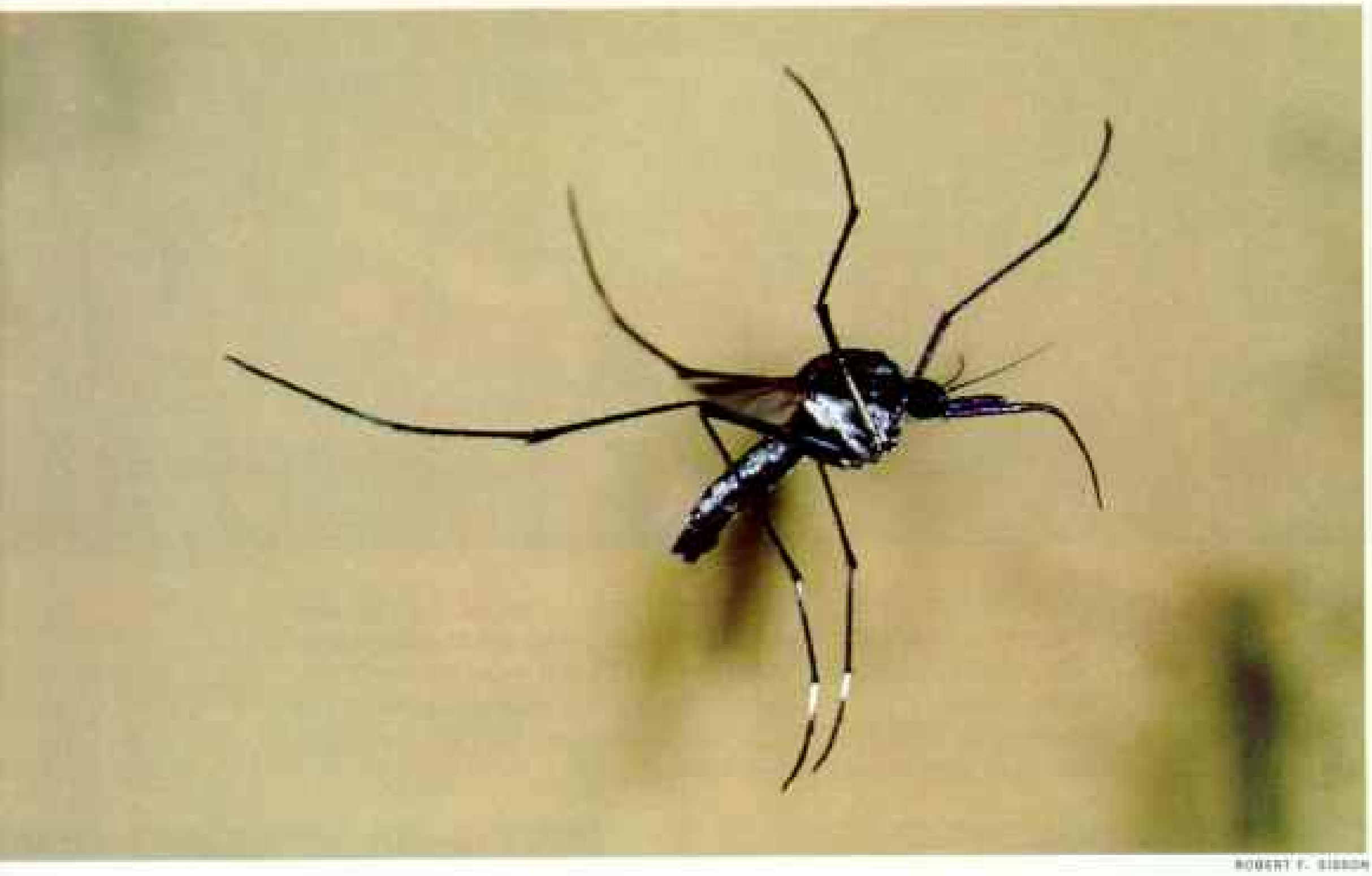
*larvae (**above, left**), which then starve or drown. The minnow* Gambusia *(**above**), preying heavily on larvae, already checks populations throughout the world.*

The parasite Romanomermis nielseni, *named after the author (see text, next page), coils inside larvae as it grows (**below, left**). When it emerges, the larvae die.*

Carnivorous bladderwort plants (Utricularia vulgaris) *consume mosquito larvae in the cuplike pockets that grow on their stems (**below**).*



ERNEST C. BAY



ROBERT F. SISSON

Mercenary in the mosquito war, *a giant African species is a strange ally of mosquito fighters. As larvae, these* Toxorhynchites brevipalpis *turn on the larvae of other species, devouring hundreds. Benign as adults, they feed on nectar and plant juices, taking no blood and spreading no disease.*

Those currently approved by the Environmental Protection Agency can be applied in minute amounts. Because they break down chemically soon after application, they have minimal effect on other organisms. Among promising new products are the growth regulators, chemicals that mimic natural growth hormones but prevent the mosquito from surviving to adulthood.

Experiments go on to exploit the attraction of the male mosquito to the female's vibrating wingbeat—the sound all campers dread and that author D. H. Lawrence called a "small, high, hateful bugle in my ear." A tuning fork, with the proper vibration, attracts male mosquitoes, and taped mosquito humming has been used to attract males to electrocution on wire screens.

The panacea would be natural biological controls. Current research chiefly involves predators and parasites. Attempts are even being made to change mosquitoes' heredity to make them less viable, if not sterile.

A few years ago, as I was collecting mosquito larvae near Lonetree, Wyoming, I stopped at a small willow-lined pool teeming with the wrigglers. But dozens of dead larvae lay floating at the surface, grotesquely bent and twisted. Others, still alive, were swollen and moved with great difficulty.

Examining a larva with my lens, I saw a tiny white worm coiled inside the insect's thorax (page 438). Watching another wriggler, I saw the worm within it penetrate the larval skin and escape, leaving behind a doomed victim, little more than a shell of its former self. There were no recoveries.

This parasitic roundworm proved to be new to science, and it is now being tested as a promising nemesis of the mosquito. We hope that the tiny creature will someday be available in numbers to justify scattering in ponds to feast on mosquito larvae.

Incidentally, the new roundworm was named *Romanomermis nielseni* in recognition of my discovery of it. No one could have been more pleased than I to have a worm named after him. □

NATIONAL GEOGRAPHIC SOCIETY

WASHINGTON, D.C.

Organized "for the increase and diffusion of geographic knowledge"

GILBERT HOVEY GROSVENOR
Editor, 1899-1954; President, 1920-1954
Chairman of the Board, 1954-1966

THE NATIONAL GEOGRAPHIC SOCIETY is chartered in Washington, D.C., in accordance with the laws of the United States, as a nonprofit scientific and educational organization. Since 1890 the Society has supported 1,716 explorations and research projects, adding immeasurably to man's knowledge of earth, sea, and sky. It diffuses this knowledge through its monthly journal, NATIONAL GEOGRAPHIC; its books, globes, atlases, filmstrips, and educational films; *National Geographic WORLD*, a magazine for children age 8 and older; information services; technical reports; exhibits in Explorers Hall; and television.

ROBERT E. DOYLE, President
GILBERT M. GROSVENOR, Vice President
OWEN R. ANDERSON, Vice President and Secretary
HILLEARY F. HOSKINSON, Vice President and Treasurer
WILLIAM T. BELL, FRANK S. DELK,
LEONARD J. GRANT, RAYMOND T. McELLIGOTT, JR.,
C. VERNON SANDERS, EDWIN W. SNIDER
Associate Secretaries

MELVIN M. PAYNE *Chairman of the Board*
ROBERT E. DOYLE *President of the Society*
MELVILLE BELL GROSVENOR *Editor Emeritus*

NATIONAL GEOGRAPHIC MAGAZINE

GILBERT M. GROSVENOR *Editor*

W. E. GARRETT *Associate Editor, Illustrations*
JOSEPH JUDGE *Associate Editor, Text*

SENIOR ASSISTANT EDITORS

James Cerruti, *Contract Writers*; Richard J. Darley, *Cartography*; Robert E. Gilka, *Photography*; William Graves, *Expeditions*; Edward J. Linehan, *Manuscripts*; Samuel W. Matthews, *Production*; O. Louis Mazzatenta, *Layout*; Howard E. Paine, *Art*; Carolyn Bennett Patterson, *Legends*; Thomas R. Smith, *Illustrations*; Kenneth F. Weaver, *Science*; Ann K. Wendt, *Research*; Herbert S. Wilburn, Jr., *Control Center*

TEXT

ASSISTANT EDITORS: Rowe Findley, Allan C. Fisher, Jr., Robert P. Jordan, Bart McDowell, Elizabeth A. Moize, Merle Severy

