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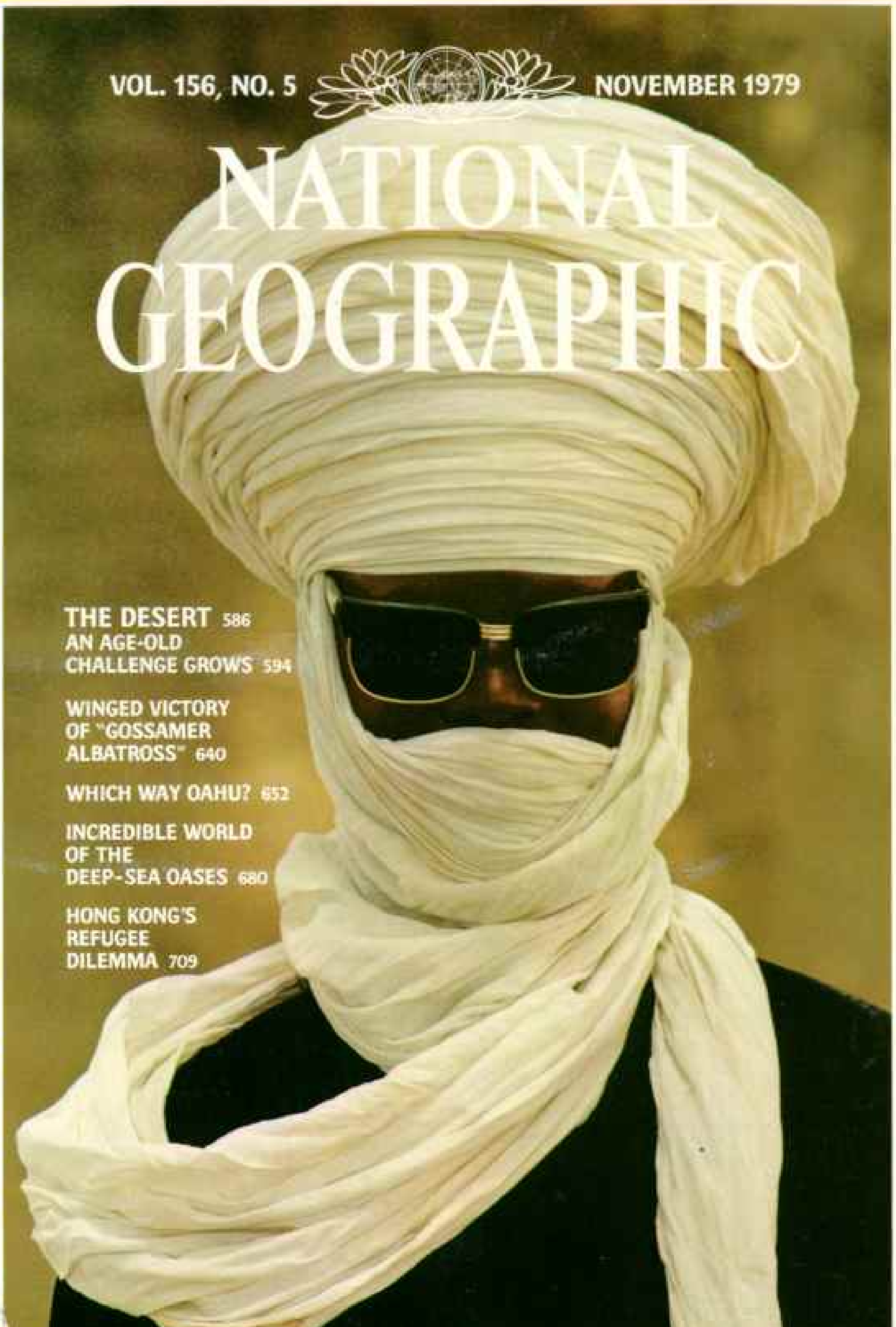

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IT IS EASY to become jaded these days, but there is a powerful antidote to that feeling. I experienced it last June in France as I witnessed the excitement and jubilation that followed the successful flight of *Gossamer Albatross*. That flimsy dragonfly made of graphite tubing, plastic, and tape, designed by aeronautical engineer Dr. Paul B. MacCready and driven by a wiry young biologist named Bryan Allen, had crossed the English Channel on Allen's leg power alone. The flight won not only a £100,000 prize but also the plaudits of a world waiting to thrill to such exploits.

A few weeks later I talked with a group of our editors who had been huddled around scientists at the Jet Propulsion Laboratory in California when the spacecraft Voyager 2 began sending back its breathtaking portraits of Jupiter's moons (pictures that will appear in our January 1980 issue). Again high excitement was in the air, as a new frontier was unveiled by a superb team effort.

While Voyager 1 and 2 probed the outer world of our solar system, a manned deep-sea research vehicle named *Alvin*, using image-making equipment of high sophistication, brought back startling scenes from the inner world far below the surface of the Pacific Ocean. There, along rifts where earth's crustal plates are separating, were revealed life forms and geologic processes never seen before. As the scientists reported their findings to the National Geographic, which helped support the exploration, they were equally excited and jubilant.

Such moments of achievement and discovery have been occurring all during the 91 years we have been publishing, and they will continue as long as human beings find challenges to meet. Those on the vast scale of the planet have given rise to vast accomplishment. When we read Rick Gore's report on world desertification in this issue, we should remember that the earliest civilizations grew out of the deserts, that both advanced technology and societies were formed in response to their challenge.

It is no time to become jaded, when man has probed only the innermost fringe of the universe, and when he has seen only one mile in a thousand of the seafloor rift system. We expect to be publishing great adventures for a long time to come.

Gilbert M. Grosvenor

NATIONAL GEOGRAPHIC

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COVER: *Dressed for the desert in Upper Volta, a Bella tribesman combines sunglasses and turban to shield against sun and sand. Photograph by Georg Gerster.*

The forests came
before civilization,
the deserts after.

THE DESERT

DESERT is the dominant landscape of our solar system. Mars shivers in its aridity while Venus bakes. Yet both worlds could well have had brief lush periods. Earth has managed to keep its oceans and foster life. Still, a third of our landmass is arid, and scientists warn we could tip our climate toward that of Mars or Venus.

Earth's deserts are ever changing. Locations vary as continents drift, mountains arise, and old climates overturn. In this article we explore the emergence of a new desert maker—man. Industrial nations pour fumes into the atmosphere in volumes that could well cause a Venus-like overheating and trigger a desert era. Meanwhile, developing nations consume trees at a fearful rate. Throughout the denuded arid world dust clouds grow. The annual value of agriculture lost nears 16 billion dollars.

Yet all is not bleak. Deserts have challenged man since antiquity. Our earliest civilizations sprang out of the desert. Even as we are losing ground in some places, technology is reclaiming land in others. Who knows? New techniques may not only help us tame our own deserts, but also let us someday colonize those on the moon or Mars.

Limbs mutilated for firewood or livestock fodder, a lone desert-defying tree rides a sea of dunes in western Mauritania. GEORG GERSTER

Dust storm bears

Mankind's labors turn to dust before the desert,

down on Syrian ruins of Dura Europus, fortified by Seleucid rulers about 300 B.C. and abandoned after A.D. 256. JEAN DUPUIS

its relentless advance often sped by man himself.

Where the land burns and blows, each tree becomes

Carpets of vegetation surround desert oaks on the fringe of Australia's Simpson Desert. GEORG GERSTER

an oasis to anchor the soil against the clawing wind.

Publisher Walter H. Annenberg's 200-acre

Yet even a wasteland can be made to bear fruit—

estate and private golf course. foreground, green the California desert near Palm Springs. NATIONAL GEOGRAPHIC PHOTOGRAPHER BRUCE DALE

by those with the will, the water, and the wealth.

A tide of sand *defies the shovels of workers clearing a road in the Great Indian Desert, where wind will soon erase their efforts. Worldwide, man struggles to halt the spread of water-starved lands. The insidious threat, called desertification, is caused largely by our impact on razor-thin resources.*

AN AGE-OLD CHALLENGE GROWS

By RICK GORE
NATIONAL GEOGRAPHIC SENIOR STAFF

Photographs by GEORG GERSTER

A ROAD from Dakhla to Farafra exists on most maps of Egypt's Western Desert. Twice a month a supply truck travels it, carrying food and a few passengers between the two oases. But for hours as our caravan of jeeps has jolted, jerked, and spun its wheels through the remote wilderness, we have seen only occasional signs of a track.

This is awesome, naked land, an empire of sand and time that chills us with its freezing winter mornings and chokes us with its dust. Aeons ago all this was seabed, and often its maze of flat-topped hills, jutting spikes, and towering pillar rocks still resembles the floor of a dried-out ocean.

We descend steep scarps that flatten into deeply eroded country and pass mountains of sand that seem to be slowly swallowing whole buttes and mesas. We drive through grotesque gardens of white chalk statues, carved by the constant wind and gleaming in fields of gray dust.

As we skirt the edge of the Great Sand Sea, we pause to take soil samples from one of its monstrous dune crests. As far as we can see, dunes undulate like frozen gold waves into a cloudless blue horizon. After Arabia's Rub al-Khali, or Empty Quarter, the Great Sand Sea ranks with the world's biggest sand fields. This grand arm of the Sahara covers 45,000 square miles, extending well into Libya. It is virtually unexplored, although dunes in its heart are said to be hundreds of feet high and a hundred miles long.

This is my first close look at a great desert. I am traveling with Dr. Farouk El-Baz of the Smithsonian Institution. Dr. El-Baz is

an expert in interpreting space photographs of the earth. He is also President Anwar Sadat's science adviser, and he hopes that ground observations in the Western Desert will help him understand better the geologic forces at work in this desert.

He wants to determine, for one thing, where the sands of Egypt came from. He and others suspect they were formed as recently as a quarter of a million years ago from Nubian sandstone far to the south, during a very wet period. The sands were then washed to the Mediterranean by rivers and floods. Now winds are driving them back southward, and Dr. El-Baz wants to know how fast they are moving.

So do his Egyptian colleagues, for 96 percent of Egypt is already desert. Its population is growing explosively. Egypt can not afford to lose an inch of its arable land. Yet on the outskirts of the Faiyum Oasis we crossed a dune field that several hundred years ago was rich, irrigated farmland. We passed another field that is headed straight for a stretch of the Nile Valley.

Nowhere is the battle between man and desert as ancient as in Egypt. That is why I am here. Egypt is the start of travels that will take me to the arid lands of five continents, exploring the increasingly stressed relationship between man and the desert.

Deserts are commanding attention today. We have begun to realize the vast mineral wealth and the enormous solar energy potential they contain. Many see the deserts as the world's last great reservoirs of open space, frontiers that man can farm and make habitable with new technology.

But first we must contend with the past and present. Too many mistakes have been made by people living in the desert, and especially on its fragile fringes. Much of the Tigris-Euphrates Valley, where agriculture was born, is today salt desert. Deserts are unforgiving. Particularly in the past fifty to one hundred years they have begun to expand at an alarming rate. This global phenomenon has been given the ungainly name "desertification," and the United Nations estimates that each year the process claims

No mirage, *a cow mummified by Egypt's bacteria-sparse Western Desert was found and propped up by motorists as a landmark after it fell off a truck in the 1950's.*

an amount of land almost equal in size to Maine. Moreover, the land that the U.N. says is in danger of future desertification equals the area of the United States, the Soviet Union, and Australia combined.

Too often desertification is man-made. In Egypt, where the great dunes march wherever the prevailing winds point them, it is mostly natural. And here in the Western Desert nature seems to mock man's presence. Often, before the road disappeared, we had to detour around huge dunes that blocked our way and nearly buried telephone poles. Now in the distance there is this improbable cow (above). As we draw nearer, our driver says that in the 1950's it too had been headed for Farafra. It fell off a truck and the microbe-shy aridity mummified it.

We reach Farafra in early evening, our jeep horns bleating. Throngs of children pour out of primitive houses and cheer our weary caravan down the narrow, dusty streets. At the village meetinghouse a sign reads *Marhaban bikum fi ard Misr al-mustaqbal*—"Welcome to you in the future land of Egypt."

The future the Farafrans anticipate lies in an immense reservoir of fresh water that has been found beneath the Western Desert.

"Egyptian oil!" says government official Mohamed Talaat Dorgham the next day, before opening the tap of one of the world's greatest artesian wells at Farafra. Thousands of gallons shoot into the air and flood the field. A rainbow appears in the geyser, and several of us dance under the drenching shower, washing away the Saharan grit.

Egypt's planners desperately hope that the promise of this water, along with free land, will draw farmers from the teeming Nile Valley to Farafra and two other far-flung oases that make up what is now called the New Valley.

There are, of course, major obstacles. One is that few Egyptians want to move to this harsh land. Also, the country cannot afford more wells, let alone the roads, schools, and facilities to support this dream. So far many well projects have been poorly planned and maintained, and there is fear that without better management the newly found water resources may be ruined.

Most scientists believe that the water in Egypt's aquifer is not being renewed, and that it would permit perhaps only fifty years of intensive agriculture. Economists say the New Valley is a marginal project, and that Egypt should forget its hopes of populating the oases with millions of people and, instead, irrigate desert less remote from the Nile, which still has surplus water. In any event, Egypt at least for the short term can see a brighter future in its deserts. Across the Sahara there is no such optimism.

IN ARABIC *sahra* means "desert." Sahara is plural. Indeed, the Sahara is not one but many deserts. It contains half the desert surface of the world, with features that range from the 11,000-foot-high baked black massif of Tibesti in Chad to the treacherous Qattara Depression in Egypt, a vast hellhole of salt marsh and quicksand

that plunges to 436 feet below sea level.

The Sahara's dryness begins at the Equator. There in the rainy tropics hot air rises and sheds its moisture as it cools. The cooled air begins to subside and warm up again between 15° and 30° north latitude. The subsiding air is too dry for clouds and rain to form. This subtropical high-pressure belt parches the earth from the Sahara through the Middle East and into northwestern India and Pakistan. It helps create the American deserts. A similar belt south of the Equator leads to the arid sands of the Kalahari and Namib Deserts of Africa as well as the deserts of Peru, Chile, and Australia's barren outback (map, pages 604-606).

In the past 65 million years the borders of the Sahara have expanded and retreated many times. Oak and cedar trees once grew in the Saharan highlands, and rock paintings portray abundant wildlife. But about 3000 B.C. the current desiccation began setting in, and man, a relative newcomer to North Africa, had to contend with desertification of the worst degree.

North Africa's rich granaries that once fed the Roman Empire have vanished. Tunisia has lost perhaps half its arable land. Algeria is planting a greenbelt of trees to keep the desert away, and there has been talk of ringing most of the Sahara with such a living Maginot Line.

Yet in only a few places is the desert advancing like an army of sand. The war is being lost in patchwork battles from within. A piece of land goes here, another dies there. The enemy is no longer just the climate. It is ourselves and our animals, chopping trees for fuel, clearing marginal lands and cultivating their fertility away, and grazing grasslands to death. In good years the lean resources of these dry lands are strained, so that each time a drought hits, the collapse is more terrible, the recovery more doubtful.

In 1968 severe drought struck the southern frontier of the Sahara, a region called the Sahel. As many as 250,000 people and millions of animals died over the next six years.

In 1974 reasonable rains returned for a few years, but when I visited the Sahel last year, drought had descended once more in places. The millet crop along the Senegal River had failed. Timbuktu was on the brink of famine. In Nouakchott, the capital of poor, mammoth Mauritania, the past rainy season had lasted only a few hours.

Drought-browned Nouakchott teems with refugees (page 615). Moorish nomads in flowing blue *boubous* and Negro millet farmers up from the deteriorating fields along the Senegal River cram into two shantytowns. Herds of wandering goats and camels have chewed back what scant vegetation exists. Sand drifts in the streets, covering mounds of trash. Overhead the sun moves dimly through a pale yellow haze.

Outside a refugee tent a young boy feeds cardboard to his cow. At the goat market a lone acacia tree sits fenced off in the sand. Someone wants to save it from the goats, or from neighbors who would lop its limbs for charcoal or fence posts.

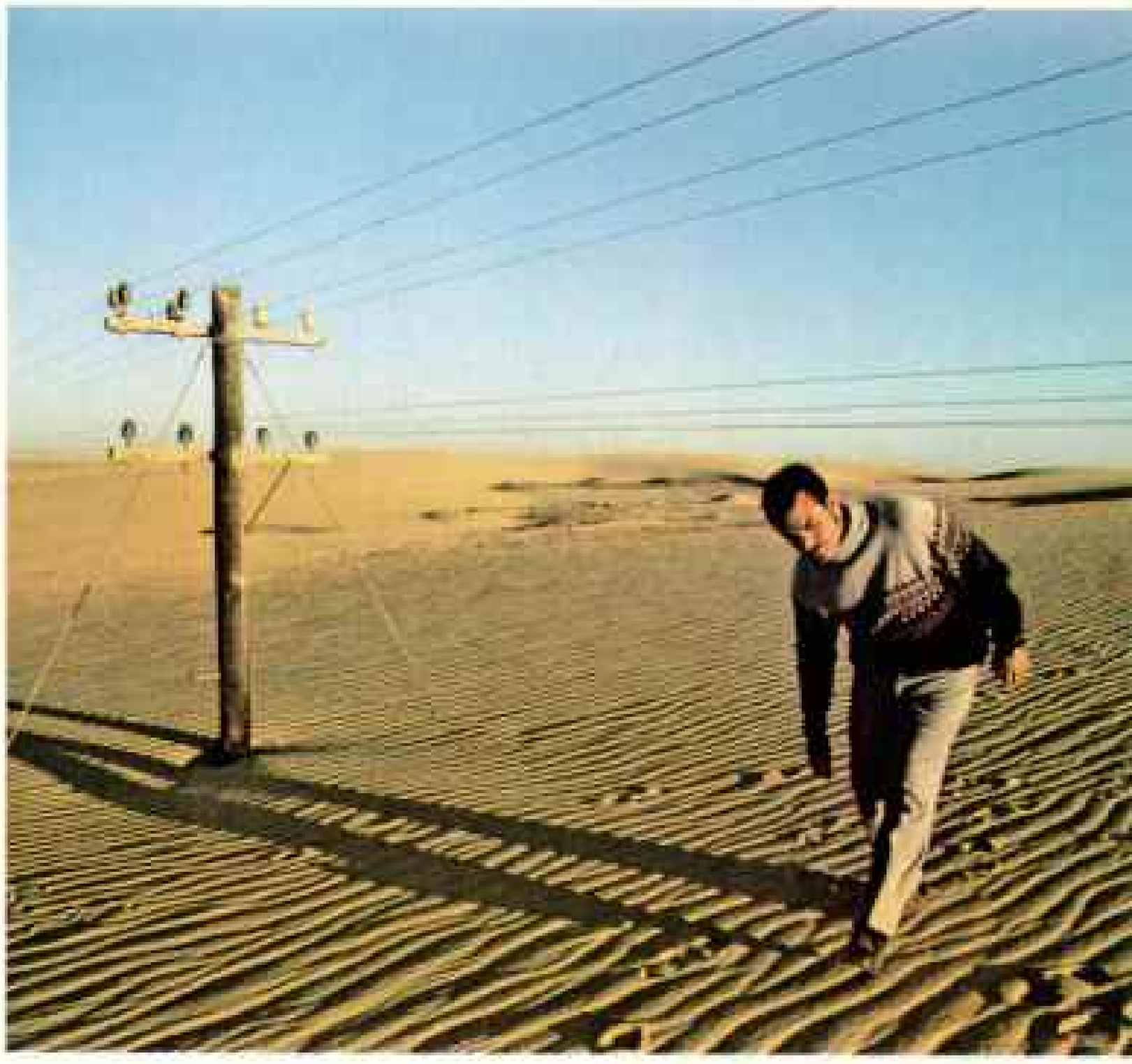
Before the 1968 drought 65 percent of Mauritania's million people were nomads. By 1976 that figure was down to 36 percent. Nouakchott has grown from 12,300 in 1964 to about 135,000 today.

At a medical station a teacher sits with three other brightly garbed women reading French magazines. They are oblivious to the flies on their hands and faces. Most people come to Nouakchott, she says, because there is no means of earning a living in the country any longer. Will the drought continue? "Allah will answer," she says.

CLIMATOLOGISTS, meanwhile, are debating whether drought in the Sahel is a short-term aberration or the onset of a long-term climatic change. Many argue that the drought feeds on itself, that as vegetation is stripped from the land, the surface dries out and reflects more of the sun's heat. This would alter the thermal dynamics of the atmosphere in ways that suppress rainfall. Others suspect that increased dust or other atmospheric pollutants could be causing desertifying changes in the climate.

"The people in Nouakchott are mostly tired," says Nicole Sandoz, a nurse at the medical station. "In way of life, I don't know what's best for them, this or the desert. Their health is much worse here with the bad water and sanitation. Maybe they are happier squashed together like this. But still, when you see the children, how dirty they are, their *(Continued on page 602)*

A plague of sand from Egypt...



A village slowly smothers *as a dune engulfs an Egyptian oasis* ***(left)*** *in the Western Desert, part of the Sahara. Most residents have pulled out to build anew, trying to escape an army of dunes on the march. Beside a buried road a shrinking telephone pole measures the onslaught of sand, so high that an official has to duck under the lines* ***(above)****.*

Desert rules all but 4 percent of Egypt, a bleak fact of life leavened by new hope: A freshwater reservoir has been found beneath the Western Desert. The government plans to farm the region, dubbed the New Valley. But development costs may prove prohibitive, farmers are reluctant to settle there, and the water supply may last only half a century.

...to west Texas

ALL BY JIM BRANDENBURG

"We've got to live on faith. *If we don't get the rain, we don't make it." During a dry spring Larry Shaw watches the wind eat away at his 2,000 acres of cotton fields near Knott, Texas* ***(right)****. While he waits for rain to bring planting time, he digs out an implement called a sand fighter* ***(left)****, designed to protect young shoots from burning by covering the sand with a layer of earth.*

The blowing sand has no more respect for the living than for the dead in the town cemetery ***(lower left)****, which Larry helped excavate—though he never found the long-lost grave of his infant brother.*

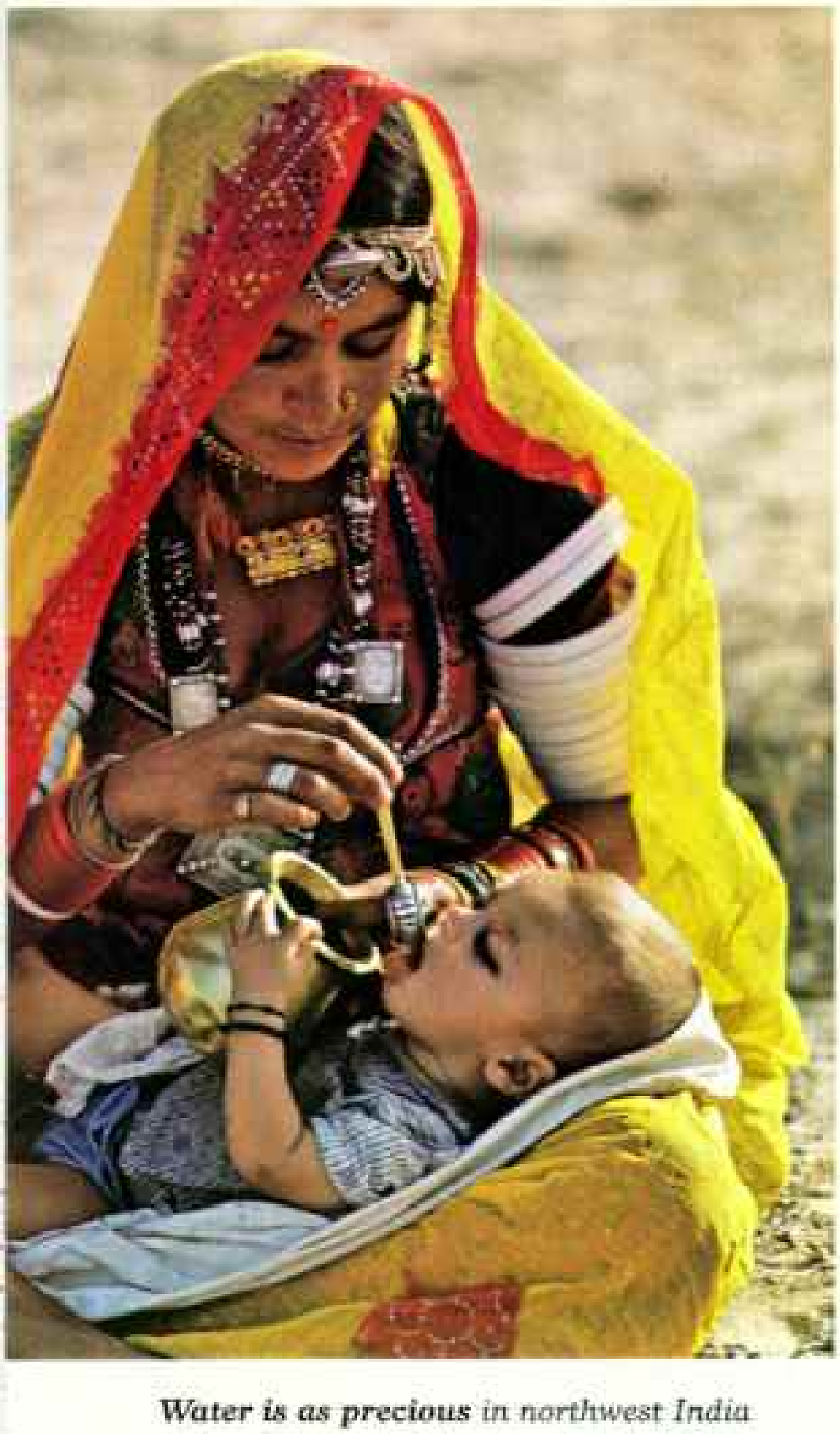
Throughout America's Great Plains the arrival of the cowboy and his cattle in the mid-19th century, along with poor farming techniques practiced by homesteaders, denuded millions of acres. The legacy of overuse blew in with the winds of the drought-stricken 1930's, creating the catastrophic dust bowl. Today a different crisis faces the nation's arid West—the depletion of limited groundwater at an alarming rate. A resident of Phoenix, Arizona, for example, uses an average of 150 gallons of water a day, compared with less than four gallons for an inhabitant of rural African lands.

(Continued from page 597) eyelids stuck together by infection. . . ."

"Mauritania is characteristic of the desertification problem," explains Abderrahmane Toure, then the government's Director for the Protection of Nature. "The northern part of our country has always been a desert, but now the southern quarter is turning into one too. Foraging animals are even wiping out the thorn trees.

"The real problem was an overgrowth of livestock in the 1950's. But then we had good rains. No one was aware the land could not support so many animals.

"Now there is a wood and charcoal shortage too. Still the people cut and cut. They think Allah will provide the rain, the trees. We hope to save whatever's left by persuading the people that they are responsible for their own environment, and then trying to reforest it. Time is running short. We should have started ten years ago."



Water is as precious *in northwest India as the silver rattle that a woman fills from a pitcher to slake her child's thirst. The problem: overpopulation, even in the Great Indian Desert, which averages 48 people per square kilometer—fifteen times more than most deserts support.*

About a third of the world's people, including 90 percent of the developing world, rely on wood for heating and cooking. Expanding populations use ever more trees.

In hot, arid lands a tree—or any plant—is an oasis. Its trunk breaks the wind. Its leaves cool the surface and, after they fall, add humus to the soil. When the plant is removed, the soil can wash or blow away, hooves can compact the earth, and the microclimate around the denuded soil becomes inhospitable for seed germination.

THEY ARE RELENTLESS, the carts and bicycles loaded with wood headed for Ouagadougou. This chief city of Upper Volta devours firewood. Often, acrid wood smoke permeates the air. More and more the peasantry of Upper Volta services the firewood appetite of its capital.

About a 24 hours' walk out of Ouagadougou, Salam Nikiema of Nakomtenga drives a donkey cart filled with branches his wife and family have collected or chopped. He says he must walk for three days to sell his load. It will bring him $15.

At a nearby tree nursery, forestry agent Jean-Paul Sangli says that few people have seen the need to replant trees. And red tape hampers the distribution of saplings. "If the cutting continues," says the Upper Voltan, "this is desert."

As I move north from Ouagadougou, other problems become apparent. With population pressure and the government push to grow cash crops, vast tracts have come under cultivation. Fields that for centuries were farmed only occasionally are now overworked.

The land is etched with barren gullies, dug by the flash floods common during the brief rainy season. Some fields have eroded to bedrock. Everywhere there are butchered

trees, their branches hacked down so that livestock can reach the leaves. Granted this is the dry season and the horrid heat has beaten the green out of the surviving vegetation, but the land looks dead.

Before the drought, farmers had pressed farther and farther into the desert fringe, tilling land that is best suited for grazing. In the past, warlike nomadic herders fought off the farmers. But, as in most parts of the world, the nomads are in decline. Governments do not like citizens who are hard to keep track of, control, and tax.

Also, before the drought the nomads built up their herds to devastating levels. Previously the cattle moved continually, following the water and giving the grasses time to recover. But Western aid organizations financed many wells in the Sahel. These encouraged cattle herds to linger, overgrazing land nearby.

Cattle symbolize wealth in the Sahel. The nomads do not want to limit their herds. Besides, more cattle means more might survive the next drought.

Twelve thousand emaciated cattle drink from the lake at Oursi in the dry season. They must then walk as far as twenty miles across fiery sands to reach grazing land. Twenty years ago these sands were fixed by vegetation. Now they are moving upon Oursi village, blowing into the houses.

The problem, says Chief Issoufi Alimonzo, is that the weather has changed in the past fifty years. He says the herders do not think 12,000 cattle are too many.

"There were once elephants and giraffes and lions here," he says. "The father of my father saw them. When his forefathers came to this place 300 years ago, there were so many trees you couldn't see the lake."

People in the Sahel live under a stress that is hard to imagine. The heat is debilitating, disease chronic. Survival means today.

At a Tuareg camp nearby, Saidou, the chief, receives me in his thatched, domed hut. He, too, talks of how the wildlife has disappeared, and how his people, once the fierce, roaming masters of the desert, have had to begin cultivating millet. The Tuareg never used to cultivate anything.

As I look at Saidou's stoic face, my questions about life here on the desert's fringe seem frivolous. Saidou lost his entire herd in the last drought. His people's millet is already gone, just halfway through the dry season. Two weeks ago his 18-month-old daughter died of meningitis. What is life like here? The deep creases and swollen red eyes speak of a pain that persists, like an infection for which there is no cure.

The problems of the Sahel seem overwhelming. So much land has been ruined, so many trees felled. There are so many hungry mouths. Yet try to close a well so the range can rest and the herders threaten to kill you. And who can blame them?

THEN there is Israel. While deserts spread elsewhere, the Israelis, with industry and financial help from Jews all over the world, have been replanting forests and turning their Negev Desert into a land of milk and honey. It is amazing what a farmer in Israel can get out of an acre of desert and water from the freshwater Sea of Galilee. Roses for Amsterdam's flower market. Oranges, apricots, and avocados, bushels of winter vegetables for Europe. Such luxury cash crops pay for the expensive greenhouses, the trickle-irrigation pipes, and the thousands of acres of plastic mulch that are reclaiming the Negev.

"Israel's agriculture produces about 80 percent of the food we consume and forms a good part of our export," says Dr. Joel Schechter of the Ben-Gurion University of the Negev. "That's pretty good for a desert country with very few water resources."

When Israel was established in 1948, 14,000 people lived in the Negev, which is geographically an extension of the Sinai. The Israelis were claiming one of the world's most desertified pieces of land.

During classical times all Palestine, including the Negev, was relatively lush, supporting as many as three million people. From 200 B.C. to A.D. 200 the Nabataean civilization terraced the hillsides of the Negev with canals to collect and store flood runoffs. They thereby produced bountiful harvests on only three to four inches of rain a year. But as ancient technologies were destroyed, Bedouin life became the only way to survive in the Negev. By the 1800's Palestine's population had fallen to 300,000.

The Negev is a mountainous, rocky desert, the kind *(Continued on page 616)*

North America

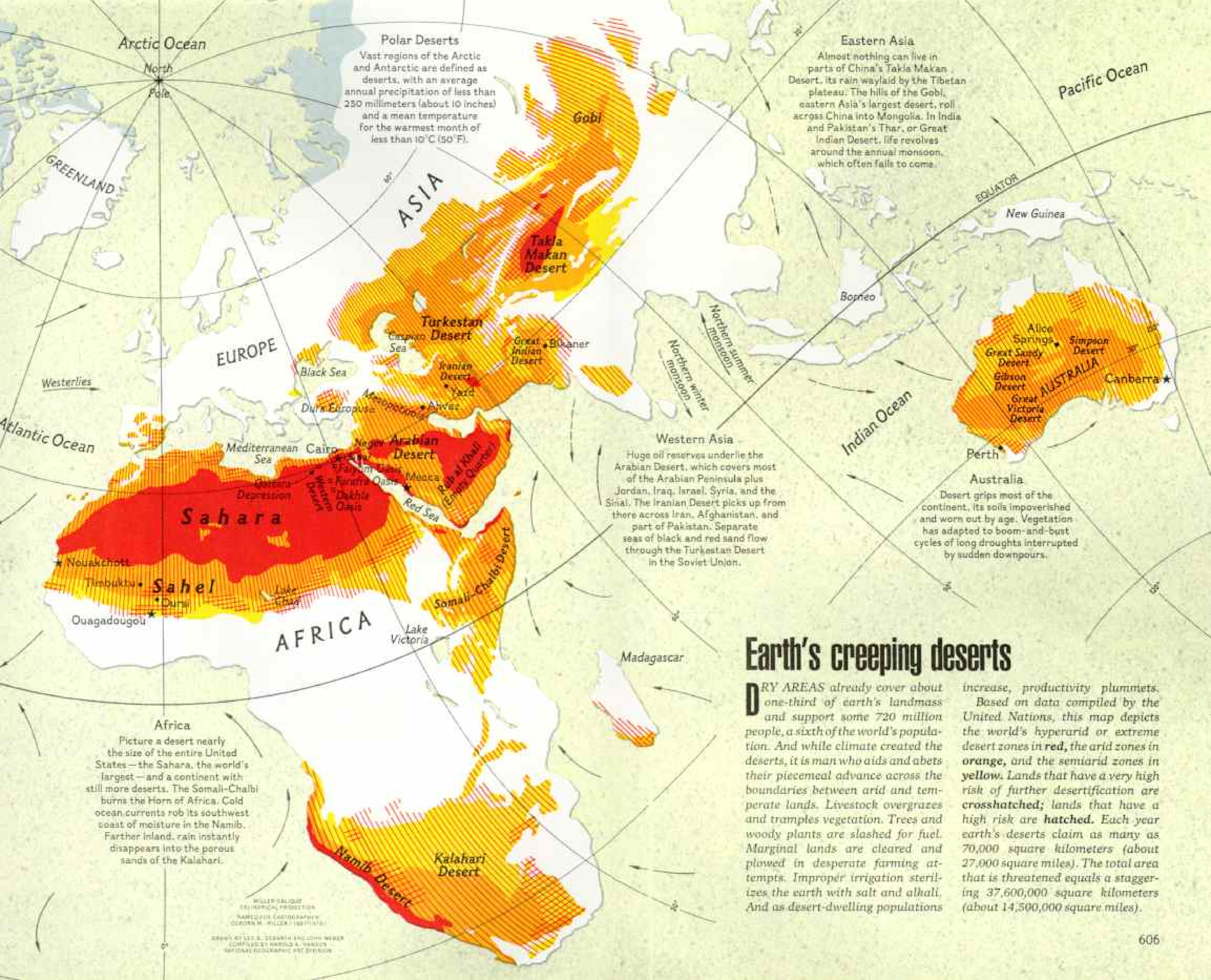
Four major deserts thread the continent. Snowmelt waters the high, cool Great Basin between the Rockies and Sierra Nevada. In the Far West, the Mojave gets most of its rain in winter. In the Southwest, summer storms moisten the Chihuahuan. Sandwiched by the latter two, the Sonoran shares both summer and winter rainfall.

South America

One town in Chile's Atacama, the world's driest desert, has never recorded rain. A pair of deserts lace Argentina: the Patagonian in the south and the mineral-rich Monte farther north. Irrigated farmlands dot the narrow coastal Peruvian Desert.

Desert-making Wind Belts

At the Equator hot air rises, dumps rain as it cools and spreads toward the Poles. Between 15° and 30° north and south — the horse latitudes — the air sinks and warms again, preventing the formation of clouds and rain and creating parallel belts of parched earth that girdle the globe.



Earth's creeping deserts

DRY AREAS already cover about one-third of earth's landmass and support some 720 million people, a sixth of the world's population. And while climate created the deserts, it is man who aids and abets their piecemeal advance across the boundaries between arid and temperate lands. Livestock overgrazes and tramples vegetation. Trees and woody plants are slashed for fuel. Marginal lands are cleared and plowed in desperate farming attempts. Improper irrigation sterilizes the earth with salt and alkali. And as desert-dwelling populations increase, productivity plummets.

Based on data compiled by the United Nations, this map depicts the world's hyperarid or extreme desert zones in **red,** *the arid zones in* **orange,** *and the semiarid zones in* **yellow.** *Lands that have a very high risk of further desertification are* **crosshatched;** *lands that have a high risk are* **hatched.** *Each year earth's deserts claim as many as 70,000 square kilometers (about 27,000 square miles). The total area that is threatened equals a staggering 37,600,000 square kilometers (about 14,500,000 square miles).*

WALTER MEAYERS EDWARDS (LEFT)

April incites a riot *of California poppies, owl's clover, and gold fields in the Mojave Desert's Antelope Valley* ***(left)****. The spectacle vanishes as suddenly as it appears, for such plants must complete their life cycles before the onset of summer.*

The desert's artwork often takes a more malevolent style. In Egypt, farmlands are invaded by dunes of a type called barchan ***(upper right)****. These crescent-shaped dunes form when a limited amount of sand is blown into an impediment like a bush and gathers behind it. As the dune grows, sand grains are swept around its edges, causing horns that point downwind. A barchan dune smothers a road built in 1963, forcing planners to construct a detour that will also be short-lived* ***(right)****.*

Knifing along Egyptian sand, seif dunes ***(above)*** *are named for the Arabic word for sword. Scientists believe they are caused by winds blowing from a prevailing direction, but with frequent shifts of as much as 45 degrees right and left.*

Denuding the land

Last shreds of green *disappear from a thorn tree as a herdsman lowers its branches to feed his goats in Upper Volta (**above**). In the same country an overgrazed moonscape lies to the left of a ranch's protective fence (**right**). Most regions with too few trees also have too many cattle, goats, and sheep. The destruction of trees has reached epidemic proportions in the other energy crisis: firewood. Approximately a third of the world's people rely on it for heating and cooking. To find a day's ration is often an all-day task in Mauritania, where a boy hacks at scant shrubbery (**left**). As vegetation vanishes, the desert advances.*

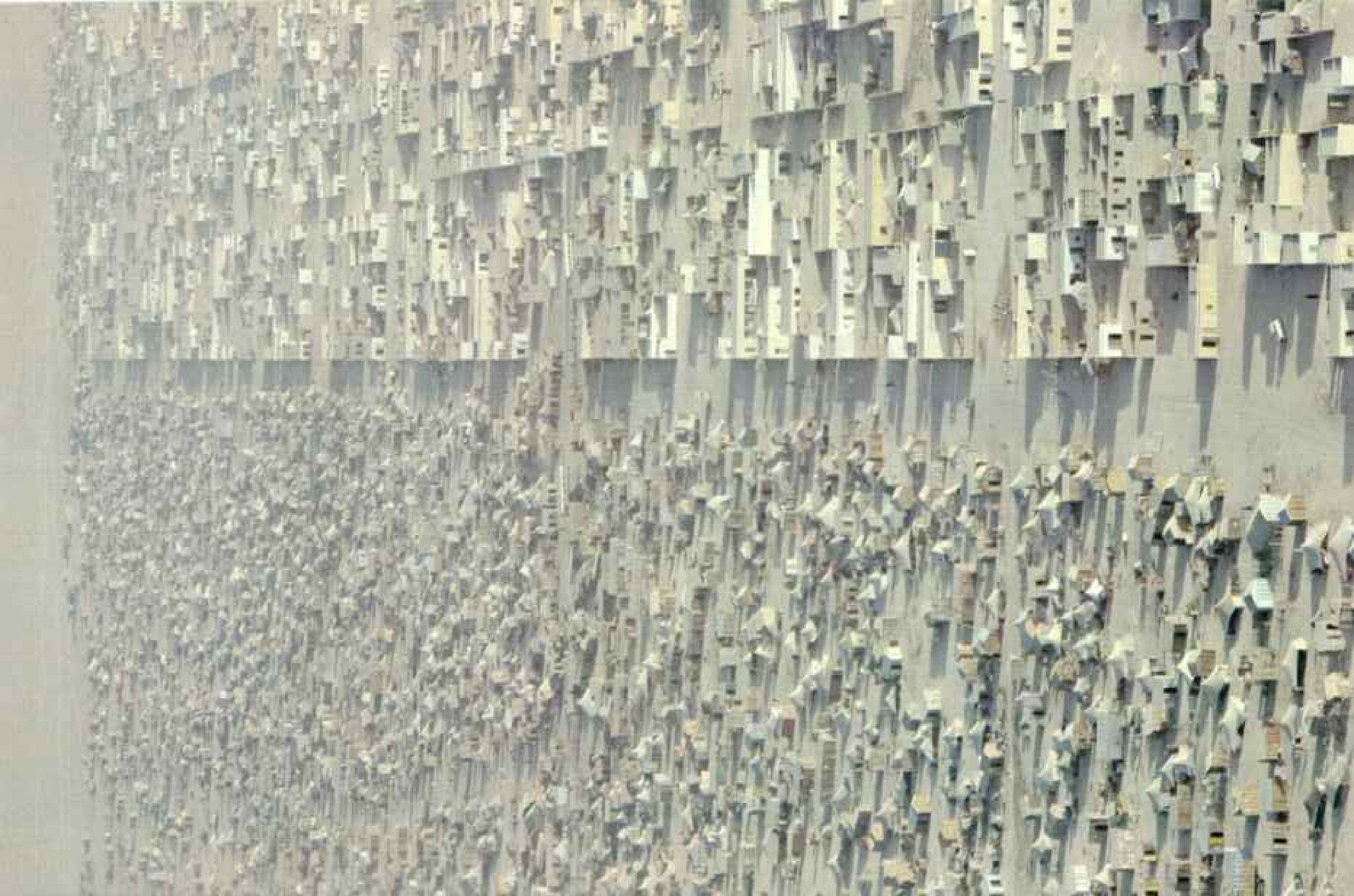
Living hand-to-mouth

What little the earth offers *must suffice for members of the Bella tribe, probing a dry riverbed for potato-like roots of water lilies (**right**). Here in Upper Volta, morning rush hour crowds a communal well (**above**). Such is everyday life in the Sahel, a southern fringe of the Sahara stretching from Sudan to the Atlantic, where a drought from 1968 to 1973 killed as many as 250,000 people.*

Fleeing in desperation

Refugee shantytown *created by the long-term effects of the Sahel drought sprawls from the edge of the orderly streets of Nouakchott, Mauritania's capital* ***(right)****. On its outskirts a family abandons the desert to follow the tide* ***(above)****. Africa's nomads, who once spread their flocks over a broad area, are rapidly taking root around settlements that their livestock, no longer mobile, strips bare.*

Before the drought, 65 percent of Mauritania's population were nomads. In 1976 the percentage had shrunk by nearly half. Nouakchott's current population of about 135,000 has increased 11-fold since 1964. Adjusting to a new life-style in the capital, a former nomad learns how to farm a garden plot in a program funded by the Canadian Red Cross ***(left)****.*



(Continued from page 603) of wilderness that seems made for a prophet to wander. In the north the bleakness is broken frequently by islands of green. These are the kibbutzim and moshavim, Israeli communal settlements. Israel is extending such settlements all the way to the Gulf of Aqaba, intending to populate the entire Negev with a million people in the next twenty years.

Israeli scientists have offered to share their desert-conquering technology. But at a 1977 United Nations conference on desertification, the representatives from 56 Arab, Third World, and Communist countries walked out on the Israeli presentation. The Arabs bristle at the contention that the Muslim invasion of Palestine triggered its degeneration. They also decry Israel's desert technology as a tool of Zionist expansion.

So far most of this expansion has been made possible by using good farming techniques and by recycling nearly every drop of rain Israel gets. The plastic mulches slow evaporation. Israelis developed trickle irrigation, a system in which thin plastic pipes with holes deliver to each plant in a row of crops the precise amount of water it needs. By wetting only the root zone, trickle irrigation saves enormous amounts of water.

"Israel uses more plastic per head for agriculture than any other country," boasts Dr. Schechter. "Plastics are going to change the desert. We'll have big plastic domes covering a couple of acres, held up by air pressure and keeping an ideal climate indoors. The only big problem will be cooling the domes in the summer's heat. Maybe we'll put solar collectors on the domes and use them to run a refrigeration unit."

Such greenhouses will need one-tenth the area and one-twentieth the water an open-field farmer needs to support his family.

To expand any farther into the Negev, the Israelis must tap groundwater. However, as in other deserts, that buried water is too salty for normal agriculture. Never mind. The Israelis are developing salt-tolerant crops. Since cattle have a tough time in the desert, Israeli researchers are trying to breed a good-tasting camel. They have already created a "goabex," a cross between a goat and the desert-adapted ibex.

The Israelis are certainly not the only country taking land back from the desert. Iran, for instance, has made great strides. But then the Persians have traditionally found ingenious ways of living with aridity.

From the air almost anywhere over Iran, one sees long rows of holes about the diameter of a manhole. These are the entrances to *qanats*, or underground canals, that channel groundwater from the highlands down to arable farmlands. For centuries men have crawled down such holes to excavate, and later to clean, these subterranean rivers.

No less striking are the country's ancient air-conditioning systems. The city of Yazd, for instance, is dominated by houses with tall towers. These wind catchers funnel the prevailing breeze down to cool the houses. Winter winds are used to freeze ice that lasts all year in underground chambers.

Yet in recent years, as intense grazing and wood gathering have created marching dune fields across much of the country, the desert has grown harder and harder to live with. In 1967 the previous government began an experiment that the new regime has found worth continuing.

The air is thick with petroleum mist and the roar of machinery as we approach the vast dune field at Karkheh in 1978. Four bulldozers tug sleds up and down the steep sand hills that stretch endlessly toward Mesopotamia. Guns on the sleds shoot a glistening black film of petroleum residue across the dunes. The film dries to a gray crust, or mulch, that holds in moisture and keeps the sand from blowing (pages 620-23).

On some dunes grass seed had been spread before mulching, but project director Mehdi Mahdavi shows me fields, alive with yellow flowers, where the natural vegetation has come back strongly on its own after mulching. New forests have sprouted from saplings planted in mulched sand. Fifty motorcycle watchmen protect these new forests and pastures from goats and sheep.

Now people have begun returning to these deserted lands and are planting fields of lettuce, eggplant, and tomatoes. "Hell has become paradise," said one villager.

To the north of Iran the Soviet Union is also reclaiming enormous desert tracts in central Asia. The Russians are building the costly 750-mile-long Kara Kum Canal and are even planning to divert whole rivers to irrigate virgin land.

Chinese geographers report that centuries of overgrazing have turned much of China into a land "where the sand pushes man around." Consequently, communes across the fringes of China's great Takla Makan and Gobi desert regions have been zealously shoveling away dunes and planting grasses and trees.

To the south the pride of India, the Rajasthan Canal, is slowly being dug through the Great Indian Desert. Some say the canal will turn the desert into the granary of India. More realistically, others say it will simply forestall famine for a while.

IT IS 4:30 in the morning in Bikaner, India, and for the third time I am awakened by my pounding blood vessels and a mild panic. The temperature reached 48°C (118°F) yesterday afternoon. My watch crystal steamed up. In the shade my pen and camera grew too hot for me to hold comfortably. Now even the bedsprings radiate the day's heat back into me. My body cannot dispel this warmth, so once more I stand under a shower until my pulse finally slows down, then return to bed dripping wet, but cool.

A few hours later my journey with scientists from India's Central Arid Zone Research Institute (CAZRI) continues. At midday we stop at dust-blown Nokhra, where there will be a pond for three months from August on. But it is June, still too early for the monsoon, and the only water comes from wells. Sheep and goats crowd around the troughs while camels and oxen haul up water in goatskin bags. Bright-turbaned herdsmen empty the bags into the trough. An uproar of bleating breaks out as the animals fight for a place to drink. I understand exactly how they feel.

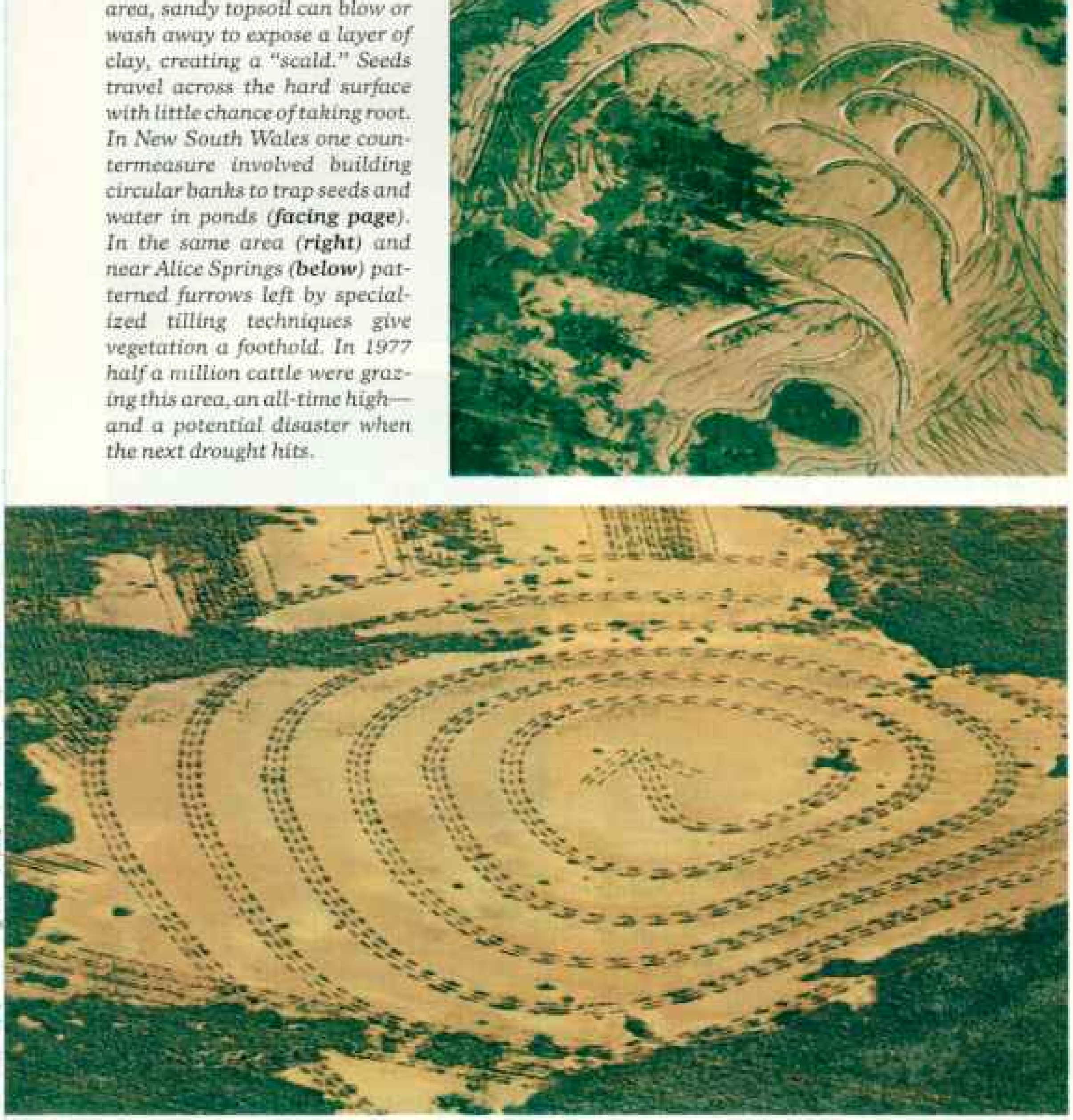
Herdsman Moda Ram senses my problem. He motions for me to kneel at the well. Then he slowly pours a bag of water over me, drenching my throbbing head.