SENIOR WRITERS: Thomas J. Abercrombie, David S. Boyer, William S. Ellis, Howard La Fay, John J. Putman, Volkmar Wentzel, Peter T. White

SENIOR EDITORIAL STAFF: Harvey Arden, Kent Britt, Thomas Y. Canby, Mike Edwards, Boyd Gibbons, Rick Gore, Noel Grove, Alice J. Hall, Bryan Hodgson, Michael E. Long, Ethel A. Starbird, Gordon Young

EDITORIAL STAFF: Robert Booth, Thomas J. Colin, John L. Eliot, David Jeffery, John L. McIntosh, George E. Stuart, Priit J. Vesilind

RESEARCH: Frances H. Parker (Associate Chief); Carolyn H. Anderson, Susan L. Anderson, Judith Brown, Susan P. Byrnes, Susan Day Fuller, Ann B. Henry, Jan Holderness, Patricia B. Kellogg, Kathy B. Maher, Jean B. McConville, Jeanne E. Peters, Lesley B. Rogers, Frances W. Shaffer; *Style:* Michaeline A. Sweeney. *Geographic Information:* Betty Joan Goss. *Legends:* Abigail A. Tipton

ILLUSTRATIONS

PHOTOGRAPHERS: Dean Conger, Joseph J. Scherschel (Assistant Directors); James L. Amos, James P. Blair, Victor R. Boswell, Jr., Jodi Cobb, Bruce Dale, Gordon W. Gahan, David Alan Harvey, Otis Imboden, Emory Kristof, Bianca Lavies, Bates Littlehales, Robert W. Madden, George F. Mobley, Robert S. Oakes, Steve Raymer, Robert F. Sisson (*Natural Sciences*); James L. Stanfield. *Administration:* John E. Fletcher, Susan A. Smith

ILLUSTRATIONS EDITORS: W. Allan Royce (Assistant Chief); David L. Arnold, Taylor Gregg, Declan Haun, H. Edward Kim (*Layout*), Bruce A. McElfresh, Charlene Murphy, Robert S. Patton, Elie S. Rogers, Jon Schneeberger, Mary Griswold Smith (*Research Projects*)

ART: William N. Palmstrom (Chief); Walter Q. Crowe, John D. Garst, Jr. (Assistant Chiefs). *Artists:* Lisa Biganzoli, William H. Bond, John W. Lothers, Robert C. Magis, Jaime Quintero, Ned M. Seidler. *Cartographic Artist:* Snezinka Stefanoff. *Map Editor:* John T. Blozis. *Research:* Virginia L. Baza, Harold A. Harmon, Dorothy A. Nicholson. *Production:* Isaac Ortiz (Supervisor); Iskandar Baday, Elie Sabban, Alfred L. Zebarth, Leo B. Zebarth

DESIGN: Charles C. Uhl, Robert E. Pullman, Betty A. Clayman

ENGRAVING AND PRINTING: Dee J. Andella (Director); William W. Smith (Assistant Director); Bill M. Aldridge, John T. Dunn, John R. Metcalfe, James R. Whitney

CARTOGRAPHY

John F. Shupe (Associate Chief); Ted Dachtera, Richard K. Rogers (Assistant Chiefs); John F. Dorr (Art Director); Margery K. Barkdull, Charles F. Case, Henri A. Delanghe, Russel G. Fritz, Charles W. Gotthardt, Jr., Thomas L. Gray, Catherine M. Hart, Donald A. Jaeger, Harry D. Kauhane, Mary C. Latham, Mary Anne McAleer, Charles L. Miller, Roland R. Nichols, Robert W. Northrop, Charles L. Stern, Douglas A. Strobel, Ellor G. Toth, Thomas A. Wall, Thomas A. Walsh

EDITORIAL SERVICES

ADMINISTRATION: Joyce W. Graves (Assistant to the Editor), Elaine R. Chisman, Lilian Davidson, Virginia H. Finnegan, Mary F. Klumpp, Lucille L. McInerney, Shirley Neff, Barbara A. Shattuck, M. Jean Vile, Barbara L. Wyckoff. *Correspondence:* Carolyn F. Clewell, Clifford R. DuBois. *Indexes:* Jolene M. Blozis. *Travel:* Virginia A. Bachan

PHOTOGRAPHIC LABORATORIES AND TYPESETTING: Carl M. Shrader (Chief); Milton A. Ford (Associate Chief); Lawrence F. Ludwig (Assistant Chief); Herbert Altemus, Jr., David H. Chisman, Ellwood M. Kehler, Jr., Geoffrey T. McConnell, William S. Petrim, Claude E. Petrone, Joan S. Simms (Assistant)

LIBRARIES: *Publications:* Virginia Carter Hills (Librarian); Patricia Murphy Smith, Carolyn Locke, Louise A. Robinson, Marta Strada. *Illustrations:* L. Fern Dame, Carolyn J. Harrison. *Records:* Lorie Northrop, Mary Anne McMillen. *Films:* Betty G. Katcher

RELATED EDUCATIONAL SERVICES OF THE SOCIETY

SENIOR ASSISTANT EDITORS

Robert L. Breeden, *Special Publications and School Services*
Charles O. Hyman, *Book Service*

BOOK SERVICE: Thomas B. Allen, Seymour L. Fishbein (Associate Chiefs); Ross Bennett, Constance Brown Boltz, Mary H. Dickinson, Robert C. Firestone, Anne Dirkes Kobor, J. Edward Lanouette, Carol Bittig Lotyk, David F. Robinson, Shirley Scott, Margaret Sedeen, Veria Lee Smith

SPECIAL PUBLICATIONS AND SCHOOL SERVICES: Donald J. Crump (Associate Chief); Philip B. Silcott (Assistant Chief); William L. Allen, Jody Bolt, Toni Eugene, Ron Fisher, William R. Gray, Sallie M. Greenwood, Mary Ann Harrell, Suzanne J. Jacobson, Geraldine Linder, Tee Loftin, Louisa V. Magaziner, Tom Melham, Robert Messer, Jennifer C. Urquhart, Ursula Perrin Vosseler, George V. White, Merrill Windsor. *National Geographic WORLD:* Ralph Gray (Editor); Ellen Joan Hurst, Margaret McKelway, Pat Robbins, Eleanor Shannahan, Veronica Smith. *Books for Young Explorers:* Cynthia Ramsay. *Filmstrips:* Jimmie Abercrombie, James B. Caffrey, Margery G. Dunn, Jacqueline Geschickter, Jane R. McCauley, H. Robert Morrison, George Peterson, Judith E. Rinard, Joan Ann Straker

NEWS SERVICE: Paul Sampson (Chief); Donald J. Frederick, William J. O'Neill, Robert C. Radcliffe. **TELEVISION AND EDUCATIONAL FILMS:** Dennis B. Kane (Chief); Marjorie M. Moomey (*Research*); Patricia F. Northrop (*Promotion*); Sidney Platt (*Educational Projects*); Yeorgos N. Lampathakis, Carl E. Ziebe. **LECTURES:** Joanne M. Hess (Chief); Ronald S. Altemus, Robert G. Fleegal, Mary W. McKinney, Gerald L. Wiley. **RECORDINGS:** John M. Lavery (Chief). **AUDIOVISUAL:** Jon H. Larimore

Free. The idea kit for growing companies caught in the travel cost squeeze.

There's no reason on earth to let the rising costs of business travel squeeze the growth out of your company.

Not when you can get the same kit that has already helped hundreds of companies put a lid on those costs.

It's the Beechcraft Business Flying Kit. And it's specifically designed to help you, step-by-step, take a realistic look at whether a company airplane can help solve your business travel problems.

Truth is, a company airplane may not be the answer for you. But with this kit in your hand, you'll know for sure. One way or the other.

And this year, the kit has been up-dated and expanded with new information that makes objectively evaluating a company airplane even easier.

Inside the kit, you'll also find answers to the most important questions you have about owning a company airplane. How do you determine the need for one? Will it be a good investment? What financing plans are available?

The kit even helps you determine the actual net capital cost to your company of owning a business airplane, like the Beechcraft Duke shown here.

Find out for yourself why the company airplane is the fastest growing mode of business travel today.

Send for your free Beechcraft Business Flying Kit now.

Write on your company letterhead to: Beech Aircraft Corporation, Dept. A, Wichita, Kansas 67201. Ask for our free Business Flying Kit, and please mention if you're a pilot. If you'd rather call, make it collect and ask for Dick Schowalter, Jr. 316-681-7072.

Member General Aviation Manufacturers Association

Beechcraft

The Beechcraft Duke. A 6-seat, cabin class, pressurized airplane that can speed you along in style and comfort at over 270 mph.

How a phone call solved the mystery of the sandy teacups.