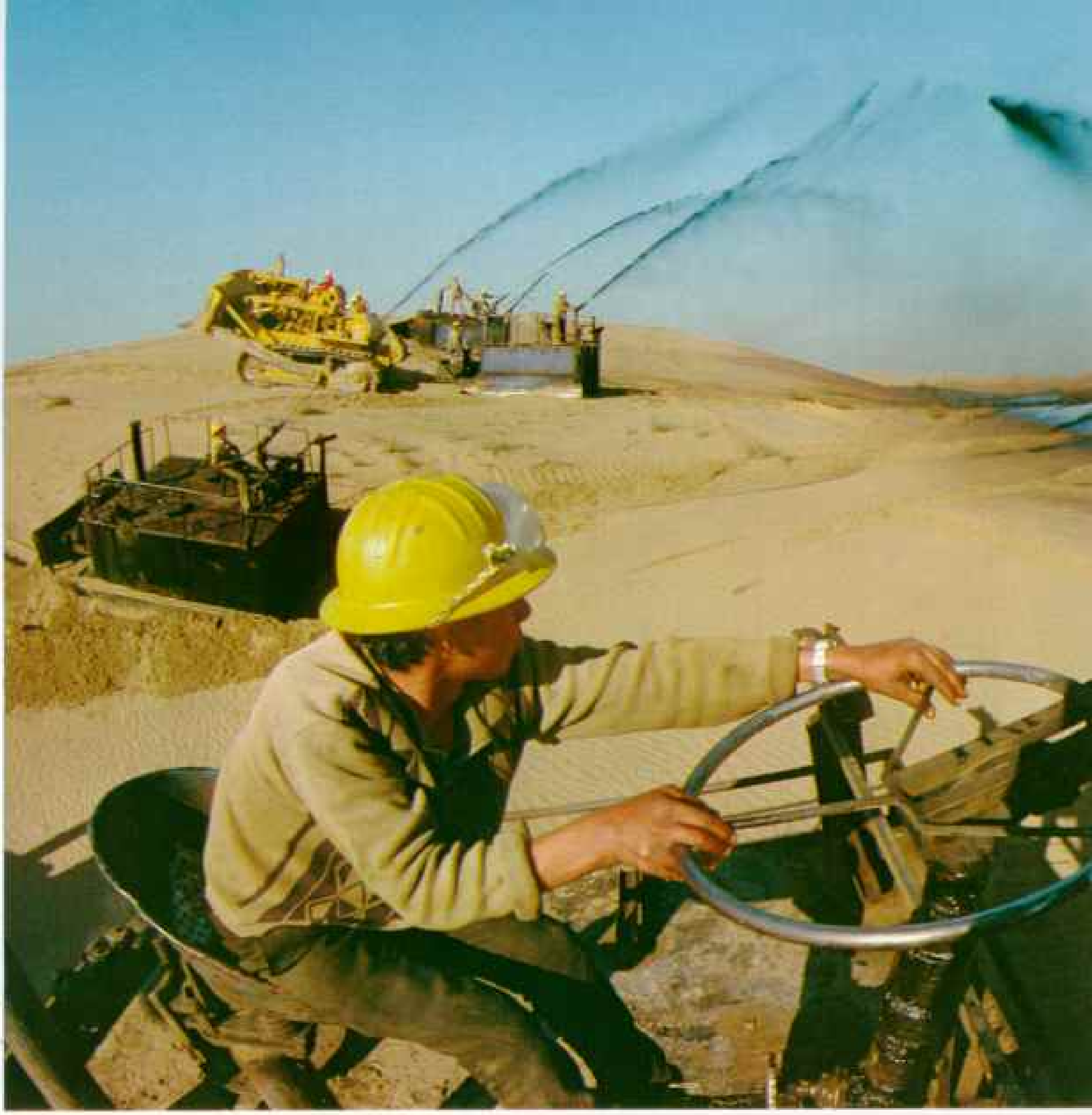
Water drawing is a sacred morning and evening ritual here in Rajasthan. Wells are often shrines. The previous afternoon in Dhani I had to remove my shoes to stand at the well for the evening draw. Before any villager could take water, a boy poured some from a silver cup over a small temple near the well. *(Continued on page 624)*

Desert weed, *if farmed, could shorten gas lines. Dr. Melvin Calvin* ***(top)*** *studies a common California shrub called a gopher plant,* Euphorbia lathyris. *The latex it yields* ***(above)*** *can be refined into crude oil and gasoline. Dr. Calvin, who won a Nobel prize for his photosynthesis research, estimates the production cost at $30 a barrel, a price that seemed noncompetitive . . . until recently.*

Man fights back...

Symbols of hope: *Australia's arid outback greens with the brush of land reclamation. If cattle and sheep denude an area, sandy topsoil can blow or wash away to expose a layer of clay, creating a "scald." Seeds travel across the hard surface with little chance of taking root. In New South Wales one countermeasure involved building circular banks to trap seeds and water in ponds (**facing page**). In the same area (**right**) and near Alice Springs (**below**) patterned furrows left by specialized tilling techniques give vegetation a foothold. In 1977 half a million cattle were grazing this area, an all-time high—and a potential disaster when the next drought hits.*





...and sometimes wins

Oil-drenched Iran *fights migrating dunes with its chief resource. Near Ahvaz, workers coat the sand with a petroleum residue (**above** and **overleaf**) sprayed from tanks towed by a squadron of bulldozers. The mist dries to a gray mulch that retains moisture and stabilizes the dunes, allowing vegetation to grow. Prior to mulching, a boy cuts a furrow (**left**) for seeds of a drought-tolerant shrub.*

*Evidence of the idea's success, a petroforest (**upper right**) shot up only six years after seedlings were planted in 60 square kilometers (23 square miles) of oil-mulched sand. Guards riding motorcycles patrol the trees, mostly tamarisks, to protect them from goats and sheep.*

The reforestation project not only increases Iran's supply of timber but also cuts down the blowing sand that once regularly invaded villages, choked farmland, derailed trains, closed airports, and buried mosques. The nation's active dunes cover five million hectares, an area twice the size of Vermont. Iran's war with the desert goes back more than two thousand years, when underground aqueducts called qanats were dug to bring water from distant hills. Today thousands of such conduits still irrigate Iranian farms.

(Continued from page 617) The thirst of the deities must be slaked so that the water will continue.

The Great Indian Desert has been called the "overcrowded desert," and nowhere do so many people subsist on such inhospitable land, relying on an unreliable monsoon. Historically, the rigors of the desert made this India's highest mortality region. In recent years the death rate has dropped sharply, but the high-fertility customs persist and the pressure on Rajasthan's marginal resources mounts.

Near Bikaner about 80 percent of the sand dunes are now cultivated, and there are ever more animals. For the past six years there have been good monsoons, and the desert should be relatively lush. Yet the sands still shift, and often the only plants that thrive are those that animals find unpalatable or toxic. CAZRI is trying to check these problems by planting shelterbelts of trees and forage grasses and by demonstrating good agricultural techniques, but the people are deafened by immediate needs.

Also, the Indian resistance to killing animals, even rodents, has created a unique menace—the Indian desert gerbil.

Gerbils have been increasing even faster than people in Rajasthan. The mud fences men build to keep goats from their fields become perfect rodent hotels, and the seed that farmers spread is breakfast in bed. In the rangelands, which now average 200 rodents per hectare, six gerbils will eat as much grass in one day as a sheep.

In a field scourged with gerbil burrows, I watch scores of rodents flick sand from their holes. "They constantly excavate to expose moist soil. That cools their burrows and reduces their water needs," says CAZRI rodent specialist Dr. Ishwar Prakash. That habit can expose more than 100,000 kilograms (the weight of a hundred Volkswagens) of soil per square kilometer each day. Most of this sand ends up in new dunes.

ANOTHER KIND OF RODENT, the European rabbit, drew me south across the Equator to Australia's dry outback. Ever since an English settler imported rabbits in 1859, these grass nibblers have been desert makers to rival the goat elsewhere. Within three years one pair of breeding rabbits theoretically can become 13,718,000. And so for decades Australians have fumigated and ripped open rabbit warrens and even introduced rabbit diseases. Many men make a living shooting and trapping rabbits for export. Still, when breeding conditions are right on arid rangelands, rabbits by themselves can easily exceed the safe stocking rate for cattle.

At Erldunda, a large cattle station south of Alice Springs, owner Sid Stanes takes me through heavily infested land pockmarked by burrows. "Oh-h-h, the bastards," he grumbles frequently. "A couple of years ago this was all grass. Now it's as bare as a baby's bottom. There's been lots of rain recently, but it brings the sprouts up just enough for the rabbits to eat. There's rabbits now from here for another seventy miles west. It's got beyond a joke. I'm wondering whether this land is ever going to recover."

Although particularly hostile and waterless regions of the Australian outback have been given names such as the Simpson, Gibson, or Great Sandy Deserts, most of the continent is in reality a desert. The Australian desert is old, its soils so ancient that they have lost most of their fertility. It is, however, remarkably well vegetated, with deep-rooted trees and grasses adapted to cycles of long droughts followed by downpours.

Until 200 years ago the only humans in the Australian desert were the nomadic Aborigines. Then Europeans began moving into the outback, hoping that rain would follow the plow and the hoof. From the 1850's on there were good rains, and few people noticed how seriously cattle and sheep were ravaging the land. The 1890's brought drought and rabbits almost simultaneously, and the sheep population of western New South Wales plummeted from 13.6 million to 3.6 million. Never again would Australia's dry lands support so many mouths.

Today scientists and graziers argue whether the outback continues to desertify. "I've seen it so bad you couldn't feed a rabbit on fifty square miles," says one rancher. "But after rain it always comes back."

The scientists point out that the land usually comes back in less desirable species.

"I've just returned from the Gascoyne River area. It was once productive country. Now there isn't an animal to be seen," says

range specialist Andrew Mitchell in Perth. "They've all died. They ate out the perennials. When drought came and the annuals didn't sprout, nothing was left to eat."

When beef prices and weather have been good in Australia, marginal lands have historically been overstocked. When conditions are bad, lands are abandoned or overgrazed for short periods of time just to forestall bankruptcy.

Australia—where you can drive all day without seeing another person, and where rancher Mac Clark tells me he has two neighbors, "one 53 miles to one side and one 47 miles the other way"—is a striking contrast to India or the Sahel. In those places desertification means starvation. But as Australian geographer Dr. Jack Mabbutt puts it: "Desertification here is when a man walks off his land because he can't pay his bills, because he can't keep up the Australian standard of living."

FAR ACROSS the Pacific in Chile, the world's driest desert rises abruptly from the sea. This is the spectacular Atacama, famous for its camanchaca, or thick fog, that rolls in over the coastal mountains, swaddling and nourishing sparse colonies of cacti before dissipating on the sterile pampa.

Frequently on the coast the camanchaca makes a thunderstorm seem imminent. Nevertheless, the Atacama is almost utterly arid. Air moving inland over the upwelling cool coastal waters holds only a limited amount of moisture. Its relative humidity is drastically lowered over land by subsidence. Together, these two factors prevent formation of rain clouds. "Every few years we get a mist—but the drops are very small," says one resident. Many roofs in the Atacama coastal towns have holes. People in Iquique recall the "flood" of 22 years ago, when it rained all day and houses were wet inside.

On the still drier Atacama pampa there are places where rain has never been recorded. However, every ten years or so storms in the Andes send flash floods, called *avenidas de agua*, racing in sheets across the pampas.

Despite its aridity the Atacama supports some agriculture. Here and there rivers of Andean runoff have cut deep canyons, called *quebradas*. The pre-Hispanic people began irrigating these quebradas, which today from the air look like thin green snakes lying across the desert. There are also the tiny oases of Pica, which produces superb fruit on spring water, and Matilla, which the Spaniards once prized for its wines.

Somehow, too, a unique tree called the *tamarugo* manages to survive the ten-year droughts between the avenidas de agua. It is startling to drive for miles across the hard-baked, cracked, gray pampa and suddenly find a forest of these tamarugos. Early Spanish maps actually show some regions of the Atacama as densely jungled. Since tamarugos make good firewood, most of the jungles disappeared long ago. Today, because tamarugo leaves and fruit also make good fodder, Chilean scientists are trying to establish tamarugo plantations and foster a livestock industry in the desert.

Once there were Indian desert cultures and considerably more agriculture in the narrow Atacama. The indigenous people had technologies and social organizations that let them survive in the desert. The Spaniards broke that organization.

"The arrival of Europeans was the beginning of desertification in Chile," explains Dr. Sergio Lailhacar. "They brought goats and sheep. Then, to fuel their mining operations, they stripped the land of trees."

With Dr. Lailhacar, I tour north-central Chile. It is not part of the Atacama proper—yet. Here, some 400 years ago, the Spanish crown doled out lands to its colonial officers. Centuries of inheritance have reduced many of these once large estates to communities of micro-farms called *comunidades*. Each generation of the *comuneros* who farm them has had to get more from less and less land. Legions of invading cacti now cluster on the degraded hillsides. There is a saying: "Wherever a comunero puts his foot, the grass doesn't grow any more."

Even in southern Chile, where there is ample rain, the land is desertifying. The rain actually makes the mountainous terrain more vulnerable because it washes away topsoil more quickly. More than a hundred years ago wheat was planted on these erodible mountainsides for export to feed the gold rush in California. The damage continues as the people clear forests to create grazing land. The new pastures are quickly eaten

Cures for salt cancer

BRUCE DALE

A pale malignancy *spreads through an alfalfa field (**above left**) strangling under a buildup of salt in Grand Valley, Colorado. Diagnosis: Irrigation without adequate drainage has allowed dissolved mineral salts to invade root zones, thus restricting crop yields. Scientists believe a more efficient irrigation plan for Grand Valley will vastly reduce salt buildup.*

*To desalt California's Imperial Valley, a system of perforated pipes called tiling (**left**) has been installed beneath more than 400,000 acres. The conduits flush saline irrigation water into the Salton Sea.*

*When the salt problem can't be licked, perhaps it can be lived with. At Bodega Bay Marine Laboratories in California, researcher Dale Rush compares commercial tomatoes to midgets grown with seawater (**above**). The two were crossbred to produce the variety growing beside him, which tolerates salty water. Not juicy enough for the supermarket, the hybrid is rich in pulp and ideal for the canner.*

Pests multiply misery *by thieving scant resources. In Upper Volta a herdsman's stick raises a horde of locusts from a tree that might have fed livestock* ***(right)****. Grass-gobbling rabbits scourge Australian cattlemen like Sid Stanes* ***(below)****, his rifle a poor defense against their proliferation. Says Stanes of the Englishman who imported the vermin in 1859: "He should have been drawn and quartered."*

out, and their soils run off with the rain.

"Technically, these lands could be restored in twenty years, a hundred at most, by replanting," says Dr. Lailhacar. "But to do that, most of the people have to go."

Not surprisingly, as everywhere in Chile the land deteriorates, poverty has increased, and people have fled to form the slums that now ring Santiago. The problem is not Chile's alone. Cattle have devastated much of Argentina's dry lands, and Brazil's arid northeast is also under severe stress.

Nor is the United States immune to the ravages of desertification. In terms of dollars lost or threatened, our problem may be the world's greatest.

In Arizona the water table is dropping sharply as water is pumped from aquifers to supply greatly expanded agriculture and a massive influx of new residents. "Arizonans are consuming their children's water," warns one scientist.

As a legacy of the cowboys and the sheepmen, three-quarters of our rangelands are eroded or overrun with invader plants such as creosote bush, mesquite, and tumbleweed. Although most of our ranges are now stabilized, wild horses and burros, which were protected by Congress in 1971, are eating out large areas. Herbicides, fences, wells, and management could restore the range, but there is little money available.

All across the arid West, injudiciously irrigated land has turned too salty or alkaline

to farm. Even the lush lettuce fields of the Imperial Valley are in long-term trouble from salt buildup. Already some fields have been abandoned. Many more would be dead without the massive installation of underground "tiles." These perforated plastic pipes carry irrigation water containing dissolved salts to the Salton Sea before it can seep back up to the root zone of crops.

"Salt is a cancer on the land," says agricultural agent Keith Mayberry. "Everybody's got it here, and most farmers don't realize how badly. I think our technology will let us keep one step ahead of it—at least for the next 25 to 30 years. After that? Well, I've got a lot of faith in our scientists."

The most serious difficulty we face in our dry lands is wind erosion. "We are watching our fertility blow away," says desertification expert Dr. Harold Dregne of Texas Tech in Lubbock, reputedly the dustiest city in the country. "In the southern Great Plains alone we lose in soil productivity the equivalent of sixty million bushels of wheat a year."

AN EVERYDAY SANDSTORM is brewing near Big Spring, Texas. It is April and, as the wind builds, brown dust streams across endless bare furrowed fields, obscuring the windmills and pumping jacks, piling up against fences and abandoned farmhouses. Almost every inch of land here seems cultivated, and almost every inch of *(Continued on page 636)*

Photographs of desert creatures
on the next four pages
by BRUCE DALE
NATIONAL GEOGRAPHIC PHOTOGRAPHER

VALLEY OF COAHUILAN

Outwitting the elements, *creatures with specialized anatomy and behavior thrive where man must struggle to survive.*

*Living storage tanks, honey ants (**right**) bulge with nectar from plants and secretions from other insects to sustain a colony during drought. The swollen worker ants, called repletes, have been fed by other workers until their abdomens are nearly grape size. The sluggish repletes cling to the roof of the nest, regurgitating when signaled.*

*Nocturnal crawler, a scorpion (**top**) remains well camouflaged under a flashlight's beam, but fluoresces in ultraviolet light (**above**), a reaction that remains a mystery to scientists.*

Equipped to survive...

MYRMECOCYSTUS MEXICANUS (ABOVE); DIPODOMYS MERRIAMI

Miniature broad jumper, *a night-roaming kangaroo rat* ***(left)*** *navigates the desert with foot-long leaps on specially adapted, powerful hind legs. The rodent's enlarged middle ear helps detect approaching danger, and its unusually large nose helps fight aridity by retrieving moisture from its own exhaled air.*

...wildlife meets the challenge

Burial means life *during most of the year for a South American toad (**left**), here seen in a laboratory at California State University at Fullerton. In fall, winter, and spring it lies dormant, nestled in a shallow burrow in Argentina's dry Chaco region. There the toad develops a cocoon of dead skin to retain fluids that would otherwise be lost to dry soil. Cued by summer rains, the toad sheds its protective coat (**below**) and emerges to breed and feed in temporary ponds.*

CROTALUS CERASTES (RIGHT); LEPIDOBATRACHUS LLANENSIS

Signature of a sidewinder *is penned by an S-shaped motion that permits the rattler's deft movement on loose sand (**right**). Tracks are laid as the snake grips the ground at two or three constantly changing points along its belly. Here the snake's head and most of its body glide above the sand as the tail signs off a completed track.*

Active at night or dawn, sidewinders avoid the midday furnace lethal to such cold-blooded animals.

NATHAN BENN (LEFT); BRUCE DALE (BELOW); DAVID KUBINEC

Plastic revolution *engineers a harvest of peppers at kibbutz En Gedi in Israel's Negev Desert* ***(left)****; water condenses on greenhouse walls to be recycled. Such experimental technology helps the desert nation produce more than three-quarters of the food it consumes and export lucrative winter vegetables to Europe. Dr. Elliot Birnbaum* ***(top)*** *studies another promising desert crop, the jojoba plant. It yields a superlubricant that could replace sperm-whale oil and thus help save an endangered species. Jojoba beans grown in Arizona* ***(above)*** *signal the plant's increasing cultivation in the United States.*

A living accordion, *the towering saguaro cactus* ***(below)*** *swells up to store water and then contracts slowly as supply wanes. To conserve water further, the plant's pores remain closed by day and open at night to absorb life-giving*

BRUCE DALE

(Continued from page 629) it is in cotton. Cotton prices are good, and a lot of sandy land that normally would not be considered for farming has been plowed up.

I head out in a pickup with a young farmer, Larry Don Shaw, to inspect equipment that an earlier sandstorm has buried.

"When I was a senior in high school, we had so many storms I had to repaint my car. It got sandblasted," says Shaw. "By all rights we should be blown away, but the machinery we've got now lets us keep ahead of the weather."

We stop to dig out some of this machinery—big claws designed to turn over the earth and bring clods of fine-textured dirt to the surface. The clods bake hard and resist the blowing wind. This kind of technology makes drought less dramatic than during the dust-bowl days. Not everyone uses such equipment to combat wind erosion, however, and even those who do can lose a lot of soil in bad years. Recently in Gaines County, for instance, a farmer plowing two feet deep struck a pipeline that had been laid four feet deep. Incredibly, dust from west Texas has been found in the middle of the Atlantic Ocean.

The farmers do not think the problem is urgent. "This is west Texas," says Ruby Allred of Ackerly. "It's always been this way." Most now use more fertilizer, however, to keep up productivity.

"It's like losing your hair," explains local wind-erosion expert Bill Fryrear. "You don't notice the first few hairs. Then you deny it. The best farmers on the best land may not see much difference in even twenty years, but they sure will in sixty or seventy. Right now technology is just keeping pace."

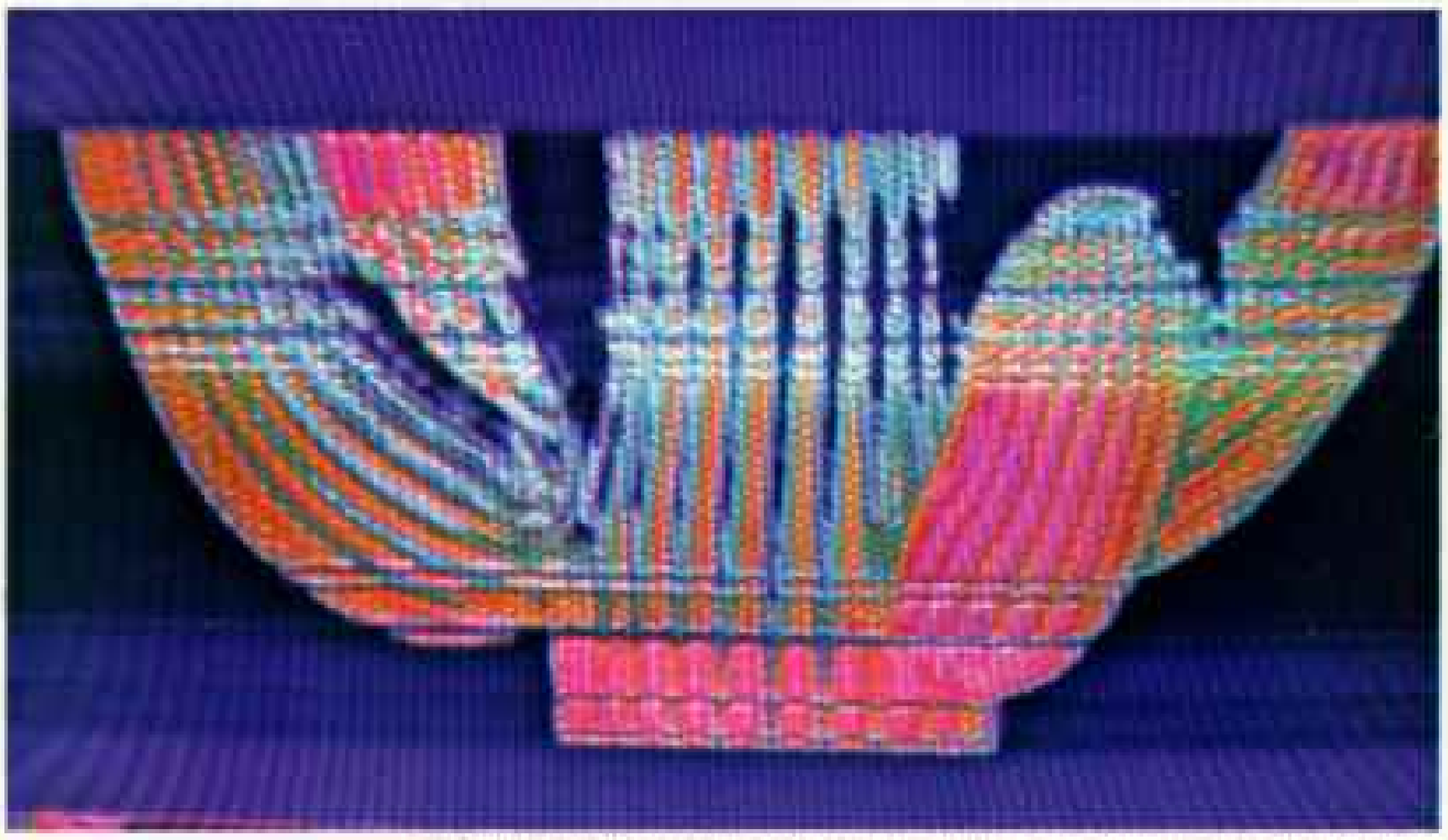
During a sandstorm west Texas seems as much a desert as the Sahara, but it is not a true desert because it averages more than ten inches of rain a year. Our deserts proper stretch from Washington through Utah and south into Mexico. Twenty-five percent of California is desert.

IT IS A WEEKEND NIGHT at the Oh My God Hot Springs, some three hours east of Los Angeles. Sleep is impossible. All night long moonlight bathers drop in for a skinny-dip and a few beers. Dirt bikes race across the dark hills, their motors whining like oversize mosquitoes. A radio blares a song by a group called America: "In the desert you can remember your name, 'cause there ain't no one for to give you no pain."

In this desert, at least, there are a lot of people, and they can be a big pain.

The desert has become a sandbox for the 13 million people of urban southern California. On weekends it seems as if all 13 million own off-road vehicles, or ORV's. Besides upsetting those who like to relax quietly in the desert, ORV's in mass do significant ecological damage. Not surprisingly, the desert has become an environmental

carbon dioxide; the intake increases as the saguaro reduces its temperature. One cooling method, the radiation of heat into the night sky, is revealed by an enhanced infrared photograph ***(below)****. Blue marks coolest areas, red warmest.*



BRUCE DALE, BENTON MOUSHER, NIGHT VISION LABORATORY, NATIONAL BUREAU OF STANDARDS

combat zone, and Congress has told the Bureau of Land Management to come up with a desert land-use plan by late 1980. Already some sensitive regions have been closed and 17 desert rangers have been deployed to encourage users to respect the desert.

The ORV enthusiasts despise these controls. Many have invested thousands of dollars in their vehicles. Dune-buggy racing in particular is promoted as a high-machismo sport, and on a Saturday afternoon at the base of Competition Hill in the Imperial Sand Dunes scores of sportsmen rev and cruise their exquisitely upholstered sleek chrome machines, waiting for a challenge to race up the steep dune. Countless jeeps, dirt bikes, and pickups careen across the less prestigious dunes. Everywhere joyful kids on three-wheel motorbikes are jumping dune crests and rearing up like mustangs on their two hind wheels.

Down the road, cloaked in dust, is the Glamis Store, which proprietor Bill Boyd claims is both the Dune Buggy Capital of the World and California's leading seller of Budweiser and Coors beer. The Imperial Sand Dunes, he says, are the only major sand hills that have not been closed or overregulated. "People have to play," he says.

"You gotta do something to get your aggression out," adds Lloyd Elmsley of San Gabriel. "It's a lot better to beat the dunes than to beat your wife or kids."

Few ORV enthusiasts believe they are damaging the dunes. Indeed the winds do continually erase the tracks they lay. Moreover, four-wheel-drive vehicles and motorbikes do more extensive damage in other parts of the desert. Still, environmentalists argue that despite their barren look dunes support considerable life, including burrowing reptiles and insects that surface only at night or in special seasons. A dune buggy can easily kill or cripple these buried creatures without the driver's knowing it.

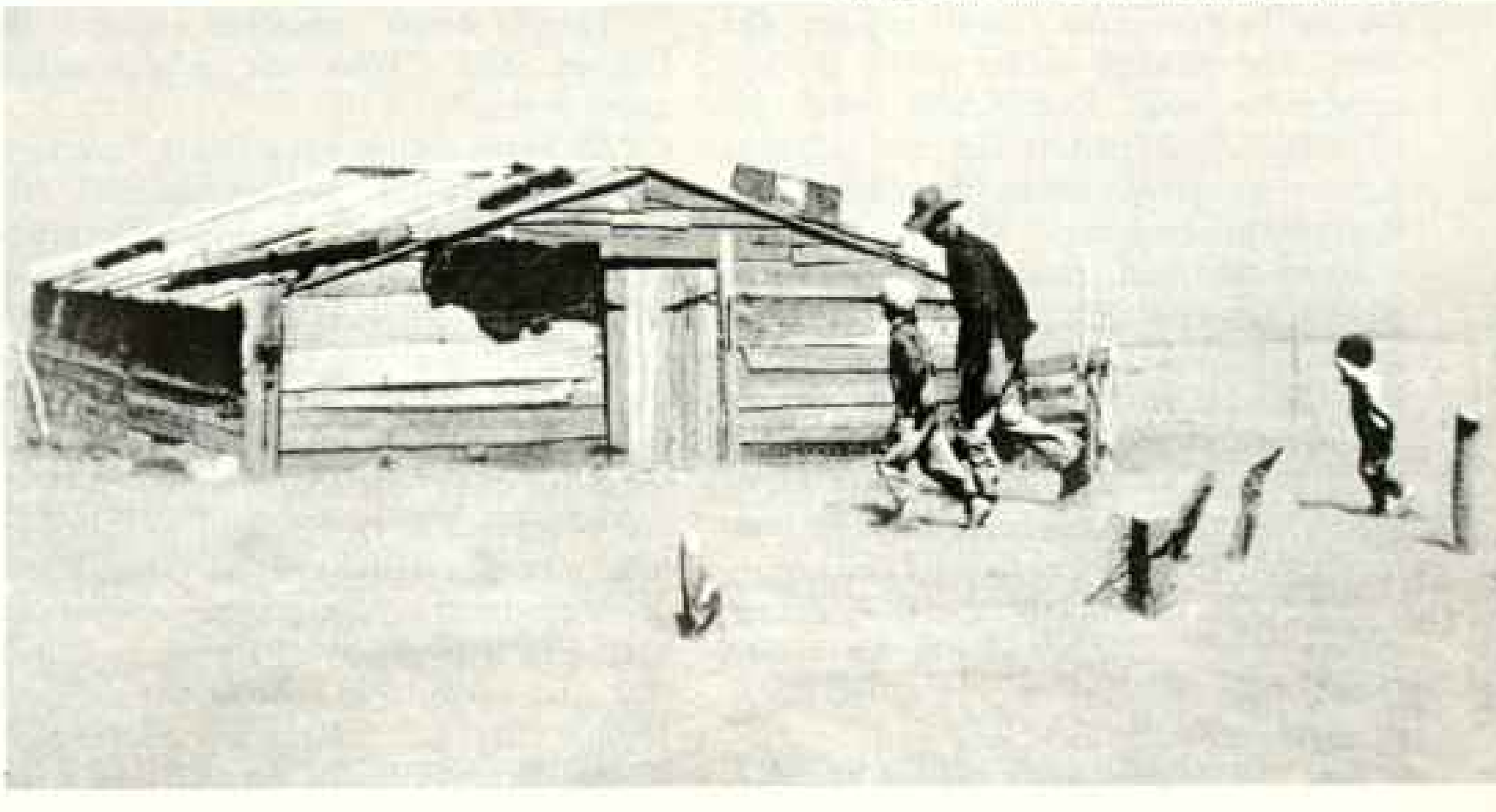
More specifically, the environmentalists say the ORV's imperil seven species of plants in the dunes and that therefore the dunes should be closed.

"They're weeds!" responds a man at the Glamis Store. "Who cares about endangered weeds?"

"All living things have rights," counters desert zoologist Dr. Robert Stebbins. "It's wrong to expect each organism to justify itself according to our perspectives. Even so, where would we be in medicine without a mold called penicillin? Who's to say what the burrowing cockroach's genes may do for us someday? ORV's are helping turn parts of the living desert into true wastelands."

A few years ago a desert plant called jojoba was considered a weed. Then it was discovered that jojobas produce a substance very similar to sperm-whale oil, an expensive and invaluable industrial lubricant. Jojobas may soon be farmed on a large scale without irrigation on desert tracts. So might

BOTH BY ARTHUR ROTHSTEIN, FARM SECURITY ADMINISTRATION (BELOW)



Greening of the dust bowl: *Darrel Coble* (**left,** *at far right) was 3 years old when Arthur Rothstein made this classic photograph of a family fleeing a dust storm in Cimarron County, Oklahoma, in April 1936. On the same land 42 years later, Darrel and two sons walk billowing wheat fields* (**above**). *Irrigation water helped make the difference, but some experts fear that its underground source, the Ogallala aquifer, is rapidly being depleted throughout the Great Plains. Texas author Walter Prescott Webb's warning still echoes: "The desert is the guest that came to dinner, never to go away."*

the desert-adapted, rubber-bearing guayule plant. And Dr. Melvin Calvin believes that a common California dry weed called the gopher plant, or *Euphorbia lathryis*, can brighten our energy outlook.

At his garden in Berkeley, Dr. Calvin pulls off one of the spindly plant's leaves. A milky latex runs out from the wound. This latex can be refined into crude oil, and hence gasoline. Currently it would cost about $30 a barrel to produce oil from euphorbias, but Dr. Calvin insists that improved technology will bring that cost down considerably.

"One hundred thousand acres of desert right now will produce a million barrels of oil," Dr. Calvin calculates. "One Arizona could produce a tenth of the crude oil America now consumes."

Like so many scientists, Dr. Calvin is a technological optimist. He shows me an artificial kidney and says the same type of membranes it uses to filter impurities from human blood could be used to remove salt from seawater, which could then be used to reclaim desert lands.

IT'S A LONG WAY from a laboratory at Berkeley, or even the Imperial Valley, to the great dunes of Egypt and the battered lands of arid Africa and India. In the time it took me to travel that distance, some rain finally fell on Mauritania. Neighboring Niger had grass all the way to the Algerian border. Yet even with bumper moisture the land will not be able to meet the needs of the people who now live on it.

It is easy to fantasize about plantations of jojoba or euphorbia turning a profit in the Sahel, or plastics greening the sands of Rajasthan. Great kidney machines may indeed someday desalinate the Colorado River or irrigate Saudi Arabia. But the lands that need technology the most desperately will find it the least available. The U.N. estimates that it will take 40 years and 20 billion dollars just to reclaim the land lost to deserts in the past 25 years. Who will provide that money, even if protecting the soil is the most rational investment on earth?

Two centuries ago the French philosopher Chateaubriand mused that the forests came before civilization, the deserts after. It is the challenge of the next century to prove him wrong. □

Winged Victory of "Gossamer Albatross"

ON JUNE 12, 1979, a 26-year-old California biologist named Bryan Allen made aviation history. As part of a 22-man team led by environmentalist and aeronautical engineer Dr. Paul B. MacCready, Allen flew a bizarre yet superbly designed aircraft dubbed Gossamer Albatross across the English Channel. The 75-pound airplane's engine: Allen's own two legs.

The achievement earned MacCready's team world acclaim and a prize of £100,000 (about $220,000), offered by British industrialist Henry Kremer for the first man-powered flight across the Channel. Two years previously a MacCready team had carried off a Kremer prize of £50,000 for making a sustained man-powered flight overland along a figure-eight course—a feat reported in the January 1978 NATIONAL GEOGRAPHIC. Pilot Allen's account of his even more dramatic Channel crossing appears on the following pages.*

At right, team members review weather data before the predawn takeoff near Folkestone on England's southeast coast. The goal: France's Cap Gris Nez, 22.5 miles across the Channel.

**Gossamer Odyssey: The Triumph of Human-Powered Flight*, by Dr. Morton Grosser, will be published next year by Houghton Mifflin Co.

NATIONAL GEOGRAPHIC PHOTOGRAPHER OTIS IMBODEN

By BRYAN ALLEN

I WILL NEVER MAKE IT NOW. At takeoff 90 minutes ago, I felt confident. As *Gossamer Albatross* lifted from the makeshift runway, I sensed that this was the day we had worked toward for a year and a half.

The start was smooth, with only a single small mishap—a broken wheel on the initial attempt, which we managed to replace for a second takeoff. Finally, at 4:51 a.m. Greenwich time, the plane handlers released their hold and I pedaled down the short board runway laid out on a concrete ramp near the water's edge. Within moments I reached liftoff speed of ten miles an hour, and *Albatross* was airborne. . . .

4:52 a.m. For the first time I am flying over water and feel a sense of elation. As I survey the breakers several feet below me, it is as if I have emerged from a world of black-and-white dreams into full-color reality.

What audacity, I think, to challenge the elements in such a machine, yet it is designed especially for this flight. Above me the huge transparent wing extends 94 feet, slightly more than the wingspan of a DC-9. In front, mounted on a lightweight pole, hangs the stabilizer by which I can control my direction. Behind me is the 13-foot pusher propeller, connected by a reinforced plastic chain to a bicycle sprocket beneath my seat in the cockpit.

Total weight of the machine, including two-way radio, altimeter, airspeed indicator, and four pints of drinking water, is roughly 75 pounds—plus, of course, my own weight, 140 pounds. Morning dew on the wings and fuselage adds perhaps two pounds. To maintain cruising speed of 12 to 14 miles an hour, I must pedal constantly at 80 to 90 rpm and generate about a third of a horsepower.

For company I have a flotilla of fifteen escort boats, including three inflatable Zodiacs filled with teammates, one stationed astern and one on either side, all with radios. The radar-equipped cabin cruiser *Lady Ellen Elizabeth* stays 500 yards ahead of me with Paul MacCready, the plane's designer, guiding me toward France.

5:07 a.m. The first warning of trouble. Wind and swells make for constant air turbulence. Flying at an altitude of eight or ten feet, I must make frequent adjustments to stay on course. As I begin to sweat from exertion, moisture forms on the transparent cockpit walls, obscuring my view. Variable head winds slow me down, and I sense that I'm falling behind schedule.

5:48 a.m. From the Zodiac on my right Sam Durán, my flight manager, radios a time check every ten minutes or so. The intervals seem more like hours. The turbulence continues, costing me precious time and energy in maneuvering, and I cannot relax for a second. Bending over to sip from the water flask, I veer thirty degrees off course. I glance over my left shoulder; dishearteningly, I can still see the cliffs of Dover. I vow not to look back again.

6:05 a.m. From the lead boat well out in front of me Paul radios that head winds are increasing. "There is another one and a half. . . ." The radio crackles and I catch

only the last words: ". . . to reach France."

One and a half *what?* Hours? How can I do *that?* Never mind the head winds, just pedal, I think to myself, hoping that the message will seep down into my muscles. Pedal and fly.

6:26 a.m. It's no use . . . I'll have to ditch, or take a tow from one of the Zodiacs. The turbulence is heavy, and I sometimes drop to just a foot above the wave crests. My radio transmitter has failed, probably from a dousing of sweat, but Sam sees that I'm near exhaustion. I raise my right hand, the signal for scrubbing the flight, and two Zodiacs zoom close alongside. Bill Watson stands ready with a fishing rod and grappling hook to engage a loop on *Albatross*'s underside.

For Bill to hook up, I must gain altitude, and with a burst of energy I climb to 15 feet. I've gone too high for Bill to make contact. But I've made a big discovery: Above ten feet the turbulence is greatly reduced. In the smoother air I think I can continue. I shout at the crew below, "No tow yet, I'll try it up here for a while." They look dubious but veer away and resume stations. Having barely escaped ditching and having waved away a tow, I struggle to stay in the air.

6:31 a.m. I have almost finished my water now, for we had planned only a two-hour flight. Dehydration presents a serious threat. Dr. Joseph Mastropaolo, our exercise physiologist, has warned that energy output drops drastically with overheating and the loss of body fluids. Pedaling constantly in my plastic greenhouse, I'm dehydrating as fast as a hiker in the Sahara at high noon!

STEVE HANNAGAN

***Failure threatens** just past the halfway point. Skimming about five feet above the English Channel, Gossamer Albatross meets increasing air turbulence and drops to a few inches above the waves (**below**). Signaling defeat, the author pedals furiously to lift the craft so that a crewman can attach a towline with a fishing rod (**above**). But at 15 feet the air is smoother, Allen realizes, so he pedals on, as a ferry from Folkestone churns past, background.*

JANICE A. DUGAN

My receiver still works, but the altimeter batteries are dead, the airspeed indicator is failing, and condensation continues to blur the cockpit walls. I fly now totally by feel and at the limit of my skill.

6:40 a.m. One hour and 49 minutes since takeoff. By now I should be about to touch down at Cap Gris Nez in France. Something looms in the distance, and for one wild moment I think: Land! But it's only a supertanker, making its ponderous way eastward through the Channel.

Paul radios that he's altering my course. Costly but necessary, I think. Such a behemoth can leave a trail of turbulence in the air, even as far as a mile astern. The Channel swells alone are bad enough.

Much later I learn that the British and French coast guards have done a magnificent job of alerting Channel traffic to *Gossamer Albatross*'s flight path. Altogether I glimpse only three large vessels in one of the world's busiest shipping lanes.

The swells pick up again, and the airspeed indicator has quit completely. I rely on the escort boats to warn me of trouble. "One foot!" Crewman Taras Kiceniuk barks over the radio. From somewhere I gather an extra burst of energy and increase the altitude to five feet. Grimly I recall one of the rules of the Kremer prize: The plane's altitude must not exceed 50 meters. No problem there, for sure.

6:59 a.m. At last, word comes over the radio from Sam: "We have France in sight—four miles to go. . . ."

Four miles or four hundred. I'm fading now and know it. Gradually the head winds have been building up, and word comes through the receiver: *Gossamer Albatross*'s airspeed is 12 miles an hour, the surface speed only six. I'm battling a six-mile-an-hour river of air.

I talk to myself and sense that my friends below me are talking too: Don't give up now, you *can* do it! As I waver between hope and despair, the radio crackles again:

"Altitude six inches, six inches; get it up, you've got to get it up!"

Somehow I do, then feel a stab of pain—a growing cramp in my right leg. I shift power as much as possible to the left leg, and the pain gradually eases, only to settle in the overworked left thigh. Long experience has taught me that cramps don't go away with exertion. I'm stuck with them now, along with thirst and head winds.

7:29 a.m. I can make out the French coast, but it seems to come no closer. I am wrong. "*Gossamer Albatross*," Paul shouts over the radio, "you have approximately one mile to touchdown!"

One mile. Less distance than I had flown *Gossamer Condor* two years before for the original Kremer prize. Then, however, there were no head winds or turbulence, no thirst, no cramps. . . .

Some instinct *(Continued on page 651)*

CRIS HRODEN (LEFT, ABOVE, AND FOLLOWING PAGES)

Ounce by ounce. *Thus the 75-pound Albatross was trimmed. The designer, Dr. Paul B. MacCready, checks polystyrene foam around the fuselage of a backup plane (**above**). The 140-pound "engine" trained on a bicycle and an ergometer (**facing page**), which measures power output. Maintaining .30 hp for two hours, the estimated flight time, Allen grabs a drink.*

Albatross *(**following pages**)* *wings toward France, convoyed by official observers, reporters, and design, construction, and logistics experts, including a representative of the flight's sponsor, the Du Pont Company.*

JAMES A. SUGAR

JAMES A. SUGAR

One last barrier *stands between the author and victory* ***(above)****. "I was out of drinking water and my legs were cramping," Allen said. "But I had to pedal another half mile to reach the beach beyond the rocks." Two hours and forty-nine minutes after takeoff, he landed at Cap Gris Nez, France. Unfortunately, a rush of helping hands, trying to steady the craft, grabbed the wrong wires, snapping the 94-foot-long wing* ***(left)****, a testament to the fragility of* Albatross.

Clutching a bouquet ***(right)****, the author describes his epic crossing. Success earned the team a £100,000 prize.*

Why did they do it? Designer MacCready answers: "A great challenge and fun. With limited energy supplies, the ability to do jobs with low power or even human power is important. Our research could mean more efficient surface transportation and improved ultralight aircraft."

OTIS IMBODEN

(Continued from page 645) warns me, and I react just in time. Taras senses danger at the same moment: "*Albatross*, you're mushing! Altitude six inches, and mushing."

At an altitude of six inches I can't dive to gain airspeed. Despite the cramps, I struggle back up to five feet. "Against all hope," I repeat to myself, "against all hope."

7:33 a.m. Sam makes a rare mistake, comic in retrospect, but typical of the strain we are all under. As winds from the land shift into the southeast, his Zodiac begins leading me across the shallows, and he radios: "*Albatross*, fly straight into the sun."

Despite my pain and exhaustion I am forced to smile. The legendary Greek aeronaut, Icarus, with wings fashioned of bird feathers and wax, flew too close to the sun and fell into the sea when the wax melted.

"Correction," Sam announces hastily, "fly *toward* the sun."

7:36 a.m. Four hundred yards to shore. Briefly I survey the beach: A crowd has gathered to welcome me below Cap Gris Nez lighthouse. A small barrage balloon indicates wind direction for a landing.

But I am not there yet. The head wind claws at me, and I note a scattering of offshore rocks, a sure source of turbulence. I look for an alternate route but there is none. OK, then, the rocks. But not too close.

One hundred yards now. I am running on reserves I never knew I had. *Albatross* suddenly yaws, away from the beach. I bear down on the controls and wonder if wing or stabilizer will snap from the strain. Hideous thought, a hundred feet from the beach.

7:39 a.m. *Albatross* answers the controls beautifully, and suddenly I am flying in smooth air, banking into a light head wind that runs parallel to the beach. People cheer and dash back and forth, trying to predict my landing point.

Good enough, I think at last; time to land. I stop pedaling and am suddenly furious: After nearly three hours of desperate pedaling to stay aloft, I naturally assume that when I stop, *Gossamer Albatross* will instantly settle to earth. Perversely it doesn't, but hovers for seconds in the air. Are they going to have to *pull* me down?

Finally my craft, having played its little joke, deposits me gently on the sand.

7:40 a.m. It's over. Two hours, 49 minutes of flight, and a man-powered aircraft has conquered the English Channel. The distance: 22.5 miles, though later I learn that head winds and course changes lengthened the flight to the equivalent of about 35 miles through still air.

On the beach there is pandemonium. Hands clutch at support wires, wing, everything. Vainly I shout, "Turn it *into* the wind." I punch a hole through the taped-up door of the cockpit, and hands reach in to unstrap my feet from the pedals. Under pressure from the wind and from scores of hands, the wing finally snaps, folding with a sigh I can only echo.

To my astonishment I am able to walk. Within seconds I am hugging Sam, Blaine Rawdon, Bill Watson, and other crew members. It is no small feat, considering I am holding a bouquet of flowers and an open bottle of champagne. Surrounded by hordes of cheering people, I feel a sense of bliss amid the indescribable turmoil.

And at last there is Paul, beaming and hobbling toward me on his cast, the result of a jogging accident. One giant bear hug, and we grin at each other. "Take the rest of the day off!" he roars above the crowd.

It seems like a good idea. □

Faces and fashions *of two centuries meet in the boardroom of the Bishop Estate, Oahu's largest private landowner, with 55,000 acres. Estate revenues help educate children of Hawaiian ancestry. The land was bequeathed for that use in the late 1800's by Princess Bernice Pauahi Bishop and her husband, Charles. Their portraits overlook the trustees, who personify Hawaii's ethnic mix. From left: Matsuo Takabuki, Richard Lyman, Hung Wo Ching, Frank Midkiff, and Myron Thompson.*

Which Way Oahu?

EACH DAY the jumbo jets disgorge their throngs of passengers at Honolulu International Airport on Oahu. Then a curious phenomenon occurs. Instead of scattering to pleasure spots all over the Hawaiian Islands' 6,450 square miles—an area triple that of Delaware—90 percent of those visitors will spend at least part of their stay in a 602-acre patch of drained swampland called Waikiki.

Why? Because, to most of the world, Waikiki *is* Hawaii. A staggering 27,000 hotel rooms line its streets, and when winter hits the mainland, virtually all the rooms are full. Three and a half million visitors came to the islands last year, spending more than two billion dollars.

Waikiki got most of it.

Those visitors join the shopping crowds on Kalakaua Avenue, edging past hand-carried surfboards and waiting lines in front of restaurants, bicycle-powered pedicabs seeking passengers, and unsteady tourists on rented roller skates.

Across Kalakaua is the beach of Waikiki, much of it hidden beyond hotels and shops. Overhead, palm fronds rustle. At night propane-fueled torches add their flicker to the multicolored glow of store windows.

These are the memories many tourists bring home from Oahu. I have them too. But even more, I savor recollections of lively prowls through Honolulu and drives into the green world beyond the skyscrapers. Out there, jagged mountains slope down to gorgeous bays. Valleys are carpeted with sugarcane and pineapples. Villages as

By GORDON YOUNG

Photographs by ROBERT W. MADDEN

BOTH NATIONAL GEOGRAPHIC STAFF

WERNER BODE, CAMERA HAWAII

Lofty reflections *of the state's two-billion-dollar tourist industry, hotels and condominiums (***above***) rise between the Ala Wai Canal and Waikiki Beach. In a 1960 photograph showing the same swath of real estate from a different angle (***left***), the extinct volcano Diamond Head, background, had few rivals in prominence. The skyscrapers sprang up during a building boom that has continued unabated since Hawaii gained statehood in 1959. More than a third of Hawaii's 900,000 residents live in Honolulu, capital of the state and its tourist center. Of 3.5 million visitors every year, Oahu gets the lion's share.*

The Waikiki strip now has 27,000 hotel rooms and more on the way. Though the skyline is symbolic of the prosperity of Honolulu, Oahu, and Hawaii as a whole, some see it as an omen of what will happen in still pristine areas of the Hawaiian archipelago if development is not checked or strictly controlled. A big factor will be the actions of the Bishop Estate and 38 other private landowners, who together own 45 percent of Hawaii's 4.1 million acres—88 percent when government land is excluded.

interesting as their vowel-laden names peep out along the road that almost circles Oahu.

If I were a Honolulu dweller, I'd spend my weekends out there.

Many do, of course. You're lucky to find a parking spot near Sunset Beach on a Saturday when the surf is up. Cars line the road for miles.

Like the state's five other major islands, Oahu has a nickname: the Gathering Place. It was sighted by Britain's Capt. James Cook in 1778, but contrary winds prevented his landing there; he sailed on to Waimea on Kauai, where he first set foot on the archipelago he named the Sandwich Islands. Then came New England missionaries, with their dark wool suits and pious ways.

But that was a century and a half ago. Oahu has changed since then. Particularly Waikiki (preceding pages).

"More than half the hotel rooms in the state are jammed in there," an islander grumbled. He talked of Waikiki's still booming construction, symbolized by skeletal blue construction derricks that rear above unfinished buildings. "Our state bird: the great Hawaiian crane."

In spite of the building bustle, Waikiki's tourist population explosion is beginning to taper off. Hideto Kono, director of the state's Department of Planning and Economic Development, assured me that the hotel-building boom is ending. "The ceiling has almost been reached. We may allow a few thousand additional hotel rooms, and then tourists will have to go elsewhere."

Neighboring islands will absorb much of Hawaii's anticipated 5 percent annual tourist growth, but state officials are eyeing rural Oahu too. I walked out of the office bearing a volume describing the state plan.

The gist of it is this: Rather than strew tourist hotels all over Oahu, a few resort areas should be chosen and tourism concentrated there—experience has shown that tourists get restless at isolated hotels. Those new resort areas should create jobs (Oahu's unemployment rate runs more than 7 percent) and generate income for local stores.

The state plan is not universally loved. Driving around the island, I passed hand-lettered signs telling of dissent. TO HELL WITH THE STATE PLAN, read one. STATE PLAN IN THE CAN, read another. Many Hawaii farmers—and, for that matter, owners of homes and condominiums—view the

plan with deep distrust. Don't turn my farm into a subdivision, mutter farmers. Don't bring Honolulu's traffic jams out here, growl homeowners.