Based on an actual call made to the toll-free 24-hour Whirlpool Cool-Line® service.

(Telephone Rings)

Cool-Line Consultant: Whirlpool Cool-Line. May I help you?

Woman: I just bought a Whirlpool dishwasher and I keep finding sand in my teacups. Can you help me?

Consultant: That's why I'm here. Now, about the sand. Are the rest of your dishes clean?

Woman: They're fine. My husband's a Mexican food freak. Even pans with baked-on refried beans get clean. But where did the sand come from?

Consultant: What does the sand look like?

Woman: Like . . . sand. In a puddle of water that didn't drain out of the teacup.

Consultant: If you're seeing "sand," it could be your dishwasher detergent hasn't dissolved. Do you have a cup with some "sand" in it now?

Woman: Right here by the phone.

Consultant: Does the "sand" look like detergent?

Woman: You mean this is detergent?!?

Consultant: Look closer.

Woman: It does look like detergent. So why didn't it dissolve?

Consultant: Check your water temperature. At your dishwasher. It should be at least 140°. If it's okay, then I suggest you buy a fresh box of detergent. Dishwasher detergent sometimes has a very short shelf life and doesn't dissolve completely when it's old. And make sure you load your teacups properly, so all the water drains out.

Woman: Wow. You really helped. Sorry I bothered you, but at least I didn't have to call a repairman. Thanks for your time.

Consultant: Glad I could help.

This is the kind of two-way communication we've been having with our Whirlpool Cool-Line service for the past eleven years. It's just one example of the continuing concern we have for customers who purchase quality Whirlpool appliances.

If you ever have a question or problem with your Whirlpool appliance, call our toll-free 24-hour Cool-Line service at 800-253-1301. In Alaska and Hawaii, dial 800-253-1121. In Michigan, call 800-632-2243. If our Cool-Line service can't help, we have Whirlpool franchised Tech-Care® service representatives all over the country who can.

Whirlpool
Home Appliances
Quality. Our way of life.

BOTH © C. C. LOCKWOOD

The Atchafalaya: a swamp imperiled

HALF A MILLION acres of southern Louisiana teem with fish and wildlife in the continent's largest river-basin swamp, the Atchafalaya. But this rich pool of living resources threatens to dry up, choked by sediment from the Mississippi and Red Rivers and stretched thin by the demands of lumbermen, oilmen, sportsmen, commercial fishermen, farmers, and flood-control planners.

Longtime area resident C. C. Lockwood uses a hollow cypress stump (**above**) as a natural blind for such rewarding photographs as a great egret's delicate plumage (**above left**). His work spotlights this issue's report on the troubled Atchafalaya and the people whose lives are entwined with its bayous. Share such insights on today's world by nominating a friend for Society membership below.

Color Naturals.® Quality and style in one luxury paint. Our finest wall paint ever.

Color Naturals brings deep, rich texture and soft, new natural colors together in one luxury paint.

You notice the difference the moment you start to apply Color Naturals ... its consistency as it eases onto the wall. The evenness with which it covers. In one coat.

And you'll enjoy the lovely finish for years.

Color Naturals was formulated to give you, at last, the five things people want in interior wall paint. One coat coverage. Washability, again and again. A low spatter paint. One that's durable. And a wall paint that's warranted. Color Naturals is, for eight years.*

Color Naturals costs a little more than other wall paint. But, Color Naturals gives you the opportunity to be outrageously good to your walls.

Glidden

GLIDDEN COATINGS & RESINS
DIVISION SCM CORPORATION
CLEVELAND, OHIO 44115

*Full details available at your Glidden dealer.

After 75 years, EF Hutton & Company still has one name.

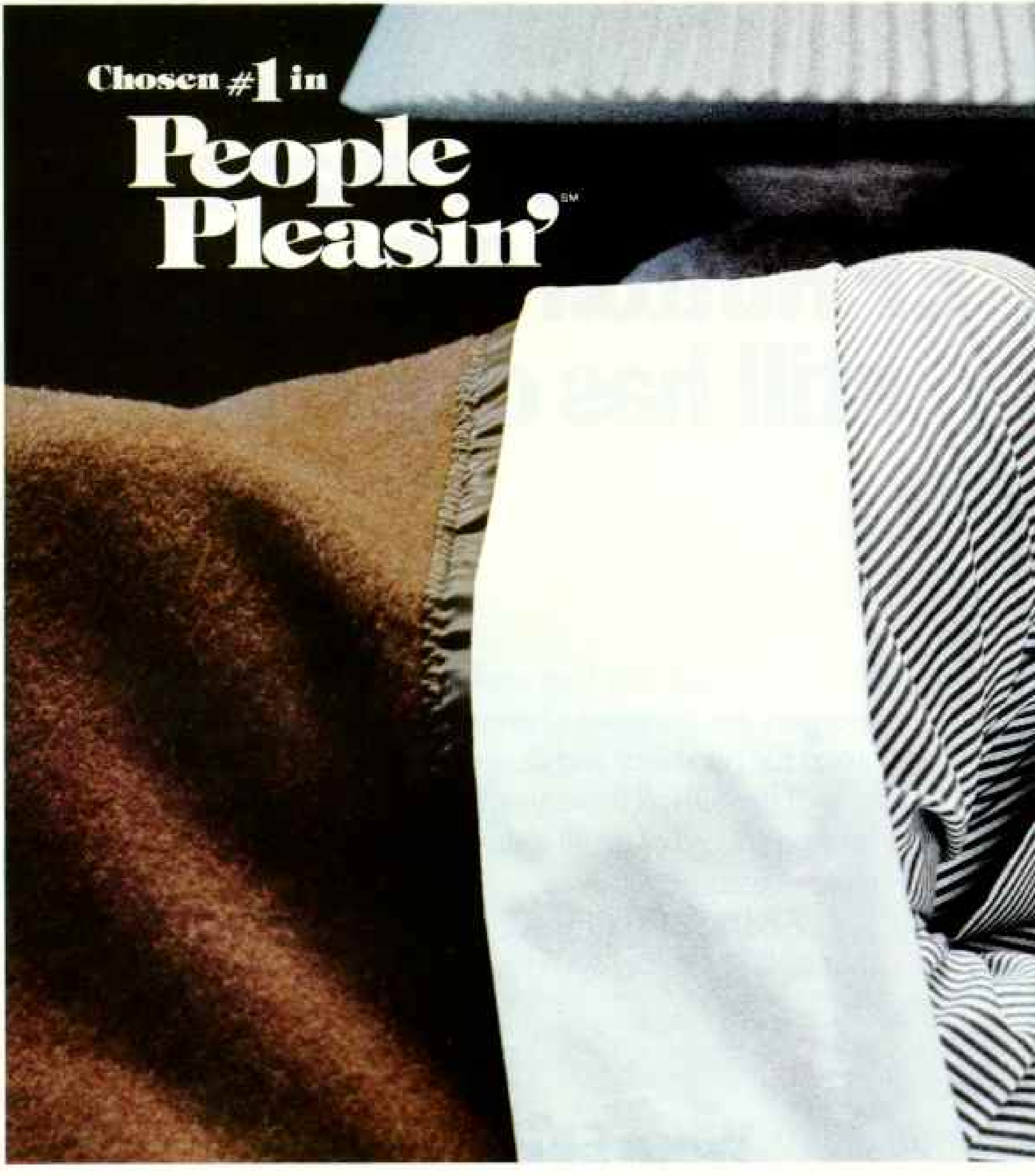
In an industry that undergoes ups and downs, mergers and constant change, E.F. Hutton has always stood for reliability and dependability.

Through all those years, we've maintained an unbroken record of profitability and of continuous service to our customers.

And now, at our three-quarter century mark, that stability seems even more impressive.

When EF Hutton talks, people listen.