Still, pressure for more tourist accommodations continues. With Dave Raney, regional vice-president of the Sierra Club, I drove to the north end of the island, where the Prudential Insurance Company of America hopes to build a large complex, the Kuilima Resort Community. A renovated 487-room hotel is already open. The plans, Dave said, call for as many as 4,700 rooms in additional hotels, as well as condominium apartments and single-family homes.

Resort Growth Pushes Land Prices Up

"Prudential is trying hard to do a responsible job of this," he admitted. "But they are thinking on a mainland scale. A project this size in rural Oahu? I wonder if they realize the impact it will have."

The complex, stretching three and a half miles along the shores of Kahuku Point, will indeed furnish construction jobs. "But when everything is built," Dave commented, "only the hotels will need many employees. Most of the buildings are scheduled to be condominiums, and they will create mainly temporary construction jobs. The basic problem, though, is that land prices will shoot up. Low-income families won't be able to make high lease payments, so they'll either have to go farther back into rural areas and start over, or move into Honolulu, onto the welfare rolls. And the rural character of this part of the island will be threatened."

How, I wondered, can a small farmer survive on high-priced Oahu? Supermarkets buy produce from big mainland growers, who often can ship it to Honolulu and sell at lower prices than Oahu's farmers must ask.

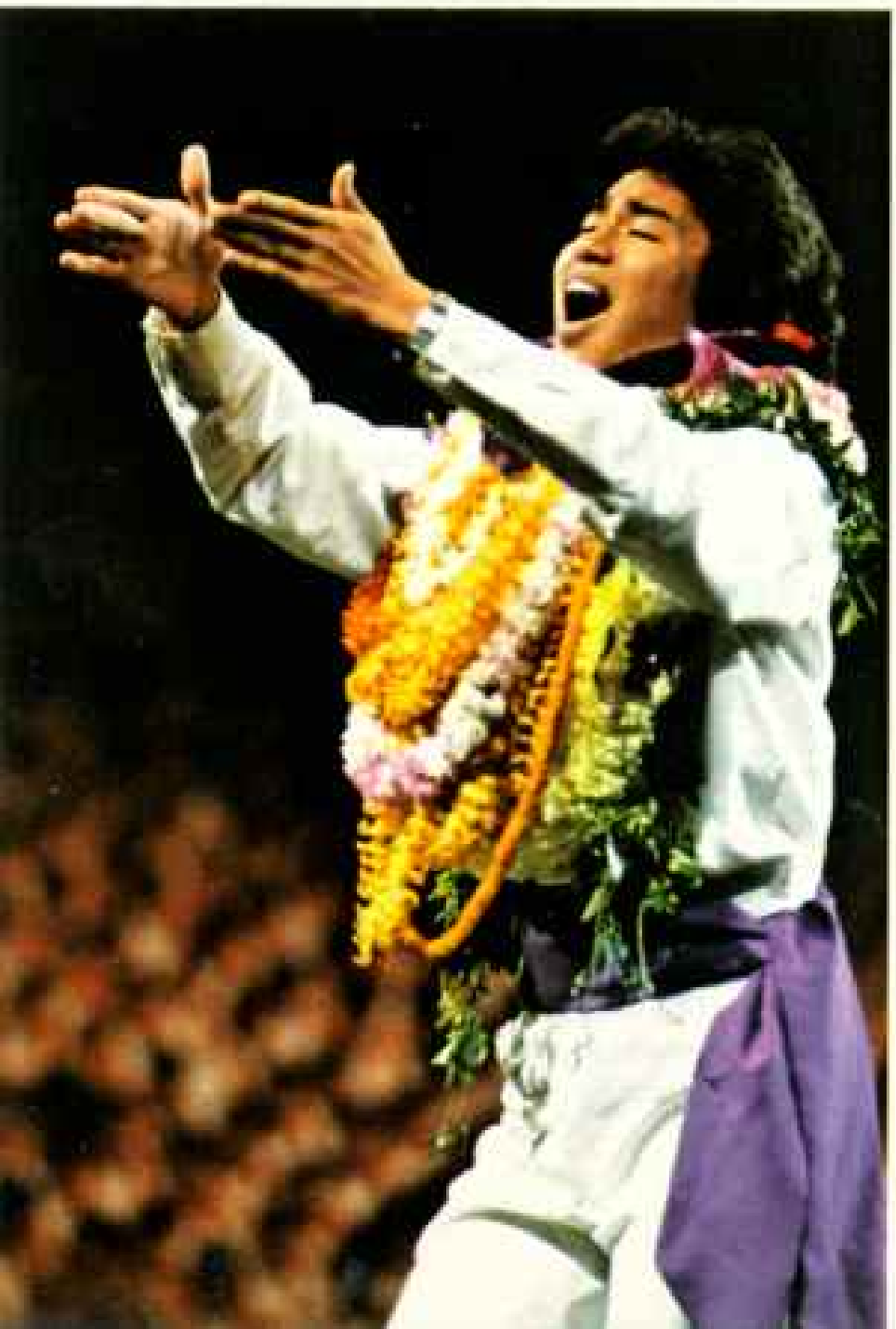
"Local people sell their crops in village markets or through a wholesale cooperative," Dave said. "Sometimes they just barter for things they need, and there's a lot of sharing among Hawaiians. That's why it's hard on low-income residents who are displaced from their traditional communities. They need more cash to survive in the city."

He was silent a moment. "Bartering sidesteps inflation, but it's a trap too. They can't afford to move to another community, away from their trading connections."

Islanders talk about land prices in terms of lease payments; more than half of Oahu belongs to large private landowners (map, page 659). In Honolulu, even without the land, home prices average $110,000—in a place where basements, heating plants, and insulation are superfluous.

"My monthly mortgage payment is more than $700," an acquaintance lamented to me. "No wonder so many married couples hold down two jobs. It's expensive to live in paradise."

Some native Hawaiians on Oahu feel that *they* should be the landowners. From graceful, dark-haired Billie Beamer, past chairwoman of the state's Hawaiian Homes Commission, I learned about that claim.



Spirits jump an octave *during the annual intramural singing contests at Kamehameha Schools, beneficiaries of the Bishop Estate. The senior boys' leader eggs on his charges* ***(left)****; junior and senior girls embrace after a tie* ***(far left)****. The schools educate 2,600 on-campus students from kindergarten through 12th grade.*

"These Hawaiians believe that the overthrow in 1893 of our last monarch—Queen Liliuokalani—was illegal. After she was forced to abdicate and was put in prison, the businessmen who organized that move took more than 900,000 acres of crown land, which ended up as government property. The Hawaiians want it back, plus damages. Congress is studying their claim."

She reflected. "Hawaiians are becoming more obsessed with their Hawaiianness these days. They are making progress—the literacy rate is high, and many are moving up in business—but there's the feeling that the world is moving away from them."

Immigrants Brought Many Cultures

Mrs. Beamer, whose ancestors lived on this island long before the arrival of Captain Cook, believes that religious and social customs made it almost inevitable that Hawaiians would fall behind in the economic struggle.

"Remember," she told me, "most immigrants—Japanese, Chinese, Filipino, Portuguese, and others—came here from long-established civilizations, each with its strong religion, and they worked hard to get ahead. On the other hand, Hawaiian society was adrift, halfway between its old gods and the one the missionaries brought."

About one percent of the islanders today are pureblood Hawaiians, though any fraction of Hawaiian ancestry is enough for official recognition as a member of that race. Seventeen percent of the islanders qualify. I asked Mrs. Beamer about her lineage; she laughed.

"I'm three-eighths Hawaiian. But really, I'm 'calico'—like a lot of us on these islands. Among my ancestors were an Irish sea captain, a Spanish sailor, and a Chinese cook. All of them married Hawaiian women. My full name is Martha Mary Ah Ung Kawaiola Fernandez Beamer."

She pointed out to me that the hunger for landownership extends to Oahu's other ethnic groups as well. "Hawaii's Land Reform Act gives leaseholders the right to petition the state to buy the land they are renting. The state can force private landowners to sell at a price determined by formula. But the state's land prices usually are considered too high by the petitioner and too low by the landowner. Extended litigation is delaying many of the land transfers."

Even Waikiki's posh hotels rest on crazy-quilt patterns of landownership. An official of the fine old Halekulani Hotel expressed satisfaction at the hotel's relatively simple land-rent situation: "We have only four different leases to pay on the land that we don't own outright."

Considering the land tangle and all of Honolulu's business affairs, it came as no surprise to find that the island telephone book has ten pages of attorneys. Many of them are kept busy on the complex problems of converting leasehold land into fee-simple ownership, or are engaged in the tortuous business of arranging new leases.

Waikiki's borders are well defined—by an ocean, a park, and two legs of a drainage canal that fifty-five years ago turned swamp into high-priced tourist acres now packed with hotels. A different world lies on the other side of that canal.

Give that other Honolulu a casual glance and it resembles any number of mainland cities, with busy traffic, quiet suburbs, and towering downtown office buildings. But there is a royal palace near the city center. You can buy octopus tentacles in the local supermarket and have your hamburger at McDonald's with a side order of Oriental noodles served with chopsticks.

One of life's simple pleasures in this city is to amble shirt-sleeved through Ala Moana Park on a winter's day. Joggers will be out in force; so will Hawaiian youths, each with a transistor radio tuned to a rock station, and a pretty *wahine* attuned to him.

One day I roamed through downtown Honolulu, looking for a certain restaurant. "Go *ewa* one block, turn *makai* at the traffic light, go two blocks Diamond Head, and you'll find the *(Continued on page 664)*

Born amid fire and water, *Oahu is the offspring of two volcanoes that eroded into parallel mountain ranges. Their steep lava slopes are mostly unsuitable for development, putting a premium on lower elevations. A new state plan aims at establishing policies for such land uses as conservation, recreation, and historical preservation.*

Oahu

KILOMETERS 10
STATUTE MILES 10

DARK GREEN . . . Conservation district
LIGHT GREEN . . . Agricultural district
YELLOW . . . Urban district

DRAWN BY SNEZHKA STEWART
COMPILED BY OLIVER G. A. M. PAYNE
NATIONAL GEOGRAPHIC ART DIVISION

MAJOR ISLANDS OF HAWAII
0 KM 100
0 MILES 100

Kahuku Point
Kuilima Resort Community
Sunset Beach
Hawaii Earth Station
Kahuku
Sunset Beach
Waimea Bay
Laie
Hauula
North Shore
Kaena Point
Missile Tracking Site
JEEP TRAIL
Waianae Range
Kaala 1,229 m 4,020 ft
Schofield Barracks
Wahiawa
MILITARY RSRV
Wheeler Air Force Base
Makaha
Waianae
Maili
Waianae Coast
Nanakuli
Pearl City
Waipahu
USS Arizona Memorial
Aiea
Pearl Harbor
Ford Island
Naval Shipyard
Hickam Air Force Base
Ewa Beach
Barbers Point Naval Air Station
Coral reef
Honolulu International Airport
Iolani Palace
Mamala Bay
842 m 2,763 ft
Koolau Range
Waikane
Waiahole
Kaneohe Bay
Waihee Stream
Kaneohe Bay Marine Corps Air Station
University of Hawaii Marine Laboratory
Kaneohe
Kailua
Nuuanu Pali 361 m 1,186 ft
Waimanalo
University of Hawaii Agricultural Experimental Station
Punchbowl 152 m 500 ft
National Memorial Cemetery of the Pacific
Honolulu
ALA MOANA PARK
Waikiki
Diamond Head 232 m 760 ft
KAPIOLANI PARK
Koko Head 196 m 642 ft
KOKO HEAD NATURAL PARK
Makapuu Point
157°50'
157°40'
158°10'
158°

Windward Coast

Originating over cool ocean water, northeast trade winds make temperatures seem milder and bring abundant rain to windward slopes.

160° Kauai 158° 156° 22° Niihau Oahu Honolulu Molokai Lanai Maui Kahoolawe NORTH PACIFIC OCEAN 20° Hawaii

KILOMETERS 10
STATUTE MILES 10

Oahu landownership

STATE OF HAWAII
HAWAIIAN HOMELANDS
FEDERAL GOVERNMENT
MAJOR PRIVATE OWNERS (LIST BELOW)
SMALL PRIVATE OWNERS (LESS THAN 5,000 ACRES)

1 Amfac, Inc.
2 Austin Heirs
3 Bernice P. Bishop Estate
4 Capital Investment Co., Ltd.
5 Castle & Cooke, Inc.
6 Estate of H.K.L. Castle (Kaneohe Ranch)
7 Gay and Robinson
9 James Campbell Estate
9 McCandless Heirs
10 Queen's Hospital
11 Samuel M. Damon Estate
12 Zion Securities Corp.

Vaulting like a dolphin over a spuming wave, a windsurfing board

BILL MCCAUSLAND

puts sail and sailor horizontal on a seaward sprint off Diamond Head.

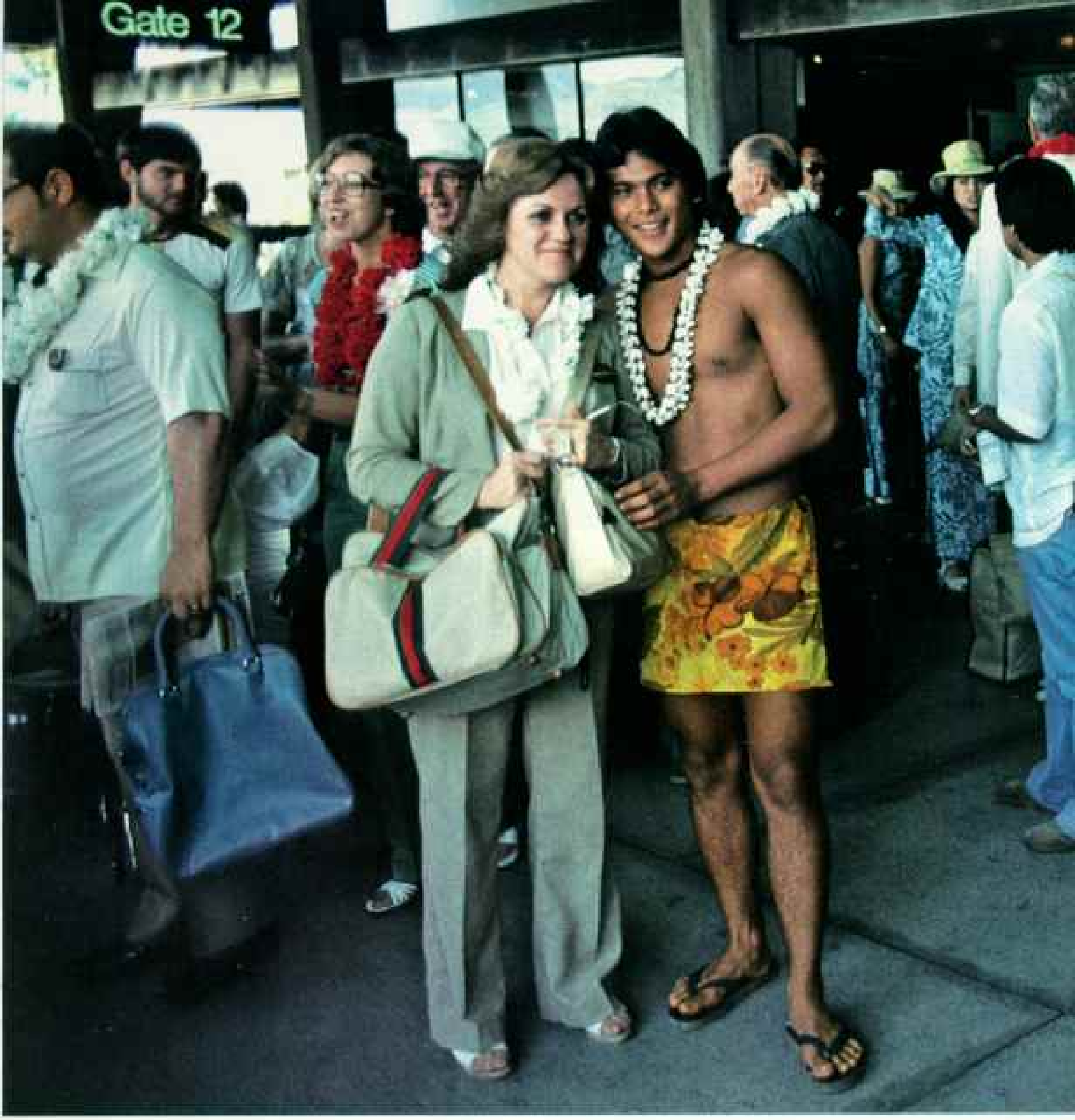

Gate 12

PHOTO MANAGEMENT, INC. (ALL BELOW)

An assembly-line aloha *awaits arrivals at Honolulu International Airport, where Rickie Manuel poses with tourists after presenting them with leis* ***(above)****. Averaging less than ten seconds a person, Manuel greets as many as 500 passengers a day. His employer, using a stable of 40 greeters and 14 photographers, every year sells about 40,000 souvenir pictures such as these.*

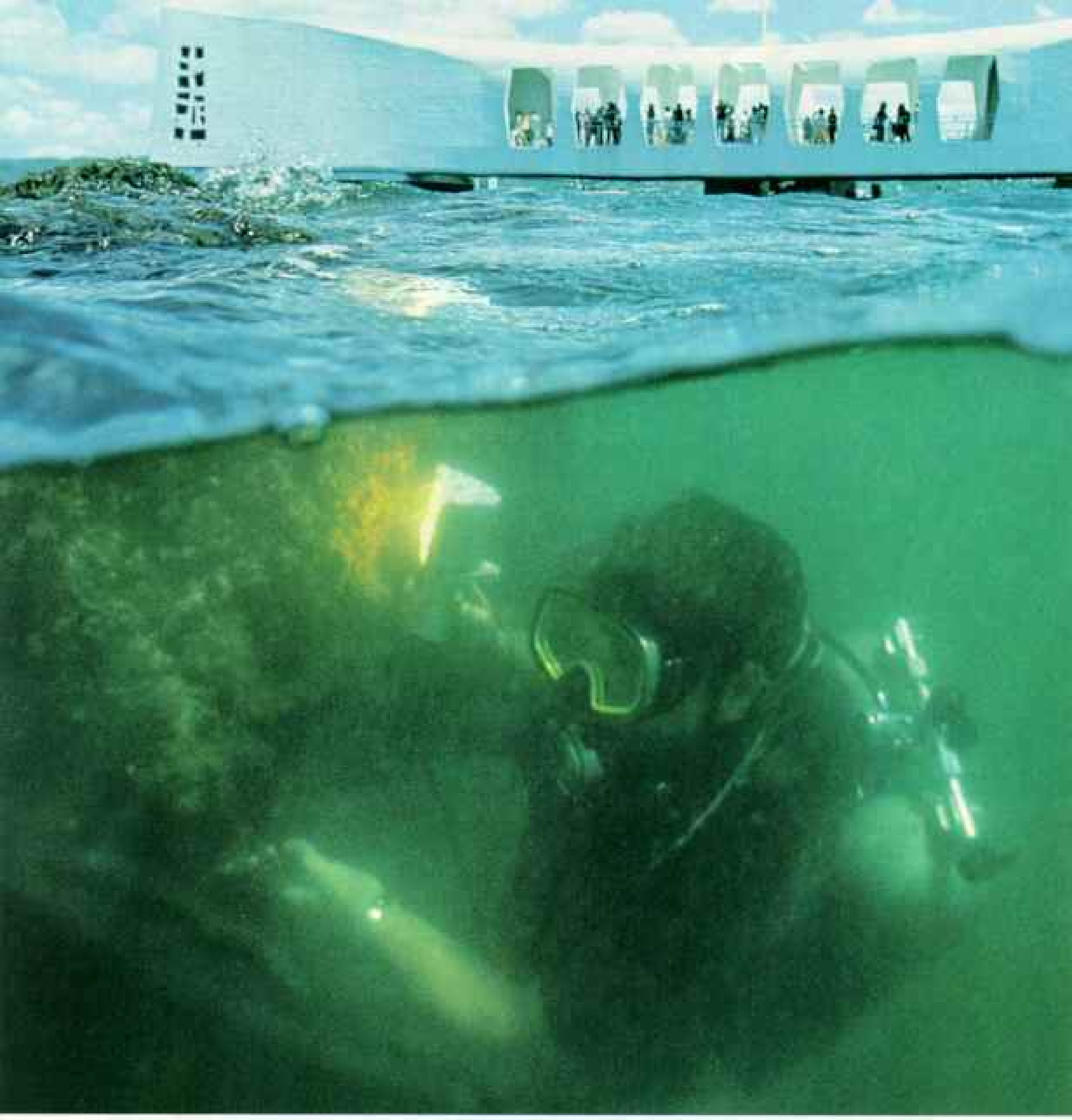
Japanese enter Pearl Harbor *to open arms these days, as this lei-bedecked destroyer on a refueling stop demonstrates* ***(above)****. Beyond lie the mountains crossed by Japanese planes that bombed the harbor on December 7, 1941. Nearby, a U. S. Navy diver views the hulk of the U.S.S.* Arizona ***(right)****. Sunk in the attack, the battleship still entombs more than a thousand of her crew. Though almost completely submerged, much of the ship is visible from the* Arizona *memorial, background.*

(Continued from page 658)

place on the *mauka* side of the street," a helpful passerby advised. I mumbled my *mahalo* (thanks) and studied my map again, unenlightened.

It would do little good to translate these as directions here—for on the other side of Oahu two of the terms are not used, and the other two have opposite meanings.

In addition to its exotic touches, Honolulu has most of the unglamorous problems that plague other United States cities. "Robberies on Oahu Soar by 36%," a front-page newspaper story reported. Alarming, but



when I read the first paragraph of the article, I learned that robberies had climbed from three to four a day. Most cities on the mainland should be that lucky, I thought.

Mike Keller, criminal-justice reporter for the *Honolulu Advertiser*, had written that news story, and he grinned at my observation. "We're not comparing ourselves to anyone, but just looking at our own problem. It's a way of reminding people here that there *is* a problem."

The crime increase, he feels, reflects the arrival of more people in Honolulu each year. "Vandalism is on the upswing too," he pointed out. "Maybe it comes from the population increase—or it could be the result of a growing conflict in life-styles."

Green Harvest of "Gold"

Another big problem is Hawaiian marijuana—"Kona gold." It has frustrated local police for more than a decade. In 1977 the state conducted its first Operation Green Harvest—an aerial sweep over all the major islands to spot marijuana patches. "They located and destroyed plenty of them," Mike

Big push for charity: *In the annual Carole Kai Bed Race, teams propel passenger-laden beds down Honolulu's Kalakaua Avenue* (**above**). *Named for the singer who founded the benefit for handicapped children, the event attracts entries sponsored by firms such as the bank whose advertising logo decorates T-shirts* (**below**).

said, "but not enough to put much of a dent in the traffic."

And growing pot is a lucrative business in Hawaii. "If you grow sugar," Mike said, "you get about 15 cents a pound. Kona gold brings $2,000 a pound."

Politics, too, makes headlines in Honolulu. Hawaii became a United States territory in 1900, a state in 1959. For the first half of this century, the Republican Party ruled. Then came the "revolution of 1954." Backed by the International Longshoremen's and Warehousemen's Union and many AJA's—Americans of Japanese Ancestry—a Democratic regime began. Governor George R. Ariyoshi now heads Hawaii's government.

Honolulu's mayor, Frank Fasi, like the governor, is a Democrat, though party regulars consider him something of a maverick. For nearly a decade Mayor Fasi and the governor have conducted a running feud that has enlivened the political scene.

Governor Ariyoshi would like to hold down the growth rate of Oahu's resident and tourist populations. Mayor Fasi believes growth is inevitable and wants to plan for it, to lessen its impact. While both agree that improved transportation is needed on the island, they differ on how to achieve it. The governor favors a new highway; the mayor wants a mass-transit rail line.

Trade Winds Always Return

There are days when the northeast trades are stilled, and the kona (leeward) wind blows. Back on the mainland the unsettled breezes would hardly be noticed, but Oahu residents are inclined to grumble about such "terrible weather."

Terrible? I left my home near Washington, D. C., with a foot of snow on the ground and subfreezing temperatures. I stepped out of the plane at Honolulu into the balmy 70's. "Bundle up a little bit tomorrow," the TV newscaster advised that evening. "It will be getting down into the 60's."

Such "cold" days are rare, for the yearly average temperature range in Honolulu is less than 14 degrees. Nevertheless, during my stay the weather made front-page news on the Big Island of Hawaii, at the southern end of the archipelago. Torrential downpours there caused major damage and sent Governor Ariyoshi flying over to declare it a disaster area. Meanwhile, only occasional rains fell on Waikiki, not nearly enough to dampen tourists' spirits. "Pineapple juice," they called the rain, and went on strolling Kalakaua. After a week the northeast trades came back, sweeping the skies clear again.

Just past Waikiki famous Diamond Head looms—a towering reminder that this island was born in volcanic fire and smoke. Another long-dead volcano rises from within the city of Honolulu itself; residents know it as Punchbowl.

Together, the craters of these two mountains tell of another inferno—the day Japanese warplanes bombed the United States fleet at Pearl Harbor.

Diamond Head's crater became a fort. The gun emplacements carved through the crater's rim are empty now, visited only by hikers. The Punchbowl crater became the National Memorial Cemetery of the Pacific. Many of the gravestones on its vast green lawn are dated December 7, 1941.