Member of SIPC



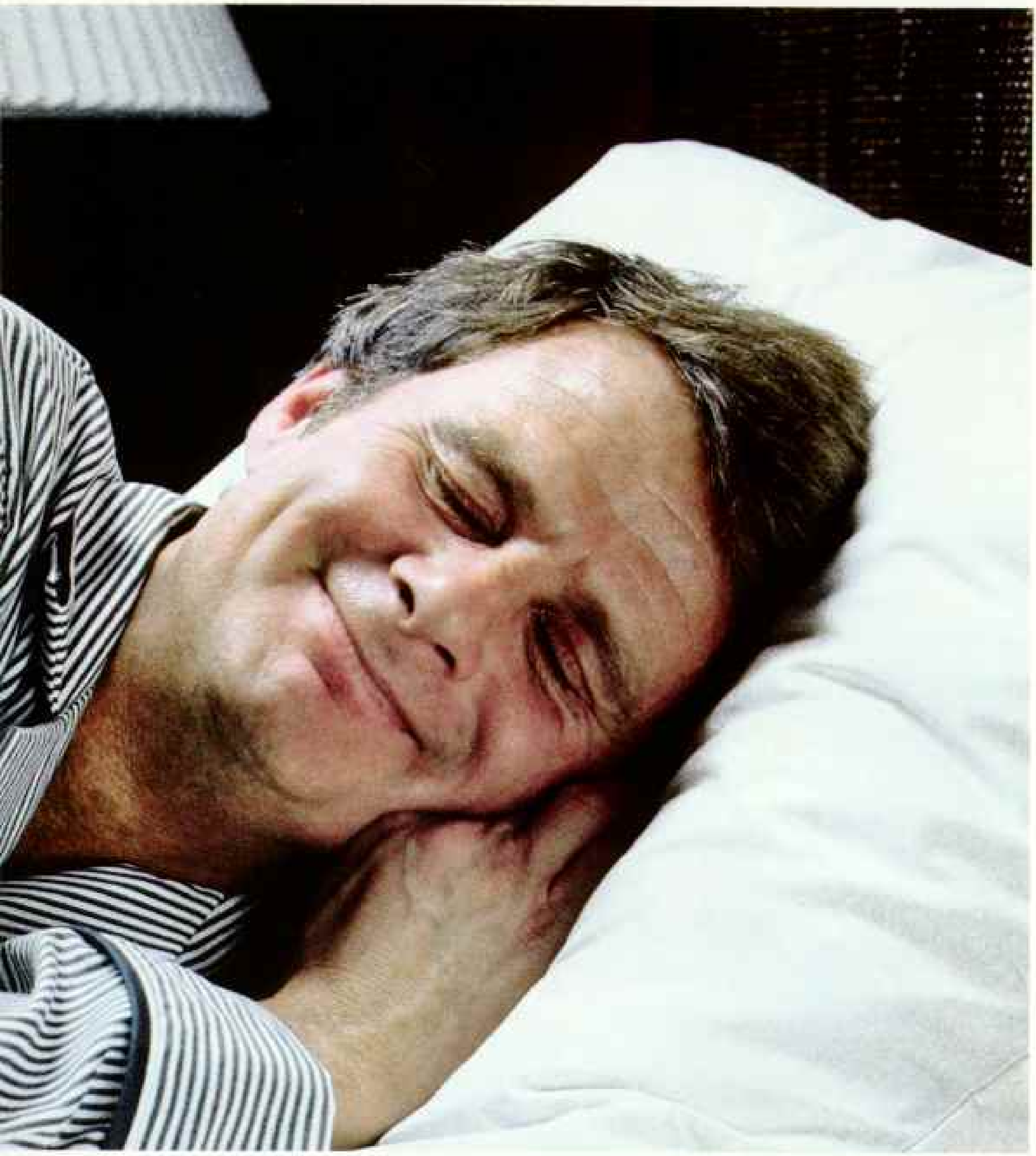
At Holiday Inn, we really

We want you to feel welcome, and comfortable. That's why we're pleased that more people make Holiday Inn® hotels their #1 choice.

Our philosophy is simple. To give you the most important things you want when you travel: the best locations, the best standards and the special attention a businessman needs.

#1 People Pleasin' Standards:℠

Everything in our hotels must measure up to our "no surprise"℠ standards. From things you will notice, like every mattress in every room must be comfortable—specified "Manufacturer's Top of the Line." Right down to things you might not notice, like cleaning your carpet every day.



want to make you comfortable.

#1 People Pleasin' Locations:℠

Only Holiday Inn gives you the widest choice of the most popular locations, wherever you travel. You can choose among a variety of locations in and around town. Or take your choice of locations throughout the suburbs or all along the highways.

At Holiday Inn you can be right where you want to be.

These are some of the reasons why Holiday Inn pleases more travelers than anybody else. And why we know we can be #1 in pleasing you.

Holiday Inn®
We Welcome You To The Best People Pleasin' Hotels In The World.℠

On her birthday,
I always serve her breakfast in bed.

A diamond is forever.

The pin shown (enlarged for detail) is available for about $3500. The price may change substantially due to differences in diamond quality and market conditions. Your jeweler can show you other diamond jewelry starting at about $300. DeBeers.

Do you make these 10 common typewriter mistakes?

Patented Correction Cartridge

Most people make their fair share of typing mistakes. But the biggest mistake you can make is buying the wrong typewriter in the first place. There are ten things you should check out. They can help you avoid making these ten typewriter mistakes.

Check out the correction system. There are several typewriter correction systems, but they don't all work equally well.

This Smith-Corona® electric portable has a unique cartridge ribbon and correction system that lets you change ribbons in seconds without touching the ribbon. It also lets you correct typing errors quickly, neatly and easily.

Test the feel. Are the slope and height of the keyboard comfortable? The size and shape of the keys?

While you're about it, compare the feel of a Smith-Corona electric typewriter against others—we welcome head-on comparison.

Try the touch. A responsive touch makes for easier typing. You want a touch that is prompt, easy and dependable. For instance, note how smoothly the Smith-Corona performs functions such as carriage return and back-space.

Listen to the sound. Believe it or not, a typewriter has a sound of its own. If it sounds tinny, beware. It may indicate that the typewriter's construction is too light.

Note the look of the type. Lines and individual letters should be straight. The impression should be crisp, clean and even. The print quality should not vary over the page.

Consider the overall design. You want a typewriter that looks contemporary but not eccentric. Smith-Corona, for instance, is an example of classic good design you'll live happily with for years.

Look at the carrying case. Does it have double walls for air-cushioned protection? Sturdy latches and hinges? The case for this typewriter does.

Compare prices. A typewriter that sells for a lot less than others might be a lot less typewriter. Where price difference is minimal, you probably should go for the one that tests best.

Ask who makes it. Smith-Corona makes every typewriter that bears its name—which is not true of most other brands.

So consider the maker's reputation. A company with a solid reputation will still be around tomorrow and in the future to give your typewriter necessary service and maintenance.

Try the Smith-Corona carbon film ribbon. We offer a re-usable nylon fabric ribbon, good for ordinary typing jobs. This is the only kind most portables offer. But we also offer carbon film ribbon in five colors. It's the same kind of ribbon that the most expensive office typewriters use, and it's perfect for jobs requiring a crisp professional look such as term papers or a resume.

Once you've made these ten typewriter tests, we'll think you'll know why more people prefer Smith-Corona electric portable typewriters than all other brands combined.

SCM SMITH-CORONA
SCM CORPORATION

YOU CAN'T EXPECT A MERE CAR TO DO ALL THE THINGS A SCOUT® CAN.

Scout II. *Carries big loads into little spaces . . . a good combination for fishing trips.*

Scout SSII. *Built to enjoy heavy four-wheelin'.*

Snowdrifts, bumpy roads, big loads—those are just some of the times that anything less than an International® Scout® just won't do.

Outfitted to out-perform ordinary cars. Scout *does* more because it *has* more. Like 4-wheel drive for muddy back trails and snow-packed neighborhood streets. And the same extra-strong engine we use in our 2½-ton trucks—so pulling a boat or trailer is no problem.

Guts from the ground up. Scout is designed especially as a sports/utility vehicle. The all-welded steel box frame resists distortion better than riveted frames. Heavy-duty axles permit Scout to carry heavier loads than any station wagon. And even with that big inside cargo space, Scout's outside dimensions permit easy maneuvering in tough spots.

A solid selection. Choose from four different Scouts. The basic, versatile Scout® II. The Scout Traveler,® with extra space and towing power. The sporty Scout® SSII. Or Scout Terra®—our hard-drivin', do-it-all pick-up.

So don't send a car to do a Scout's job. Visit your International Harvester Scout Dealer and test drive a Scout soon. Because anything less is just a car.

SCOUT.®
Anything less is just a car.

INTERNATIONAL HARVESTER

THE BEST VACATIONS TO WALT DISNEY WORLD START WITH THE AIRLINE THAT KNOWS IT BEST.

Eastern is the official airline of the Walt Disney World Vacation Kingdom. And because we're a member of the Walt Disney World family, it's like our second home. So it isn't surprising that we have more ways to give you the time of your life there than anyone else. At surprisingly low prices.

LOW FLORIDA FARES.

Our Super Saver II fares save adults 30%-50%* off regular daycoach fares. And one child 17 or under can fly round-trip with a grownup for only $49!

MORE VACATION CHOICES THAN ANYONE ELSE.

We have Walt Disney World vacations for families. Honeymooners. Golfers. Tennis players. We even have vacations that take in other parts of Florida, or the Bahamas.