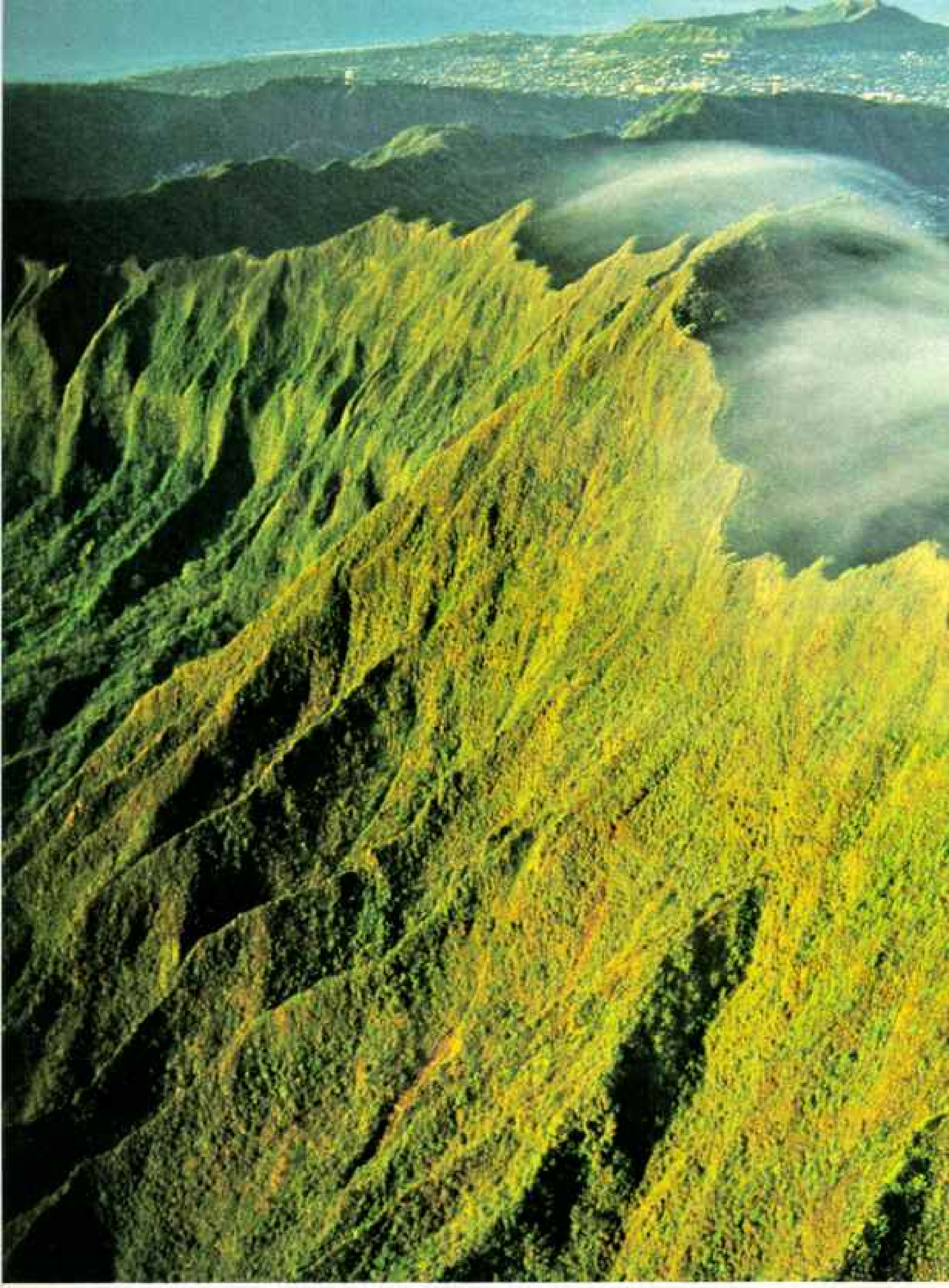
Sunken Ship Stirs Memories

World War II: It was my generation's war. With hundreds of other tourists—many of them Japanese—I cruised through Pearl Harbor, reliving that December 7 attack. Slowly we steamed past the gleaming white memorial to the U.S.S. *Arizona* (pages 664-5). As our boat turned to leave, a crewman dropped his red Hawaiian lei onto the waters, in tribute. I watched it bob in our wake and wondered what thoughts made the gray-haired Japanese near me bury his face in his hands.

Few scars of war still mark the naval base at Pearl Harbor. Its giant shipyard is the largest employer on the island, and a new generation of ships—nuclear submarines—was moored to the docks as I drove by with my Navy escort.

Yes, my war was over. A contingent of foreign warships was due to be welcomed here in the week ahead. Among them would be a Japanese destroyer.

"The Japanese own practically everything on Waikiki now," mainland friends had told me before my trip. A slight exaggeration, it turned out. Less than a third of Waikiki's 27,000 hotel rooms are Japanese owned, though many shopwindows bear signs in that language.



Honolulu sprawls beyond the Nuuanu Pali escarpment, where King

GEOFF JACKLIN

Kamehameha I's warriors pushed island defenders to their deaths in his 1795 conquest.

Where were all the Japanese tourists? Most of the "foreigners" I met at Waikiki spoke my language. They were Canadians.

"We got all geared up for the Japanese invasion, and it never really happened," a Waikiki shopkeeper told me. "The ones we see are good customers; they load up on gifts to take home. But this is a foreign country to them. I hear they're taking their vacations on Guam now, where they feel more comfortable."

That, too, was a slight exaggeration. The number of Japanese tourists on the island is growing, but at a slower rate than that of tourists coming from the U. S. mainland.

Road Circles the Island—Almost

There are four "sides" to Oahu, for the island is roughly diamond-shaped. Half the population clusters on the southern side—Honolulu and the huge Pearl Harbor Naval Base are there.

The eastern side of Oahu, known as the Windward Coast, faces intensive pressure from real estate developers, for it is easily accessible from downtown Honolulu. Three

Unquenchable thirst *of plant and man led to a water-rights dispute between taro growers and urban dwellers. Seiyu Nakata* ***(left)*** *needs fresh flowing water to prevent rotting of the taro roots, from which poi is made. A judge's order that farmers and the Honolulu Water Board share Waihee Valley water satisfied neither side. Fortunately for Aquatic Farms, Ltd., cultivated oysters thrive in algae-enriched salt water* ***(below)****.*

roads already lead to that coast from the city, and a fourth is in the planning stage.

The modest road that winds along the Windward Coast swings left at Kahuku Point and runs along the North Shore. The pavement ends just short of Kaena Point; only four-wheel-drive vehicles can cover the eight-mile gap between the North Shore road and the one that runs along Oahu's fourth side, the Waianae Coast. To reach that coast, a motorist must drive halfway back to Honolulu and resume his trip in a clockwise direction.

That eight-mile gap is not an oversight. Environmentalists and others who oppose expanded tourism on Oahu also oppose the concept of an island-girdling highway.

Much of the mountainous interior is state watershed or military land, off limits to developers. Only a broad saddle lying between the Koolau and Waianae Ranges is level enough for sizable farms, but developments are rare. The highway passing through this level area is lined with fields of sugarcane and pineapples. There are fewer of those fields than there used to be, for

The sea's awesome power *creates some of the world's most challenging surf along Oahu's North Shore. A rushing wave curls its lip in Waimea Bay* **(left)**, *where experts try to vanquish swells up to 25 feet. Flippered feet point skyward as a bodysurfer wipes out amid the fury of a "banzai pipeline" wave near Sunset Beach* **(below)**.

Surfing was common in Polynesia for centuries before Capt. James Cook saw a Tahitian "driven so fast and so smoothly by the sea" in 1777. The sport had nearly died out in Hawaii by the late 1800's, after missionaries discouraged it and natives became preoccupied with the ways of the haoles, or Caucasians. But a revival, sparked largely by haole sporting clubs, began at the turn of the century. Today surfing is widespread and a multimillion-dollar business. World surfing championships are held at Sunset Beach—and down the coast awaits what may be the ocean's ultimate challenge, the rare fifty-foot breakers at Kaena Point.

foreign pineapples and sugar have cut into Oahu's share of the market. Still it is clear, as one drives around the island, why the shoreline areas are so coveted for housing and resorts. The views are nothing short of magnificent, the roads are nearby, and the land is level enough for building lots.

With Dave Raney, I drove along the Windward Coast on the road hugging the Koolau Range. When we paused to view Kaneohe Bay, my companion cast a forlorn glance at the shoreline. "I've seen a lot of construction since I first came out here in 1968. Now look at the urban sprawl."

He pointed offshore. "The reefs out there have been smothered by as much as five feet of sediment from home and highway construction projects. They're clearing up

Bundled up *under a warm spring sun, field workers lunch amid the sharp pineapple leaves that require them to wear goggles and thick clothing while they stoop and pick. Floodlights, background, permit round-the-clock harvesting on this plantation owned by Castle & Cooke, Inc., which markets under the Dole trade name. Growers of pineapples, Hawaii's second largest farm product, suffered in the past from foreign competition, but the market has stabilized. Industry spokesmen give credit to "consumers' recognition of the fresh Hawaiian pineapple's superior quality."*

Problems still plague the state's number one crop: sugar. U. S. growers enjoyed price supports and tariff protection until the Sugar Act expired in 1974. Recession and rising food costs made Washington slow to reestablish them.

somewhat now. But Kaneohe Bay has a barrier reef around it, and that means the bay flushes slowly. It will take a long time for nature to repair the damage."

Farther north along the Windward Coast, the road passes through the Waiahole Valley. Dave told me of the fight to save it from development. "It's a farming community. When developers managed to get the leases, the farmers refused to be evicted. They organized, and even blocked the road. Public sympathy moved to their side, and the state ended up buying most of the valley. But some of the money came from the state housing fund, so people here are still nervous. Is the state planning to put housing in here? Nobody seems to know."

Another village, another real estate

battle. Waikane, two miles farther down the road, is also zoned as agricultural land. "But the land is beginning to go on the market in two-acre plots, as farms," Dave commented. "There is no way of guaranteeing that the buyers will be farmers, of course. Their 'crops' just might turn out to be high-rise buildings."

Many of the battles have already been lost. Dave guided me off the main road, onto a suburban street, wanting to show me the remnants of an ancient Hawaiian fishpond—a semicircular dike in the bay, where ocean fish once were kept as a food supply. Our view was blocked though, by a row of bungalows with high board fences. "By law all beaches are public, as far as the high-water line," Dave muttered. "There has to be an access road." We found it, finally, at the end of the street and drove in—past a stern NO TRESPASSING sign.

That afternoon we stopped to watch Hawaiian surfers ride the waves. One of them, chatting with us, pointed to a row of condominiums a quarter of a mile down the shore. "I learned to surf there when I was little," he said. "It's a better beach than this. But no way I'm going back there, because the rich haoles sit up on their balconies and give me the stink eye."

The poignant words of a Hawaiian song drifted through my mind:

The beaches they sell to build their hotels
*My fathers and I once knew.**

Only rarely on Oahu did I find the militant resentment that typifies so many minority struggles. Once, at a tiny roadside café on the Windward Coast, I overheard a conversation from a nearby table. Four islanders were sitting there, and one of them had lost his leasehold land. The bulldozers were due to move in next day to regrade his farm for housing lots.

"How much dozing they going to get done," he asked, "when I'm sitting up in the hills, popping away at them with a rifle?" But it was obviously rhetorical talk.

Oahu has enough uncluttered beaches left to satisfy any taste. Beaches with fine snorkeling and scuba-diving waters, others with waves for big-board surfing and for body-surfing (using no board at all, or the short, light "boogie board"). One of the most famous is Sunset Beach, on Oahu's North Shore. Each year internationally known surfers come here to compete.

At times the combers at Sunset Beach are too powerful for even the Hawaiian experts to challenge. The boards stay in the cars then, and hundreds of surf-watchers stare silently at thirty-foot combers breaking half a mile offshore, churning the intervening shallows into white maelstroms. Truly it is an awesome sight.

Water for Poi or People?

As Oahu's population grows, fresh water is a subject of mounting concern. Some of the island's restaurants serve it only on request, and a state agency gently coaxes homeowners to grow only "unthirsty" types of plants.

Unfortunately, one of Oahu's traditional crops—taro, from which poi is made—is very thirsty indeed. During my stay on Oahu, taro farmers were demanding more than four million gallons of fresh water a day. Only cool, flowing fresh water would do; otherwise, the taro roots would rot.

Government officials searched for an answer to the dilemma. If taro went, Hawaiian culture would be the loser, but water supplies were already critically short. The taro farmers, in the end, were allocated about half the water they had asked for—a compromise that seemed to satisfy nobody. And, of course, the price of poi went up again.

Ancient Hawaiians looked to the sea for sustenance, but that ocean orientation has been lost, some marine experts feel.

Dr. John Craven, Dean of Marine Programs at the University of Hawaii and State Marine Affairs Coordinator, summarized

* "Waimanalo Blues," by Liko Martin & Thor Wold, Mauna Kea Publ. (BMI).

Invitation to the simpler side *of Hawaiian life, well-worn stairsteps lead to a house in the North Shore town of Kahuku. On a nearby 880-acre tract, the Prudential Insurance Company plans to build a resort community with 5,000 hotel rooms and 2,000 condominiums, a plan fought by those who fear it would rob the town of its identity.*

reasons for that change. "The waves of people who came here focused on agriculture, rather than on the ocean," he said. "Now the focus is on tourism. But there is an immense potential out beyond the reef. Tuna migrate past the island about 200 miles out—we should have a true tuna-fishing industry. Mariculture [farming the open sea] has yet to be developed here. We are beginning to get into aquaculture; more than 100 acres of ponds are going in on the North Shore of the island, to raise freshwater prawns."

Dr. Craven branched off onto a new subject. "Remember, the ocean is a place. Anything you can do on land, you should be able to do out there. Build floating cities, for instance. The technology is here now—look at the offshore oil rigs, even in such inhospitable places as the North Sea."

Some are utilizing even the skies above Oahu. "This island is a communications center," a businessman declared. "A link between East and West. Because we're situated way out in the Pacific, I can line up a conference telephone call between associates in New York and Tokyo and get them both during daylight hours."

That phone call is routed to an earth station on northern Oahu, then beamed up to a satellite parked over the Equator 22,240 miles above the earth, before moving on.

Across the island from that hilltop earth station, other scientists work on a more down-to-earth project. For decades the agricultural aid that the United States has given to Third World countries has been based on temperate-zone crops. Now agronomists at the University of Hawaii's Agricultural Experimental Station at Waimanalo are developing special varieties of corn and other high-protein crops that will grow well in the earth's tropical regions.

Energy From Sugarcane and the Sun

Six years ago I landed in Honolulu at the height of an oil embargo. "We lucked out at first," a Hawaiian acquaintance told me at the time. "Then the Arabs realized that this island was really a part of the United States, and they shut us off." I still wince, thinking of getting my rental car in line each day for my allotted three gallons of gasoline.

There is no doubt about it; these remote islands are vulnerable, for they consume more than twenty million barrels of oil a year, producing not a drop of it.

Still, there are alternatives. "Sugarcane can be used to make methane gas or ethanol for gasohol," state planning director Hideto Kono said. "We can burn the leftover, called bagasse, for fuel, as we do on the Big Island of Hawaii and on Kauai. Fast-growing trees, such as eucalyptus, could be raised as fuel too. There's a project under way off the coast of the Big Island, pumping cold water up from the depths. The temperature differential between it and the warmer surface water will be translated into power."

He gestured toward the window, which framed downtown Honolulu. "There is plenty of natural energy out there. Already Hawaii has more than 7,000 solar collectors in use. The northeast trades blow 70 percent of the time—soon a 200-kilowatt wind generator will be operating in the mountains not far from here."

He stared out at the tall, air-conditioned buildings. "Our architects were trained in other states, so the legacy has been heavy mainland-type building. We should have lighter, more open structures than those; buildings cooled by the trade winds."

Mr. Kono veered to a happier subject. "You know, these are exciting days in the islands. Here we are, 200 years after Captain Cook and twenty years after statehood, ready to become the nation's major link with Asia. We have a good racial mix—well-trained people who know how to get along with East and West."

Animated, he leaned across his desk. "The Pacific trade area is growing fast, as the Asian nations work hard to upgrade their living standards. Today it develops 80 billion dollars in U. S. trade each year—more than the Atlantic trade. And we in Honolulu are in the middle of it, with people who understand Asian ways."

Mr. Kono sees Oahu as regional headquarters for great multinational corporations, doing business and shipping cargo all over the Pacific.

He is not alone in believing that Hawaii's destiny is tied to Asia. An elaborate new World Trade Center is planned for the Honolulu waterfront. A foreign-trade zone already serves as a warehouse for goods in transshipment from both East and West.

But before that Pacific destiny comes to pass, there are urgent problems to face. More than 80 percent of the state's income stems from tourism plus defense and other federal spending. Suppose an oil crisis stops the jumbo jets; suppose sizable cuts are made in military budgets? Nightmarish thoughts, these, to islanders. Last spring a strike at United Airlines reminded Oahu of its vulnerability. United's planes were grounded—and Waikiki's tourist population dropped suddenly.

Oahu Seeks a Workable Balance

Last year Hawaii became the first state in the nation to enact a comprehensive state plan, outlining its goals and the policies needed to attain them. Detractors call it an ineffective collection of noble generalities and point out that it can be interpreted to suit the convenience of any future politician.

But, say supporters, at least it is a start. While it won't solve problems, it will focus on them. Diversification of industry, protection of a fragile environment, balancing needs of farmers and developers—the problems are many. Somewhere there may be an answer to each one of them.

Wait: all but one. Waikiki's crowded thoroughfares will become more crowded still, as the tourist crush intensifies.

Unless, of course, Dr. Craven's dream of floating cities does come true. Then Waikiki's hotels could simply put to sea. □

Strength in numbers *helped Pascual Saoit and others who leased homes and land from the state on a former plantation at Waimanalo. Facing eviction, they organized, got a new 65-year lease, and used public financing to buy old houses and build new ones. Meanwhile, the state dropped its plans for an industrial park on the site.*

EMORY KRISTOF AND ALVIN M. CHANDLER, BOTH NATIONAL GEOGRAPHIC STAFF, BY REMOTE-CONTROL CAMERA (ABOVE); EMORY KRISTOF

Scientists explore rifts in the seafloor where hot springs spew minerals and startling life exists in a

Strange World Without Sun

ACROSS THE BOTTOM of the four oceans of the world runs the largest feature on the face of this planet, a mountain range and rift system some 40,000 miles long. Man has seen with his own eyes scarcely forty miles of this Mid-Oceanic Ridge.

But along those few miles in the past six years, scientists in tiny submarines such as *Alvin* (**above**) have found, in those utterly dark nether depths of the sea, animals and mineral factories unlike any seen before.

In 1979 the latest in a series of expeditions went out into the Pacific to study spreading centers of the ocean floor. These are places where the thin, rigid plates that form the hard crust of our planet are pulling apart, separating as much as eight inches a year. In the cracks molten magma wells up, meets cold seawater, and solidifies into a contorted landscape of black lava.

In such regions the scientists have been witnessing the all but unbelievable. They have seen:

- Huge blood-red worms protruding from forests of white plasticlike tubes (***right***).
- Clams far larger than most shallow-water types, their meat scarlet with hemoglobin.
- Strange dandelionlike creatures moored by threads near fountains of warm water.
- Plumes of even hotter water—350°C (650°F) or more—spewing black clouds of

minerals from seafloor chimneys (***right***).

Since William Beebe's bathysphere dives in the 1930's and the descents of Jacques-Yves Cousteau, Jacques Piccard, and others in the 1950's and 1960's, the National Geographic Society has participated in and reported on many historic ocean explorations.

In May 1975 NATIONAL GEOGRAPHIC carried a full report on Project FAMOUS, man's first look at the Mid-Atlantic Ridge. In August 1976 we described dives into the yawning Cayman Trough in the Caribbean. In October 1977 the GEOGRAPHIC reported the astonishment of geologists who descended to the Galapagos Rift in the eastern Pacific and first discovered warm-water vents teeming with life. Rich in hydrogen sulfide and bacteria, these oases apparently attract larval organisms drifting in the currents.

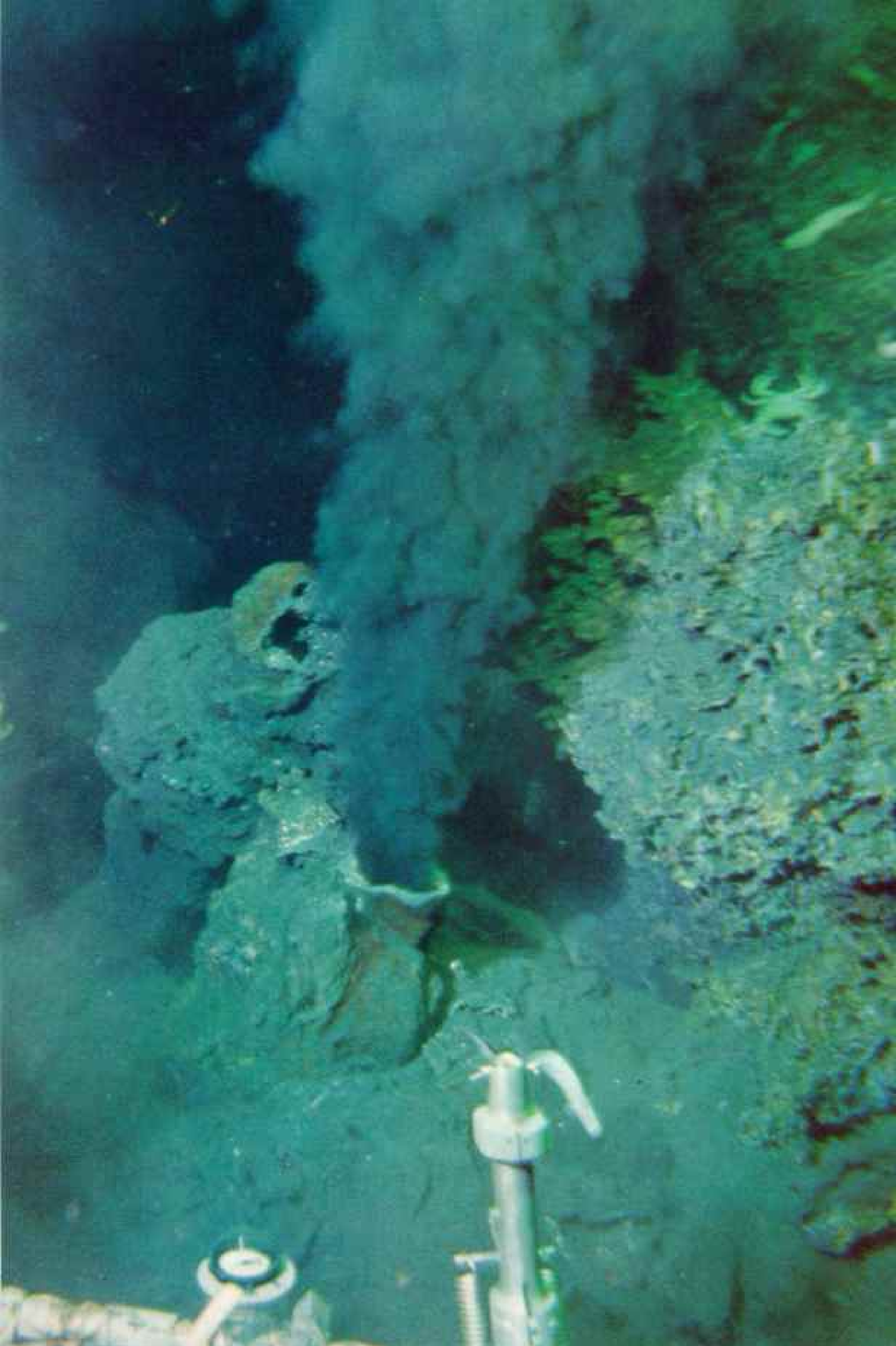
This discovery set the stage for further dives in the Pacific. In 1978, French, U. S., and Mexican scientists using the French submersible *Cyana* explored the East Pacific Rise at 21° North, off the mouth of the Gulf of California. They found inactive vents and huge dead clams, similar to those discovered on the Galapagos Rift in 1977.

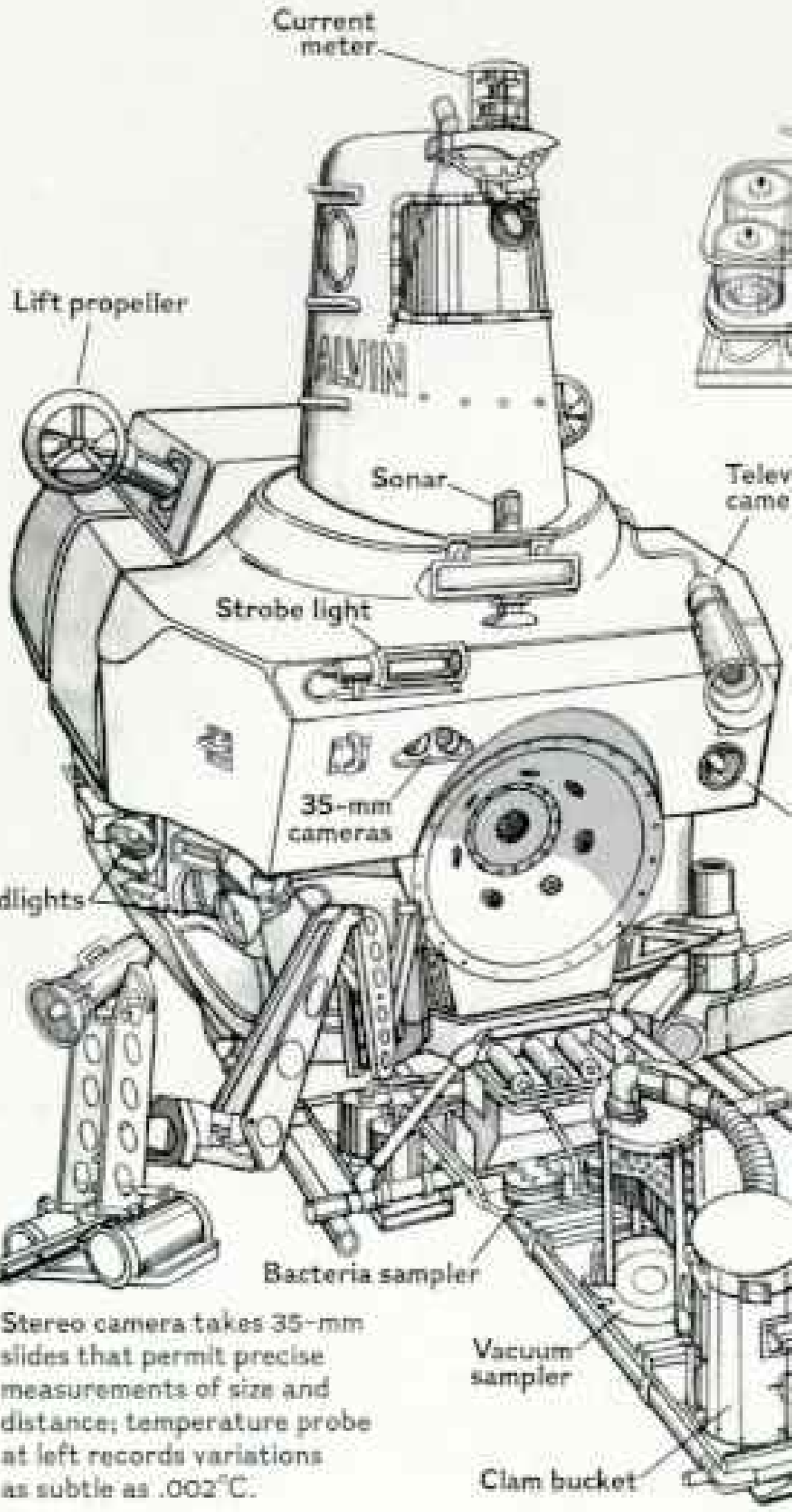
Then, in back-to-back expeditions beginning in January 1979 and continuing this fall, funded by the National Science Foundation and the Office of Naval Research, scientists returned to the Galapagos Rift and 21° N with *Alvin* and its support ships. On the pages that follow, two of the leaders report on expedition findings.