Prices range from $116 to $227** plus airfare for a family of four, for 4 days and 3 nights at a selected hotel, including Eastern's exclusive Walt Disney World Ticket Books, each good for one day's admission as well as 9 fabulous attractions.

MORE FLIGHTS THAN ANYONE ELSE.

Besides having the most vacations at the best possible prices, we also have more flights, from more cities, to Orlando than anyone else. In fact, last year alone, we flew over one million people there. And it's that kind of experience that can virtually assure you of the accommodations you want.

If you've been thinking about a Walt Disney World vacation, call your travel agent. Or us. A vacation to a fantasy world isn't something you do every day. So it makes sense to talk to the people with the most experience.

EASTERN. THE OFFICIAL AIRLINE OF WALT DISNEY WORLD.

EASTERN

WE HAVE TO EARN OUR WINGS EVERY DAY™

*Super Saver fares have advance reservation and ticket purchase requirements, minimum and maximum length of stay restrictions, limited seats are not available on every flight or over certain holiday periods. 30% saving applies to Night Coach service where available. **Prices do not include airfare, meals, transfers or local taxes, and are subject to change. Prices and hotel space are subject to availability and apply to family with 2 children under 17 all sharing a room. Valid until 12/15/79.

This view made practical with energy efficient PPG glass.

What could be more pleasant than a room like this? Open to the beauty of an inviting outdoor setting. Comfortably lighted by the daytime sun. Bright. Cheerful.

Most of all, it's practical. It helps this home conserve energy.

This glass wall exemplifies the success of a new concept in energy conservation called window management. It means that windows and glass, properly placed and designed, can use the sun's heat and light to improve the energy efficiency of your home.

PPG makes glass that can take full advantage of this idea in any climate.

In cold northern climates, for instance, PPG *Twindow*® *Xi*® welded-edge glass uses dry insulating gas between two sealed panes to reduce heat loss through a window by more than 40 percent, compared to single-pane clear glass.

And in the south, PPG *Solarcool*® Bronze glass reflects almost 50 percent more heat than clear glass. And that may help to reduce air-conditioning needs.

Both kinds of performance may add up to significant fuel savings.

PPG also makes tinted glasses which control the brightness and heat gain of a strong sun. They can be used in single, double or triple glazed construction designed to suit the needs of any home, north or south.

Work with your architect or contractor in making quality glass and the sun work together. For you.

There's much more to learn about window management. Find out how you can save energy with glass. Send for the free book, "Home Styles for the Eighties."

John D. Bloodgood, architect.

PPG Industries, Inc., Dept. NG-399,
One Gateway Center, Pittsburgh,
Pa. 15222.

PPG: a Concern for the Future

PPG
INDUSTRIES

The best way to tame a wildfire is with chemicals.

Di-hydrogen oxide, one of the world's most common chemicals, isn't enough. Because di-hydrogen oxide (water) evaporates too quickly.

Yet combine it with di-ammonium phosphate and you have a chemical called Phos-Chek® fire-retardant. Made by Monsanto, Phos-Chek fights fire by absorbing heat and depriving fire of its fuel. A plane can drop 3,000 gallons on a fire, reload and be back in action within 20 minutes.

The chemical's bright red color lets ground crews and pilots quickly locate areas that have been treated. And, when the fire's over, Phos-Chek helps fertilize the ground to promote new plant growth.

No chemical is totally safe, all the time, everywhere. But if we want to protect ourselves from the rampages of nature (such as fire, famine and disease) we'll have to use chemicals. And use them properly.

For a free booklet explaining the risks and benefits of chemicals, mail to: Monsanto, 800 N. Lindbergh Blvd., St. Louis, Mo. 63166. Dept. A–3NA–NG4

Name _____

Address _____

City & state _____ Zip _____

Monsanto

Without chemicals, life itself would be impossible.

Announcing a remarkable series of
twelve collector's plates by the Orient's outstanding artist in the classic Rimpa style
. . . her first works of art in porcelain

Birds and Flowers of the Orient

BY NAOKA NOBATA

The Peacock and the Peony

Each plate bears an original work of art
created by Naoka Nobata exclusively for this limited edition.

Exclusive Signature Edition.
Available by subscription only.
Advance deadline: September 30, 1979.

THE ARTIST. Naoka Nobata is one of the most brilliant and imaginative of today's painters in the traditional Oriental style. She is celebrated throughout her native land both for her exceptional talent and the sensitivity of her technique. Indeed, Mme. Nobata is today's foremost exponent of the classic "Rimpa" tradition of Oriental art—which marvelously intertwines the real and the imaginary.

The works of Naoka Nobata have been shown at important art exhibitions throughout Japan, including the first Sogakai Exhibition, and she has been honored with a one-woman show at the distinguished Shirota Gallery. In addition, her paintings have been exhibited in the Tokyo Central Art Gallery and the Miyuki Gallery, and her work has been acquired by many prominent collectors including the leading art critic Tetsuji Takechi for his own private collection.

And now, at the pinnacle of her career, Naoka Nobata has created her very *first* works of art in porcelain: *Birds and Flowers of the Orient.* A series of twelve collector's plates portraying exquisite flowers of Oriental lore and legend—and the exotic birds associated with them.

Each of the plates is a distinctive work of art in itself. Together, they form a breathtaking collection that will enhance the beauty of any home. Rich in the symbolism of the Orient... imbued with its meaning... touched with its mystery... this is a collection that will provide endless hours of joy and inspiration.

BIRDS AND FLOWERS OF THE ORIENT PLATES. Each plate represents a different month of the Oriental year, and combines the flower and bird symbolizing that month. Deep green pine branches and the stately white crane for January... the Japanese iris and the Mandarin duck for May... the languid water lily and the exotic egret for August... the brilliantly colored chrysanthemum and the tree sparrow for October... the yellow narcissus and the graceful wren for December... Twelve flowers and birds of the Orient brought together in works of extraordinary beauty.

These collector plates will be exceptionally large—10-1/4 inches in diameter—to provide full scope for the artist's imaginative portrayals. And, as a finishing touch for Naoka Nobata's lovely designs, each plate will be *hand-decorated* with a border of *pure 24 karat gold.*

Moreover, each plate will be produced in the finest Japanese porcelain—highly prized for its translucence and strength. And the delicate, sensitive quality of the artist's work will be meticulously captured in every detail, every nuance, every line.

A wide variety of colors will be used in the creation of these designs. Brilliant reds and oranges contrasting with pale yellows, soft greens and cool aquas. Rich browns and ambers mingled with bright blues, subtle violets and magentas. All the lovely shades one might see in an Oriental garden. And to add to the uniqueness of the plates, elements of the design will form a charming floral border on the reverse.

LIMITED SIGNATURE EDITION. The first edition of the *Birds and Flowers of the Orient* plates will be a special limited Signature Edition. This edition will be distinctive because it is the *only* edition in which the artist's "hanko" (personal signature mark) will be *impressed by hand* on the reverse of each plate.

The plates in this desirable Signature Edition will be crafted in Japan exclusively for individual subscribers, and the limit of one collection per person will be strictly enforced. Thus, the total number of sets to be issued in this edition will be forever limited to the exact number of original subscriptions entered during a rather brief offering period, plus one set for the artist and one for the archives of Franklin Porcelain, which is issuing the collection.

Because the plates comprising the Signature Edition will not be available for sale through dealers or stores, subscribers will be the *only* people who will be able to acquire them. Any collector who wishes to obtain the plates in this edition later on can only hope to do so by purchasing them from an original subscriber.

ADVANCE DEADLINE FOR SUBSCRIPTIONS: September 30, 1979. The collection of twelve plates will be sent to subscribers at the rate of one every *other* month, and the issue price for each porcelain plate is just $55. Included will be fascinating reference information and twelve individual wall brackets for display of all the plates.

To enter your subscription for the Signature Edition of *Birds and Flowers of the Orient,* you must mail the application at right by September 30, 1979. A final announcement will be made in November, and then the subscription rolls for the Signature Edition will be closed forever.

It is not necessary to send any payment at this time. However, your Advance Subscription Application must be mailed to Franklin Porcelain, Franklin Center, Pennsylvania 19091 by September 30th.

Reverse of plate bears hand-impressed "hanko," or signature mark, of the artist.

Plate shown smaller than actual size of 10¼" diameter.

ADVANCE SUBSCRIPTION APPLICATION

Birds and Flowers of the Orient

BY NAOKA NOBATA

Must be postmarked by September 30, 1979.
Limit: One collection per person.

Franklin Porcelain
Franklin Center, Pennsylvania 19091

Please enter my subscription for the Signature Edition of the *Birds and Flowers of the Orient* porcelain plate collection, bearing original works of art by Naoka Nobata. I need send no payment now. The twelve plates are to be sent to me at the rate of one plate every *other* month. I will be billed for each plate in two monthly installments of $27.50,* each, with the first payment due in advance of shipment.

**Plus my state sales tax*

Signature _____
ALL APPLICATIONS ARE SUBJECT TO ACCEPTANCE

Mr.
Mrs.
Miss _____
PLEASE PRINT CLEARLY

Address _____

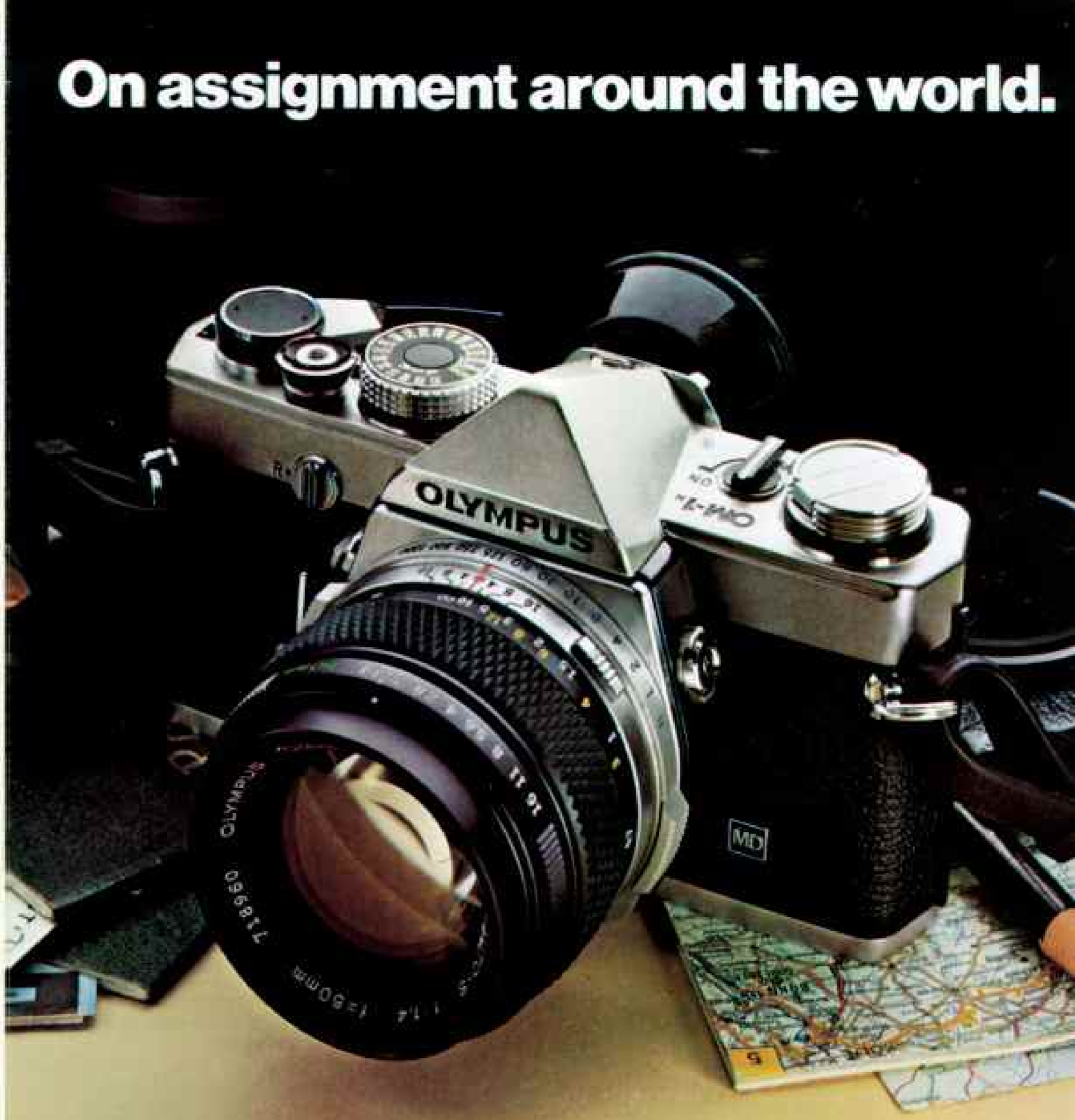
City _____

State, Zip _____

Orders from outside the U.S.A. will be billed for each plate in two equal monthly installments of $32.50, with the first payment due in advance of shipment.

Top: The Bush Warbler and the Apricot
Middle: The Egret and the Water Lily
Bottom: The Quail and the Seven Grasses

On assignment around the world.



The OM-1 doesn't get the cushy jobs. It's out earning its keep in places where they don't sell pretty picture postcards. Places with names like Tsingtao and Hamadan and Blantyre-Limbe.

You'll spot it in the heat of war, shooting as it gets shot at. This isn't dilletante equipment. This is professional gear.

No matter that there's a grab bag of SLRs to choose from. The true professionals refuse to budge from the rugged, resilient, hustling Olympus OM-1.

The OM-1 is tough, and they know it. Random samples from the OM-1 production line are brutalized with a 100,000 life cycle test, at temperatures from sub-zero to Sahara plus.

The OM-1 is compact. As the world's first compact SLR, the OM-1 set a standard that's still unmatched. It fits your hand like a glove. And as part of the largest compact SLR system, it puts over 300 accessories within reach.

The OM-1 is light. Don't think a camera that's built like a tank has to weigh a ton. And not only is the camera body light, but the lenses are light as well. Even the 300mm lens can be comfortably hand-held.

With all this going for it, it comes as no surprise to us that the OM-1 is being bought by more than professional photographers. Not only is it on assignment around the world, but in backyards, picnics and family vacations.

After all, people today are taking their 4-wheel drive cars to the supermarket, and wearing down parkas to the office.

Professional secrets don't stay professional forever.

For a detailed brochure, write to Olympus, Woodbury, New York 11797.

Olympus. You know our pictures. Now you know our name.

OLYMPUS OM-1

HEALTHY EATING AND NATURAL LIGHTNESS ARE WHAT MAZOLA® CORN OIL'S ALL ABOUT.

Mazola® is the only leading brand that's 100% pure corn oil and nothing else. It has no cholesterol, it's low in saturated fats, high in polyunsaturates. And no other leading brand of oil tastes lighter than Mazola.

When it comes to good healthy eating, golden-light Mazola is a natural.

THE ONLY LEADING OIL MADE FROM CORN.

epe

If you have ever taken a luxury sports car through a tight turn, you know the feeling. It's the sense of supreme precision with which this trim, compact camera proclaims its Nikon heritage. A feeling that is borne out by the professional quality pictures the Nikon FE delivers with automatic ease. And one that, unlike other fine things in life, is readily affordable.