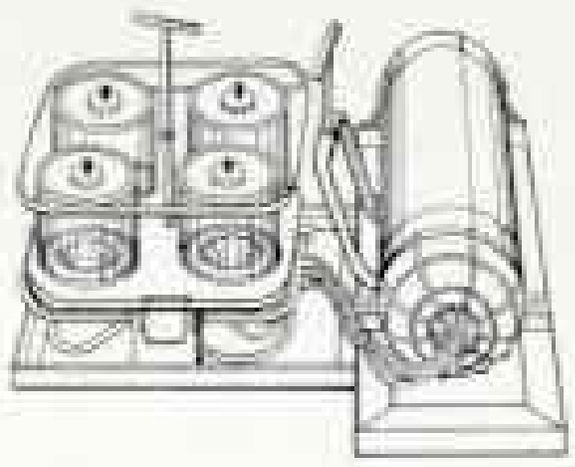
WE ARE PROUD that the National Geographic Society has played a part in these explorations. By a major research grant, as well as by providing cameras, film, and photographic experts and by operating color laboratories aboard the surface ships, the Society has markedly extended science's ability to see and record phenomena in the abyss. A revolutionary new TV system has been one result (***page 705***).

Next January 7 a National Geographic television documentary of the Galapagos II expedition will be shown by the Public Broadcasting Service. I have seen the preliminary footage and feel sure that you will be as awed by it as I was. The discoveries it relates represent a truly great milestone in our knowledge of the earth. —THE EDITOR

DUDLEY B. FOSTER, WOODS HOLE OCEANOGRAPHIC INSTITUTION







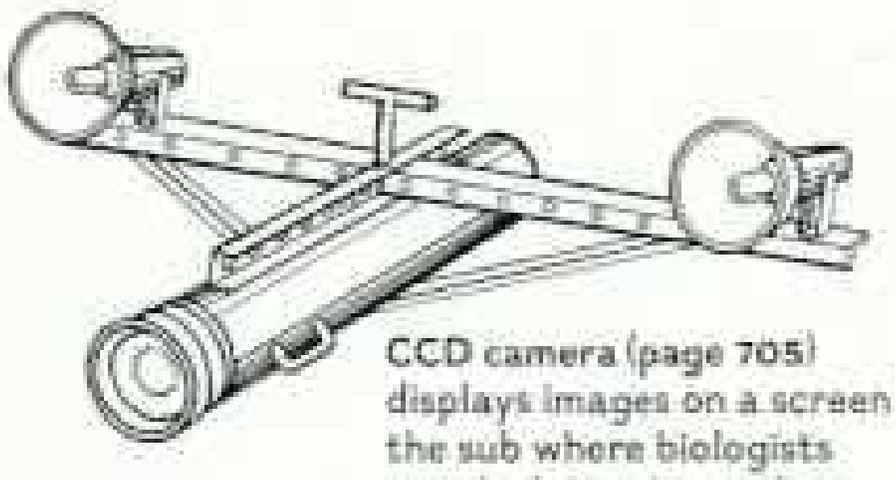
Respirometer, measuring oxygen use by mussels, rests on the bottom. *Alvin*'s claw drops specimens into its four chambers (page 694).

Collecting panels, made of slate to mimic the seafloor, were left on the bottom in January to be retrieved in November. The rates of settlement of larvae at different heights from the bottom will aid studies of colonization.

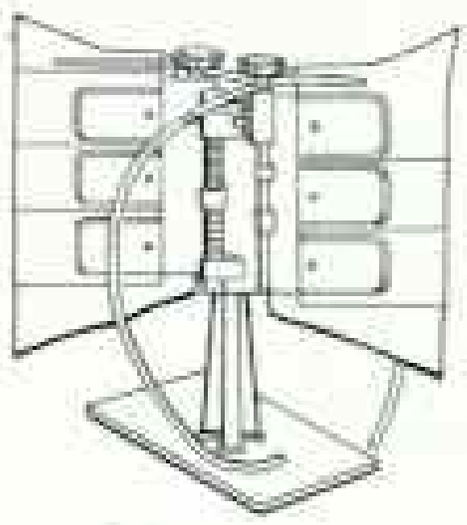
Equipment tray carries traps, corers, nets, and samplers, such as a slurp gun to vacuum up fragile animals.

Stereo camera takes 35-mm slides that permit precise measurements of size and distance; temperature probe at left records variations as subtle as .002°C.

Mud grab: Guided by the sub pilot, the claw places the tool outside the rocky vent area. A later twist of the T-bar handle takes up a sample of sediment to be screened for organisms.



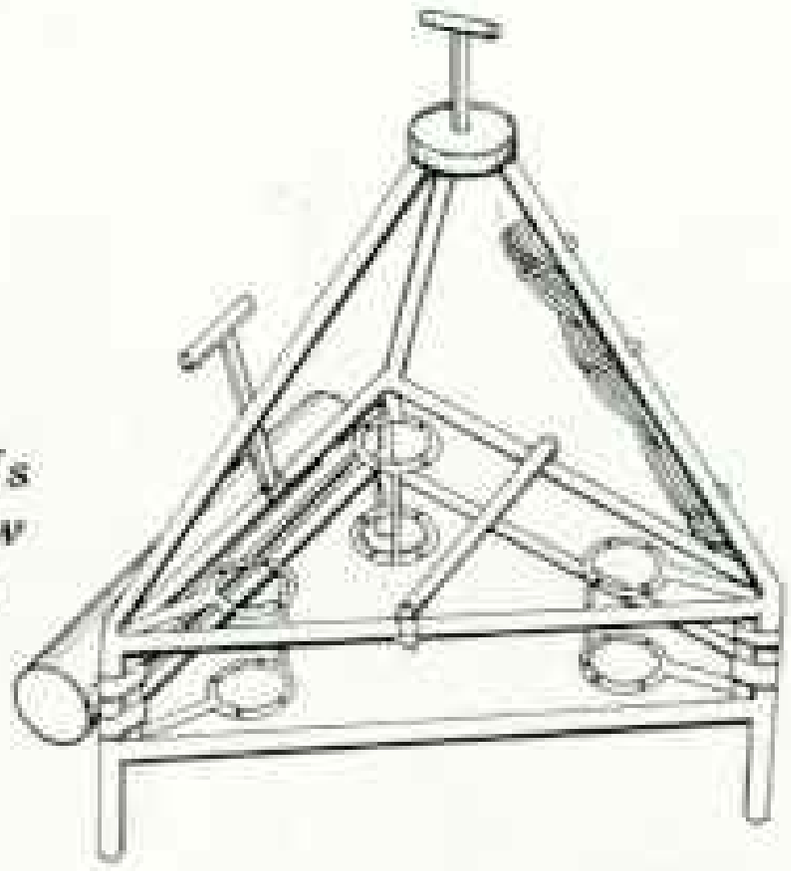
CCD camera (page 705) displays images on a screen in the sub where biologists watch close-ups, such as a crab scraping food.



Water sampler consists of two plastic bags around metal fingers; *Alvin*'s claw trips a release that snaps the fingers open to take uncontaminated water for bacterial analysis.

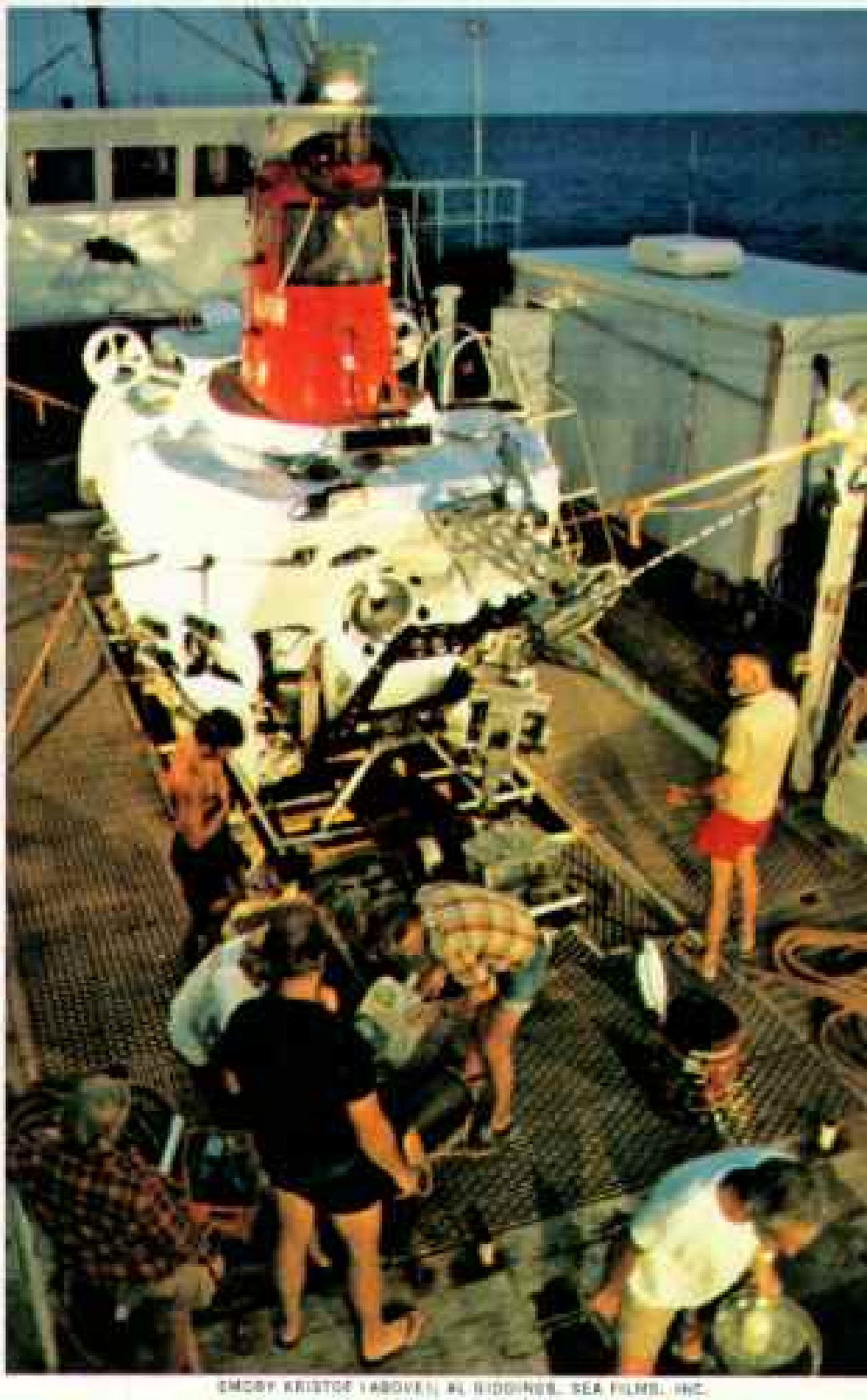
Alvin's many hands

Scientists design tools that can be maneuvered by Alvin's two arms. An adjustable claw reaches out to grab rocks or collect delicate animals.



Acoustic velocity meter measures the speed and volume of water coming from vents.

DRAWING BY DOROTHY MICHELE NOVICK AND JANE WOLFE; COMPILED BY ROSS M. EMERSON
NATIONAL GEOGRAPHIC ART DIVISION



Seafloor explorers: *Geologist Robert D. Ballard* ***(top)*** *has descended in* Alvin *to all the deep-sea spreading centers so far explored—the Mid-Atlantic Ridge, Cayman Trough, Galapagos Rift, and East Pacific Rise at 21° N—and described those adventures in the* GEOGRAPHIC.

Marine biologist J. Frederick Grassle ***(above)*** *usually conducts ecological studies of diverse animal communities living in Atlantic sediments.*

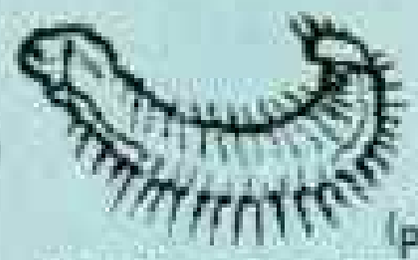
Alvin has carried scientists and their tools on more than 900 dives since it was commissioned in 1964 at Woods Hole Oceanographic Institution, WHOI. *Funded by NSF, ONR, and the National Oceanic and Atmospheric Administration, the sub travels aboard the catamaran Lulu* ***(above, right)****.*

EMORY KRISTOF (ABOVE); AL GIDDINGS, SEA FILMS, INC.

For the 1979 Galapagos expedition, other biological investigators were Carl J. Berg and Ruth D. Turner, Harvard University; James J. Childress, University of California at Santa Barbara, UCSB; Judith P. Grassle, Marine Biological Laboratory; Robert R. Hessler, Kenneth L. Smith, and George N. Somero, Scripps Institution of Oceanography, SIO; Holger W. Jannasch, Howard L. Sanders, and Albert J. Williams III, WHOI; David M. Karl, University of Hawaii; Richard A. Lutz and Donald C. Rhoads, Yale University; Jon H. Tuttle, University of Texas. Other geologists were Robin Holcomb and Tjeerd H. van Andel, Stanford University; Kathleen Crane, WHOI. Geochemists included John Edmond, MIT; John B. Corliss and Louis I. Gordon, Oregon State University; Michael L. Bender, University of Rhode Island.

On the subsequent U. S.-French-Mexican geological expedition to 21° N, the principal scientists were Fred N. Spiess and Kenneth C. Macdonald, co-leaders, and John A. Orcutt, all of SIO; Bruce P. Luyendyk, UCSB; William R. Normark, U. S. Geological Survey; Jean Francheteau and Thierry Juteau, Centre National pour L'Exploitation des Océans; Arturo Carranza, Diego A. Córdoba, Victor Díaz, José Guerrero, and Claude Rangin, Universidad Nacional Autónoma de Mexico.

Living oases: Direct observation of a dozen vents teeming with life suggests animals arrange themselves in zones, probably in relation to the food supply and mineral deposits. This diagram portrays vents actually 2,100 miles apart. At the left an oasis at 21° N spreads 25 meters around "black smokers" jetting mineral-laden water estimated at 350°C. When the plumes mix with 2°C seawater, minerals precipitate out to form chimneys and blanket slopes at their base.



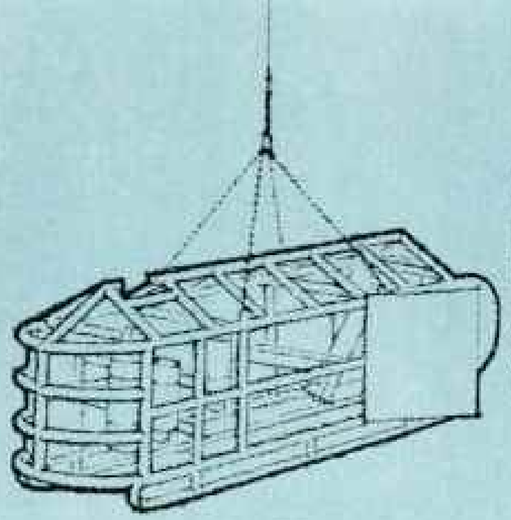
Pompeii worm, a 10-cm polychaete (page 698), cements its tube near chimneys (pages 682-3). A relative that covers Galapagos rocks is the serpulid worm, a filter feeder (page 692).

Water circulation: Seawater seeps through porous rocks to unknown depths and percolates up, saturated with minerals. Oxidizing some of these minerals, bacteria multiply in the crevices where temperatures reach at least 23°C.

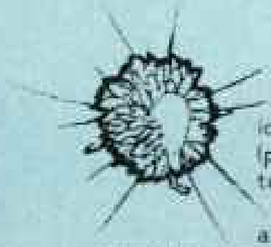
In total darkness, a new chain of life

Warm-water vents overgrown with organisms (left) *occur at both dive sites visited by scientists along rifts in the Pacific floor* (map). *The oases were found along spreading centers where earth's crustal plates pull apart a few centimeters a year* (below). *Seawater seeps into cracks, becomes superheated, and picks up minerals from the crustal rock. As solutions of hydrogen sulfide rise to the ocean floor, bacteria metabolize it and multiply, creating the primary food source for higher organisms.*

The discovery of an ecosystem based on chemical synthesis overturns the conventional idea that sunlight is always the main source of energy for life. Oases probably occur along many stretches of the Mid-Oceanic Ridge.



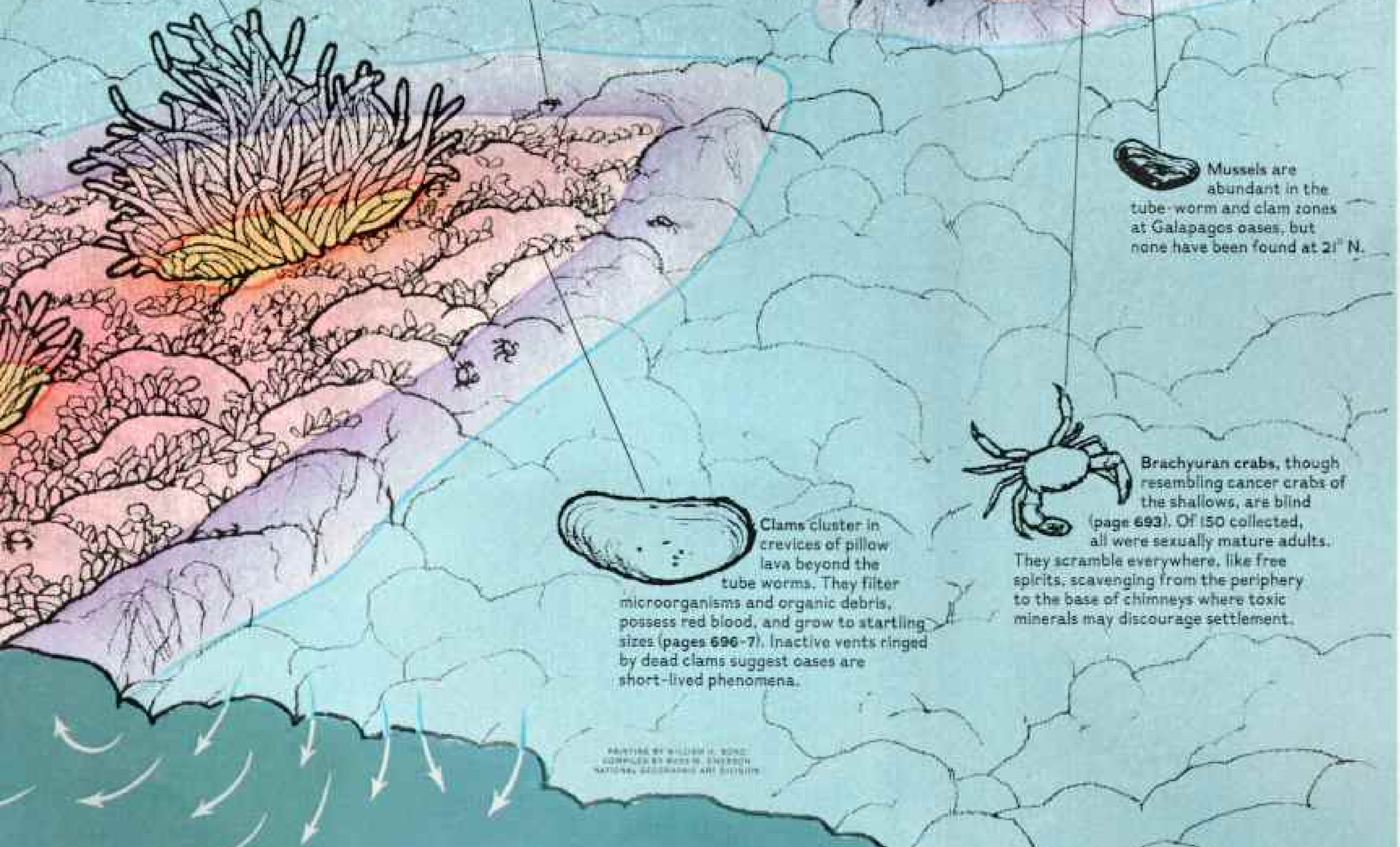
ANGUS: Controlled from a surface ship, this two-ton camera sled glides above the bottom, taking a color picture every 10 seconds for 14 hours. From a height of 18 meters, each frame covers half an acre, or 2,023 square meters. Of the 45 vents found so far in the Pacific, ANGUS pinpointed 42, *Alvin* 3.



"Dandelion," the nickname for a 5-cm creature spotted in 1977, was identified as a siphonophore (page 698). It anchors itself to peripheral rocks away from the tube worms and clams. Nearby, something geologists in 1977 called "spaghetti" turned out to be an acorn worm, or enteropneust.

Galatheid crabs are commonplace in the deep. At oases they perch on pillow lavas, possibly filtering bacterial clumps from the water.

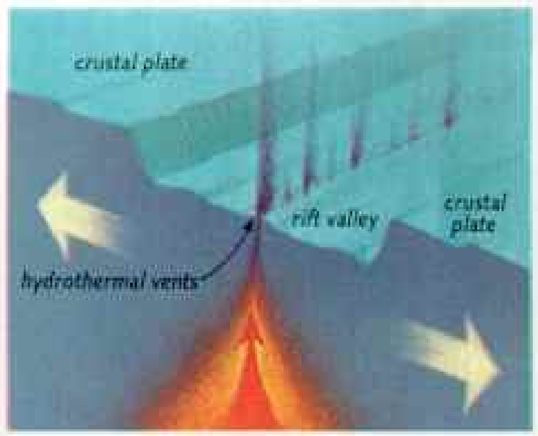
Tube worms thrive in temperatures of 3° to 23°C (pages 681 and 689-691). They absorb molecules of food through furlike blood-filled red tentacles.



Mussels are abundant in the tube-worm and clam zones at Galapagos oases, but none have been found at 21° N.

Clams cluster in crevices of pillow lava beyond the tube worms. They filter microorganisms and organic debris, possess red blood, and grow to startling sizes (pages 696-7). Inactive vents ringed by dead clams suggest oases are short-lived phenomena.

Brachyuran crabs, though resembling cancer crabs of the shallows, are blind (page 693). Of 150 collected, all were sexually mature adults. They scramble everywhere, like free spirits, scavenging from the periphery to the base of chimneys where toxic minerals may discourage settlement.



Return to Oases of the Deep

By ROBERT D. BALLARD
and J. FREDERICK GRASSLE
BOTH WOODS HOLE OCEANOGRAPHIC INSTITUTION

THE SCENE a few feet outside *Alvin*'s view port overwhelms. A riot of red-tipped worms, some of them 12 feet tall, grow around the organic-rich vents (***right***). Crabs and mussels are everywhere. These creatures that greeted geologists diving in 1977 now meet us, a group of biologists, chemists, and geologists returning to study the living oases of the Galapagos Rift (***left, foldout***).

The extraordinary worms have no eyes, no mouth, no gut, no anus. Laboratory dissections reveal they do have separate sexes, and most likely broadcast eggs and sperm into the water. Hemoglobin—red blood pigment—accounts for their bright color. Covering the solid spongy plume, more than 300,000 tiny tentacles arranged on flaps, or lamellae, absorb molecules of food and oxygen from the water. The blood carries this nourishment throughout the body.

The concentration of suspended food available at the vents is amazing. By one estimate, it is 300 to 500 times greater than just outside vent areas and four times greater than in productive surface waters.

CLASS VESTIMENTIFERA, KATHLEEN CRANE, WHOI

Fountains of life in the abyss

WE LOOK directly into the heart of an active vent as *Alvin*'s heat probe, at left, registers up to 13°C (55°F), much warmer than the usual deep-sea chill of 2°C. Yet heat is not the main lure for the flowerlike sea anemones, brown mussels, curling serpulid worms, and blind crabs gathered here, 2.5 kilometers below the surface. Sparse populations of similar animals survive the cold even at the sea's deepest point, 11 kilometers, existing on whatever organisms drift down from the sunlit surface.

Animals congregate at vents because of the enormous food supply based on bacteria. The bacteria, sulfur, and heat give the vent water its milky blue shimmer. Microbes exist everywhere in the sea, often in a state similar to suspended animation. Some types can metabolize hydrogen sulfide; when they

find that nourishment here in vent water, they proliferate, providing food for clams, worms, and mussels.