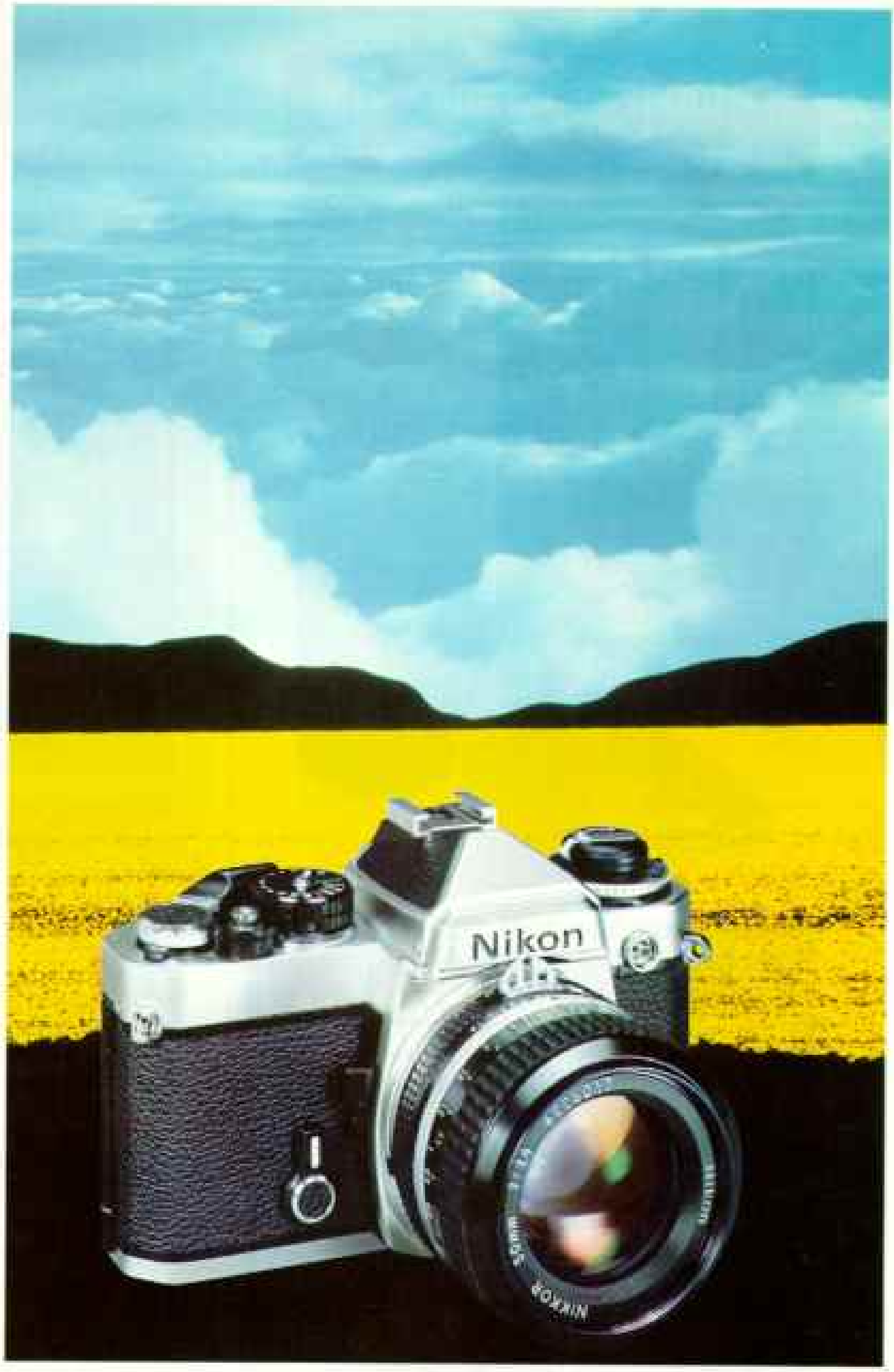
With the Nikon FE, you can simply focus and shoot... and rely on its Nikon electronics to give you sharp, magnificently exposed photographs, automatically. Or, switch to manual operation and enjoy complete creative control over every exposure, more easily than you ever thought possible.

Above all, this is a camera that makes no compromise in its supreme Nikon quality. Stroke the advance lever, and feel the smoothness of precision gearing machined to microscopic tolerances. Press the exposure button, and hear the shutter respond with hushed precision. Look through the bright, silver-coated viewfinder, and see your picture snap into sharp focus with a fingertip touch.

Know, too, that the world's greatest photographic system stands behind your Nikon FE. Add the dynamic firepower of motor drive, at up to 3.5 shots a second. Banish darkness with the ingenious automatic thyristor flash. Explore new perspectives through more than 60 Nikkor lenses, the same superb optics chosen by most professionals for their sharpness and color fidelity.

For the purist:
The Nikon FM
For those who prefer only manual exposure control, the Nikon FM offers the reliable guidance of one-step electronic metering. It's as compact and precisely responsive as the FE and costs even less. At your Nikon dealer.

Nikon Inc., Garden City, New York 11530
In Canada: Nikon Canada, Inc.



Experience a sense of perfection.

The Nikon FE.

With so much concern about health, shouldn't more people replace the vitamins they're losing?

Vitamins are essential to everyone's health. The body requires vitamins and minerals to maintain its life support systems. These nutrients are essential elements in the body's process of converting food to energy and in building body tissues.

Research has shown that it's very possible to come up short on vitamins over a period of time with gradual depletion of body stores. Then, once levels are significantly depleted, noticeable symptoms can result.

You can lose your appetite and then body weight. Irritability, sleeplessness or constant drowsiness may occur. Lowering of vitamin levels over extended periods can affect your body's chemistry and, in turn, result in abnormal metabolism. This then can influence your performance.

You may not even know you aren't getting enough vitamins.

As part of everyday living, you do things that may be lowering the level of vitamins in your body, and robbing you of these vital nutrients.

Smoking and Vitamin C.

You are probably aware of the continuing controversy about smoking and health. But, you may not be aware that smoking may rob the body of vitamin C. Fact is, studies have shown that blood plasma levels of vitamin C were as much as 30 percent lower in heavy smokers than in non-smokers.

Drinking and B_1, B_6 and folic acid.

Heavy consumption of alcohol can rob your body because it interferes with the body's utilization of vitamins. Particularly B_1, B_6 and folic acid. What's more, alcohol consumption can lead to poor eating habits and a consistently poor diet.

The Pill.

If you take oral contraceptives, your vitamin levels may be at risk. Research has indicated that a large proportion of the more than 10 million women who use the pill may have reduced levels of C, B_1, B_2, B_6, B_{12} and folic acid. Your vitamin B_6 needs can increase from two to ten times the normal amount, for instance. Ask your physician.

Dieting and poor eating habits.

If you eat on the run or skip meals, or eat less than normal so you'll lose weight, you may not be getting all the vitamins and other nutrients you need. If children snack in between, your nutritious meals may often end up in the garbage.

How to replenish the vitamins you may lack.

Fortunately, there are a variety of ways to make sure you get enough vitamins. First, eat a balanced diet, featuring a variety of nutritious foods. Today, many foods are fortified, so read the nutritional labels of the food you buy, and choose wisely.

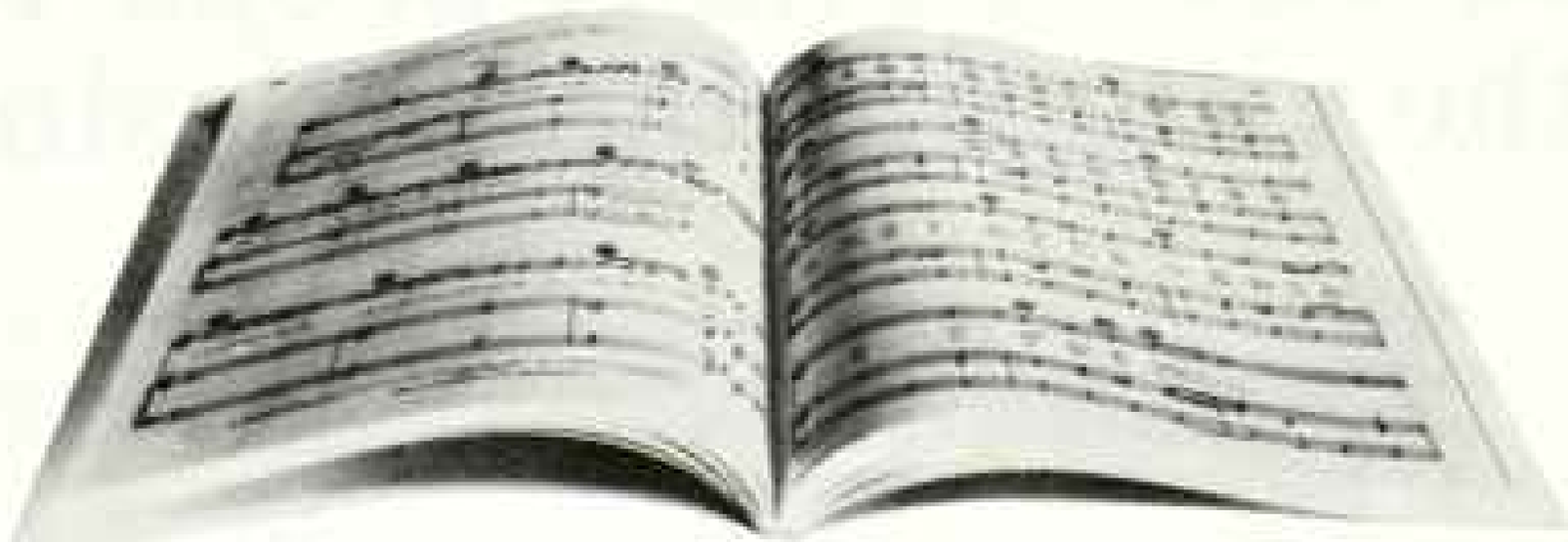
Just to be sure, you can take vitamin supplements daily. There are a number of different formulations including multiple vitamins and B-complex with C, as well as supplements of individual vitamins. Since vitamins are essential for good health, isn't it worth a few cents a day to protect yourself?

Vitamin Information Service,
Hoffmann-La Roche Inc., Nutley, N.J. 07110.

ROCHE

RCD 193608

If You Read Music... You'll Love Our Magazine



The Only Magazine You Can Play!

We call it SHEET MUSIC MAGAZINE. And that's exactly what it is! Each and every issue is filled with the most popular sheet music ever published, including *Pop, Great Standards, Jazz, Show Tunes, Folk, Country, Tin Pan Alley, Movie Songs, Classics, Ragtime, Blues,* and more.

When you sit down at your piano, organ, guitar, or any musical instrument, *we want to be your music book!* And when you want to improve your own musical ability, we want our staff of writers to *show you how.* And in every issue they do just that! There are Keyboard Clinics, Guitar Workshops, Composers' Workshops, Sight-reading, Playing By Ear, Theory And Harmony, Rhythm Workshops, and so much more.

A single year's subscription brings you more than 100 great songs. And when you consider the price of sheet music these days, about $1.50 per song, and realize that Sheet Music Magazine provides the exact same thing for about *10¢ a song,* you can understand why it has more subscribers than any other music magazine in the world today. A one-year subscription for $11 brings you over $150 worth of music!

And there is a new Easy Edition of Sheet Music Magazine, for you beginners and new students, young or adult. It contains all the same great hits as our standard version, but in easy-to-play keyboard arrangements. No matter which version you choose, each has the complete words and music, chord names for organ, and guitar frames, as well as all the same feature articles. (If you are undecided as to which version would be right for you, we suggest you try the *Easy Edition.* You can change at any time, at no extra charge.)

Let us send you your first issue with these wonderful songs . . . *As Time Goes By . . . Never My Love . . . April In Paris . . . Embraceable You . . . The Entertainer . . . If You Could Read My Mind . . . Dancing In The Dark . . . The Hustle . . . Love Will Keep Us Together . . . I Only Have Eyes For You . . . Tie A Yellow Ribbon . . . It Had To Be You . . . Bye Bye Blackbird.*

SUBSCRIPTION APPLICATION

SHEET MUSIC MAGAZINE 352 Evelyn Street, Paramus, N.J. 07652

Please enter my subscription to Sheet Music Magazine and rush me the Introductory Issue with all the songs listed above. I understand that I may cancel at any time and receive a complete refund on all unmailed issues. *No questions asked.*

☐ Easy Edition ☐ Standard Edition ☐ One Year (9 issues) $11 ☐ Two Years (18 issues) $20

Name _____

Address _____

City _____ State _____ Zip _____

Please also send ☐ 1 year ☐ 2 year ☐ Easy Edition ☐ Standard Edition

Gift Subscription to:

Name _____

Address _____

City _____ State _____ Zip _____

☐ I enclose full payment of $_____ (Make check payable to Sheet Music Magazine.)

Charge to ☐ MASTER CHARGE ☐ VISA

Account #_____ Exp. Date _____

DH-NG-99

"Coal can meet so many energy needs."

"Burning coal reminds me of soot, smell, clinkers!"

One shrinks at bad memories of coal. The other thinks of energy. Both real considerations.

Those who remember coal think of soot, clinkers, smoke, smell and inconvenience. All unacceptable to our modern way. And mining coal can deface the land. Ruin streams. Shipping coal to population centers takes rail cars we don't have, rail beds that don't exist. Unbuilt slurry pipelines. No wonder people say, "There must be a better answer than coal."

But others point to cold reality: 75% of our energy comes from natural gas and oil. We import nearly half our oil. Soon perhaps two thirds. Creating a worrisome trade imbalance. As it runs low, petroleum will go to critical non-fuel uses. Fertilizers, herbicides, pesticides, plastics, medicine, lubricants. National defense. With so much at stake and the future so obvious it makes sense to divert as many energy uses as possible to non-petroleum sources. One reason for coal fired electric generators.

A dilemma. To use coal or not. Happily a coal furnace downstairs isn't the only way to use coal. Electricity, generated from coal burned under conditions that control smoke, pollution, environmental impact, is extremely versatile. It can power everything from mass transit to home heating. We'll need even more coal-generated power tomorrow. But developing power plants, mines, transportation, assuring a reliable continuing supply won't just happen. It will take understanding, acceptance, effort, money, and personal commitment. Lots of it.

Caterpillar machines help build and operate mines and power plants. We urge support for our nation's efforts to develop tomorrow's energy.

There are no simple solutions. Only intelligent choices.

CATERPILLAR

Caterpillar, Cat and ⊞ are Trademarks of Caterpillar Tractor Co.

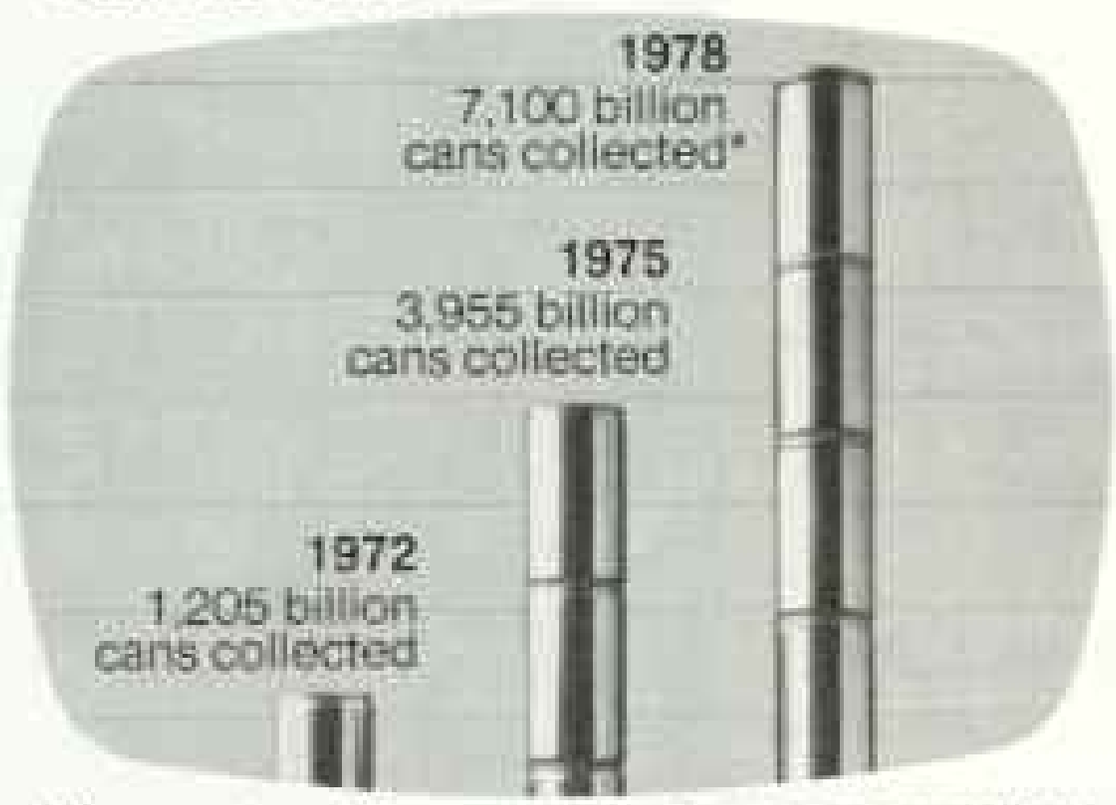
Recycling. The more you look at it the better it looks.

Everybody benefits. In the last seven years thousands of civic groups and individual collectors have earned over $180 million through recycling. The public profits from a cleaner environment. And Alcoa® gets to put the used metal back to work.

It creates jobs. The recycling industry is growing fast. Since 1970, it has added an estimated 15,000 new jobs to the economy. Jobs that involve buying, processing, transporting and remelting used cans into new metal.

It helps municipalities. Recycling this aluminum helps relieve overburdened landfill facilities. And it generates extra revenue. Aluminum is the most valuable material found in quantity in municipal waste recovery systems.

It conserves energy. Recycling saves 95 percent of the energy needed to make new aluminum from ore. In 1978, recycling also helped Alcoa reduce its consumption of coal and bauxite—both valuable natural resources.



It's growing. More and more Americans are collecting used aluminum cans. Last year alone over seven billion cans were turned in for recycling. That's almost six times as many cans as were collected in 1972.

*Alcoa estimate

We can't wait for tomorrow. For additional information about this exciting new industry that saves more and more energy as it grows, write Aluminum Company of America, 359-J Alcoa Building, Pittsburgh, PA 15219.

In The Bahamas you can live like Robinson Crusoe. Or the way he dreamed of living.

The endless islands with endless possibilities.

Some people dream of relaxing on a secluded island. Others dream of more lavish surroundings.

In The Bahamas you can have either. Or both.

Create your own world at a quiet hideaway with miles of untouched beaches.

Or stay at an exciting resort where we'll pamper you in tropical style.

You see, with us you have a choice. To be alone on one of our endless islands, pampered by nature. Or be with others, pampered by us.

For reservations and information, call your travel agent or 800-327-0787. In Florida 800-432-5594.

It's Better In The Bahamas

BaHaMas