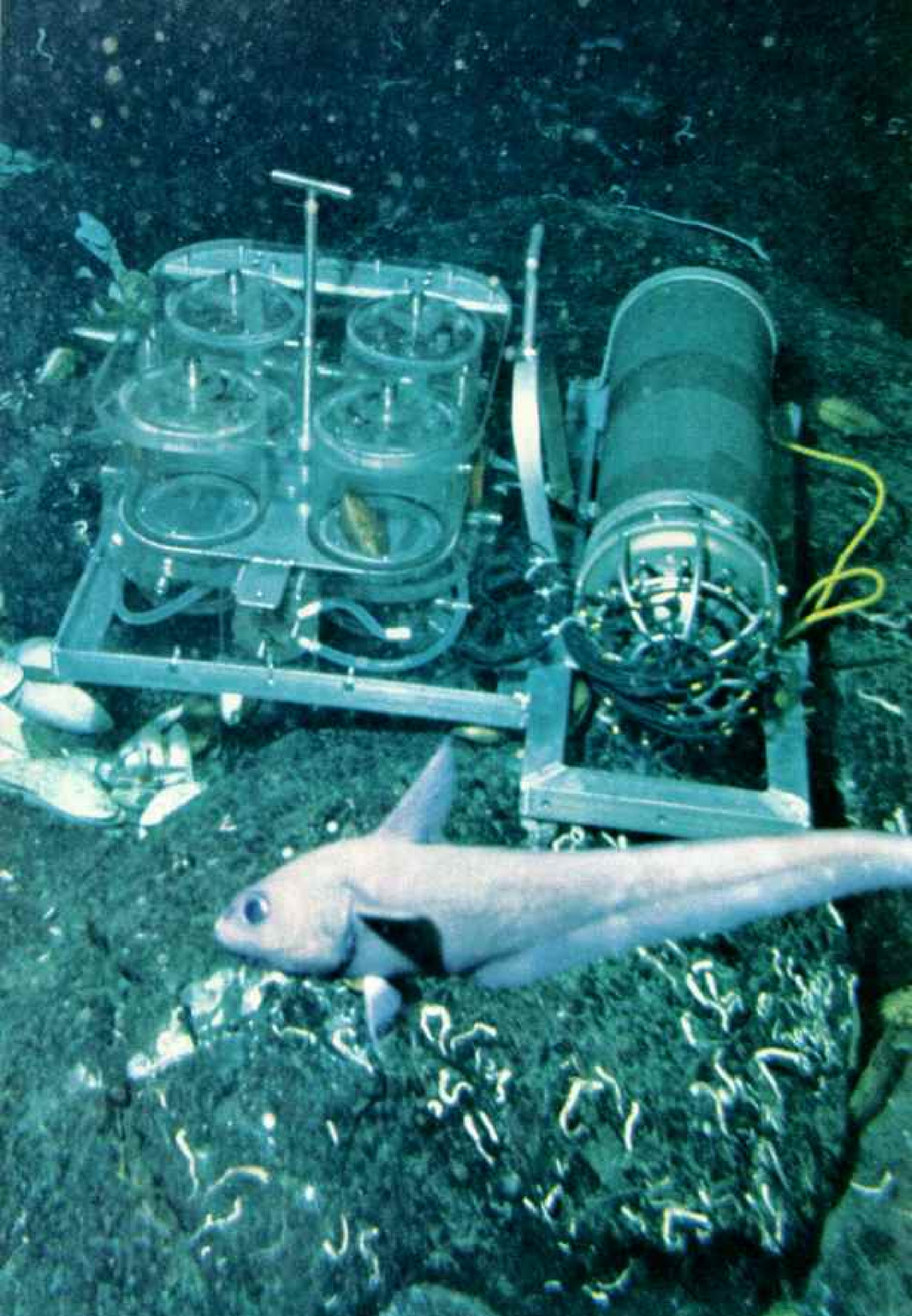
We find that the mussels have a long larval stage. Such larvae, drifting great distances in ocean currents like plant seeds riding the wind, could start a community whenever a vent opens up. Then dead mussels, in turn, become food for scavengers, such as crabs.

The white brachyuran crabs—of a crustacean family not previously known—scramble into our fish-baited traps. In insulated containers kept at 2°C, dozens survive decompression on the hour-and-a-half ascent with *Alvin*. So we select this animal as the best living subject for studies on the relationship of temperature and pressure to metabolism, investigations pursued in a laboratory at the University of California at Santa Barbara.

When kept at sea-surface pressure of one atmosphere, the crabs did not live long. But those placed in a pressure vessel set at 250 atmospheres, the same as their home environment, behave normally and easily tolerate changes in temperature. The last survivor (***below***) lived for more than six months.

ROBERT R. HESSLER, SCRIPPS INSTITUTION OF OCEANOGRAPHY

ROBERT B. EVANS



New ways to study a new world

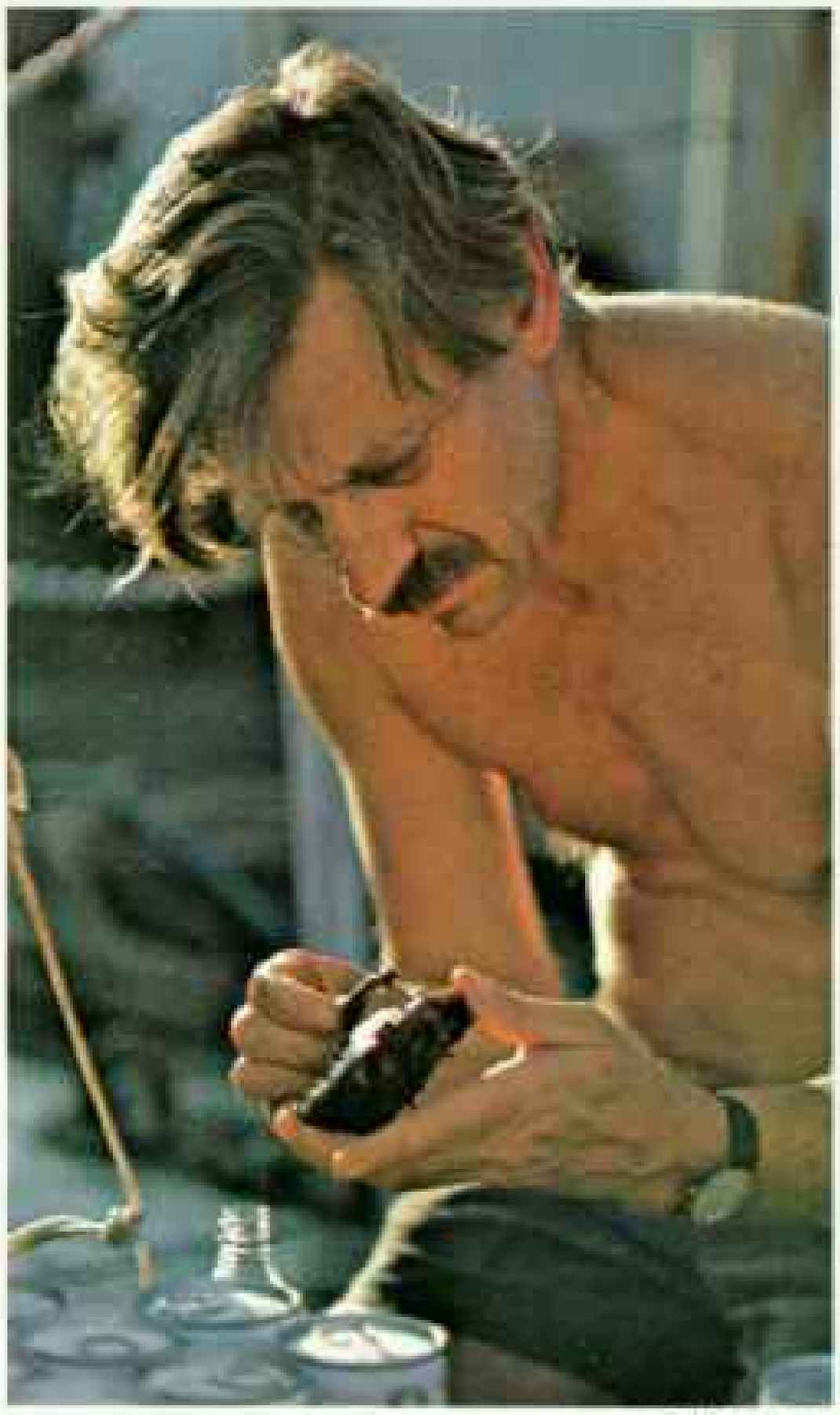
A JOURNEY to the deep sea is a little like going to the moon. We spend months preparing for an unknown realm, but can stay only a few hours on the spot. And we have not just a new geology but also a complex, unfamiliar ecosystem to investigate.

Biologists are especially curious about respiration and growth rates at the vent, since elsewhere in the abyss metabolism slows down. Using *Alvin*'s claw, we place mussels for 48 hours in a chambered respirometer to check oxygen uptake (***left***); others we leave in wire cages to test when we return this fall. The grenadier fish—common in the depths—may be attracted by *Alvin*'s lights.

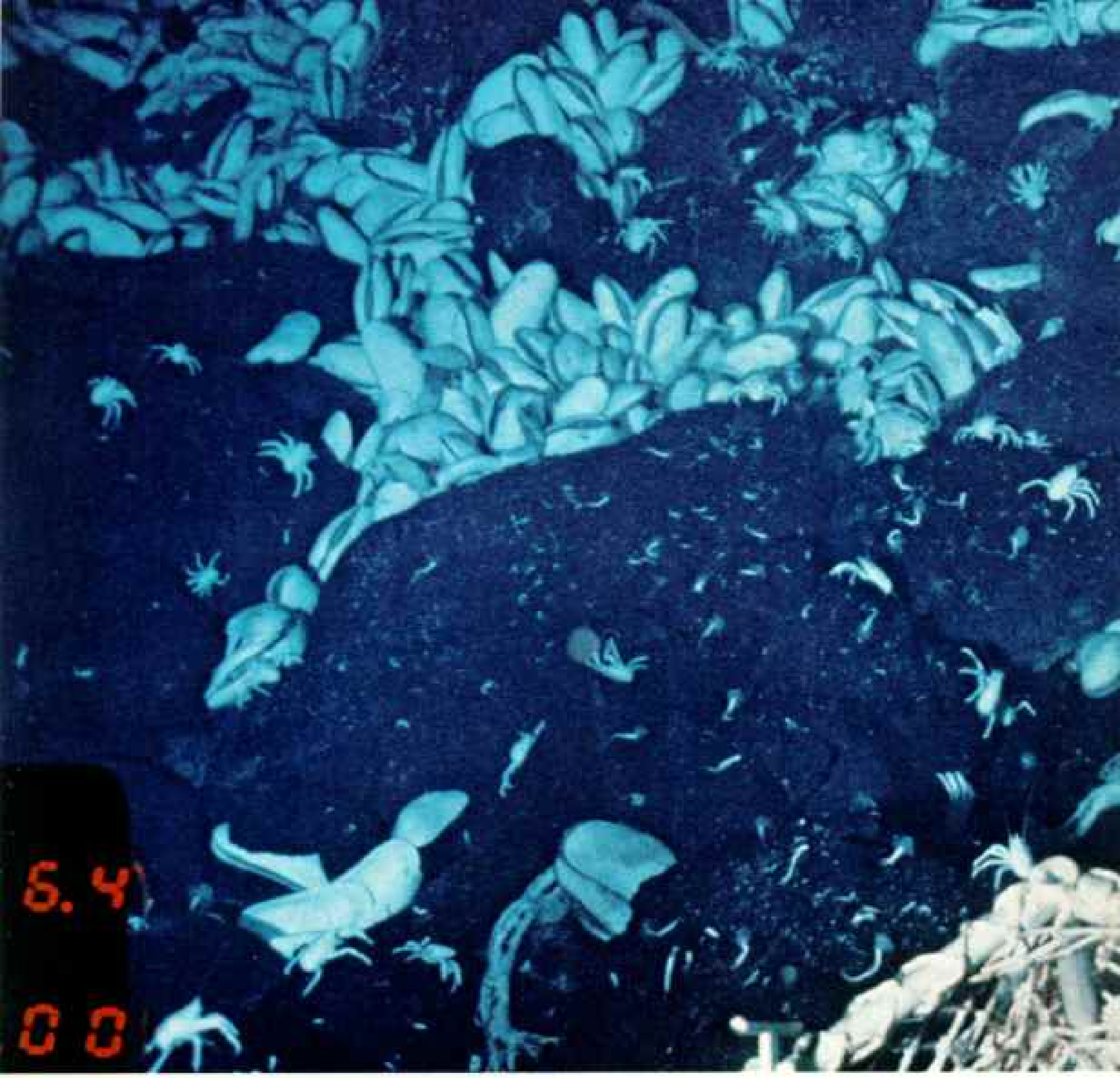
Everywhere we look for new life forms. Microbiologist Holger W. Jannasch (***top right***) searches for bacteria in water samples, on rocks, and here on a mussel shell. Later a scanning electron micrograph of the mussel's shell (***center***) raises questions. The strings are stalks of bacteria. But what are the strange protuberances? Geologists thought they might be minute manganese nodules. Dr. Jannasch has found they are bacterial cells coated with manganese and iron.

Filtered vent water yields solid evidence that bacteria multiply rapidly within the vents by metabolizing hydrogen sulfide, carbon dioxide, and oxygen. Bacteria grow in mats and clumps (***bottom***) in the subsurface spaces of porous rocks until the flowing water peels them off. The bacteria count is high, up to a million per cubic centimeter (less than a quarter teaspoonful). More than 200 different strains of bacteria are being kept alive at Woods Hole. The pink fish that we observed head down in vents may be feeding on bacterial masses.

KENNETH L. SMITH, SIO



CARL D. WINSLOW, WHOI. MAGNIFIED 4,200 X (ABOVE), 8,000 X (BELOW)



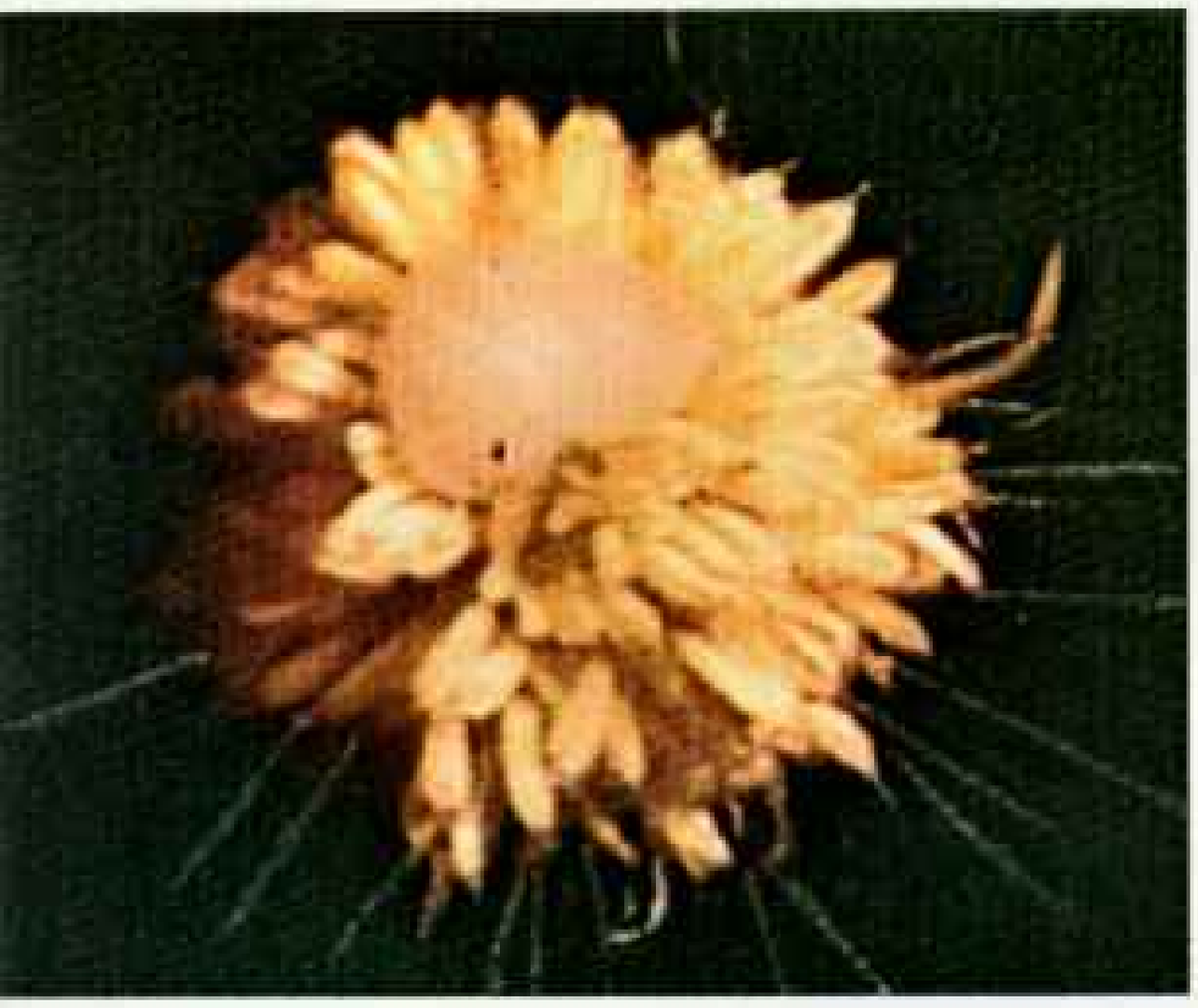
CHUCK BRISTOW

FIELDS OF FOOT-LONG CLAMS, overrun by galatheid crabs, populate active vents along the rifts (***above***). A smooth-shelled individual from 21° N proves slightly larger than an eroded Galapagos specimen (***left***). Radiochemical dating at Yale University shows vent clams grow four centimeters a year, 500 times faster than a small deep-sea cousin which can live as long as a century. Galapagos clams have numerous large and yolky eggs, but we have not yet found how the clams disperse.

The meat inside is startlingly red (***right***), a rare sight in clams. Their hemoglobin has an unusually high affinity for oxygen, possibly an adaptation to periods of low oxygen.

CALYPTOGENA ELONGATA, EXTERNAL ALVIN CAMERA, WHOI (ABOVE); AL GIDDINGS, SEA FILMS, INC.

A marvelous multitude

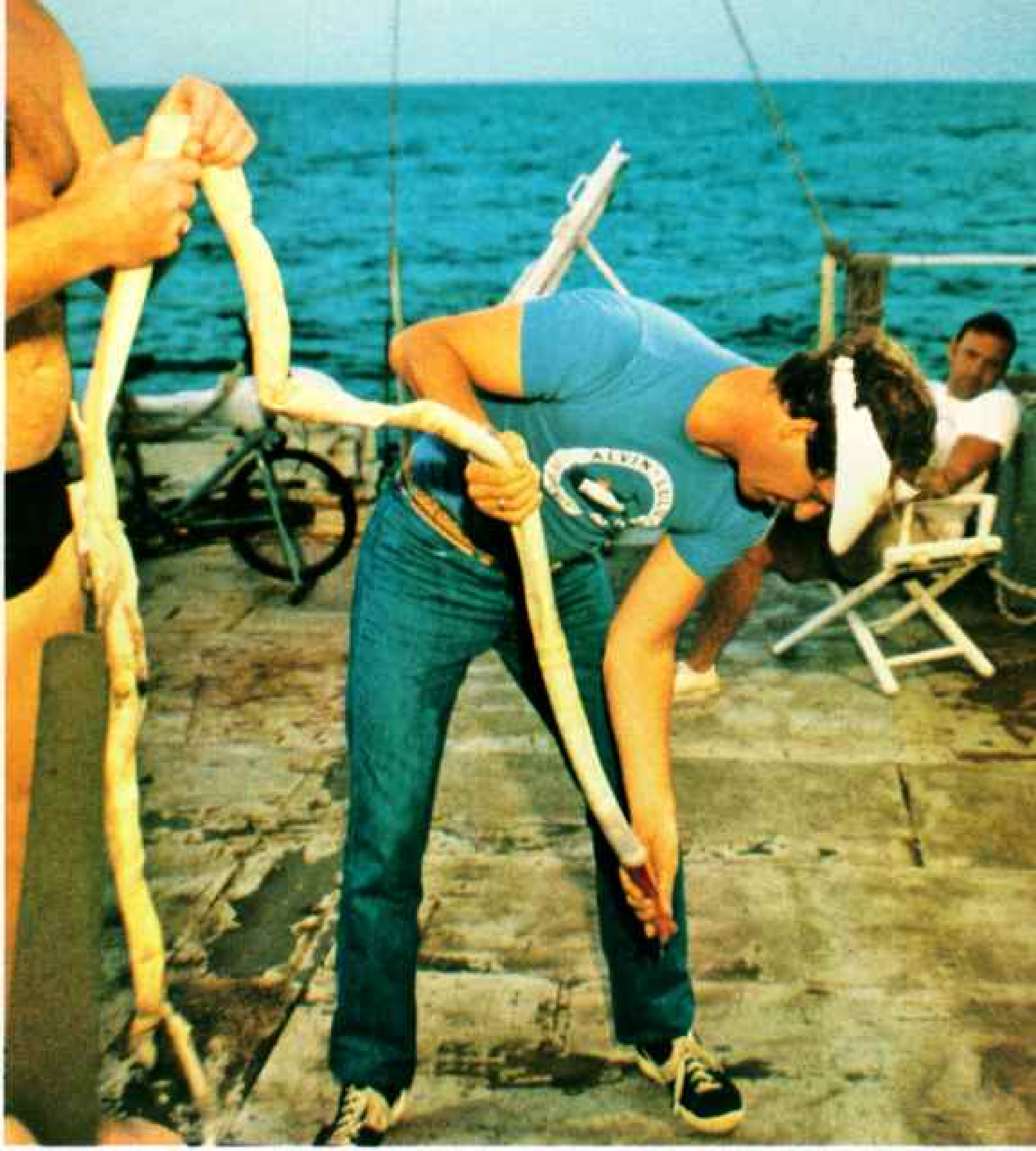


RHODALITHIDAE, AL GIDDINGS, SEA FILMS, INC. (ABOVE) AND WITH CCD CAMERA (TOP)

EMORY KRISTOF (ABOVE AND TOP)

TO MARINE BIOLOGISTS, vent communities are as strange as a lost valley of prehistoric dinosaurs. The "dandelion," first spotted suspended by filaments above the seafloor during the 1977 Galapagos expedition, proved to be a new siphonophore (***top left***). Related to the Portuguese man-of-war, it consists of a gasbag for buoyancy, surrounded by hundreds of members with specific functions—some capture food, others ingest it, still others handle reproduction. Brought to the surface, the fragile animal started to fall apart, so we quickly put it in a fixative (***lower left***).

Another unusual animal, a small worm (***lower center***) forms a tube from minerals in the water, cementing itself near the chimneys at 21° N that spew solutions hotter than 350°C (**pages 682-3**). This effluent cools so quickly on meeting the seawater that the worms don't actually live in the hottest water. Geologists



JOHN S. DONNELLY, WHOI

dubbed them Pompeii worms, since they must survive a constant rain of metal precipitates. They turn out to be bristle worms, or polychaetes, which probably consume bacteria with feeding tentacles.

Among hundreds of specimens collected, we discover even more new species of whelks, barnacles, leeches, and a red-blooded bristle worm. While dissecting mussels, invertebrate zoologist Carl Berg (***top center***) finds the worm living in the mantle cavity. On videotape from the CCD camera (***page 705***) we can see such worms leaving the mussels we collect.

On board *Lulu*, geologist-author Ballard (***above***) examines the largest tube worm brought to the surface; its body fills more than half of the 2.5-meter tube. Several juveniles had cemented themselves to this adult. We also find on such tubes a new variety of filter-feeding limpet, a living representative of fossils from the Paleozoic era.

THE SEAFLOOR near the vents gives us a big surprise. Geologists had believed that lava underwater always flowed slowly, forming bulbous pillows. Instead, we find, lava lakes fill depressions, much as on land (***below***). This means molten magma rushed up with such ferocity that cold seawater could not immediately harden it. The flow swirled and coiled before solidifying, a few hundred to a few thousand years ago, only yesterday in geologic time.

As it advanced across the cold seafloor, the lava capped water-filled cracks. This water heated and rose in a jet, hardening the lava it touched. After the lava lake drained, the hollow pillar—the mold of a water column—remained, with ledges like bathtub rings (***lower right***). Similar ledges line the lake edge three meters beyond.

On top of the pillar we see animals, perhaps tube worms. Sediments begin to collect, snowing down at the rate of five centimeters every 1,000 years, eventually

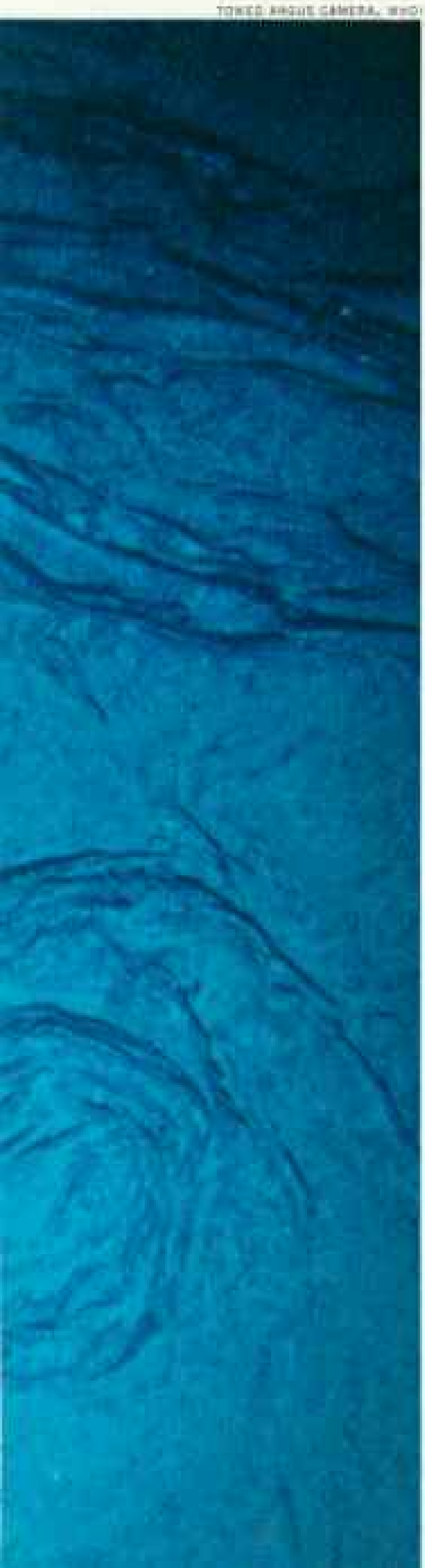
blanketing the bottom as it moves away from the rift.

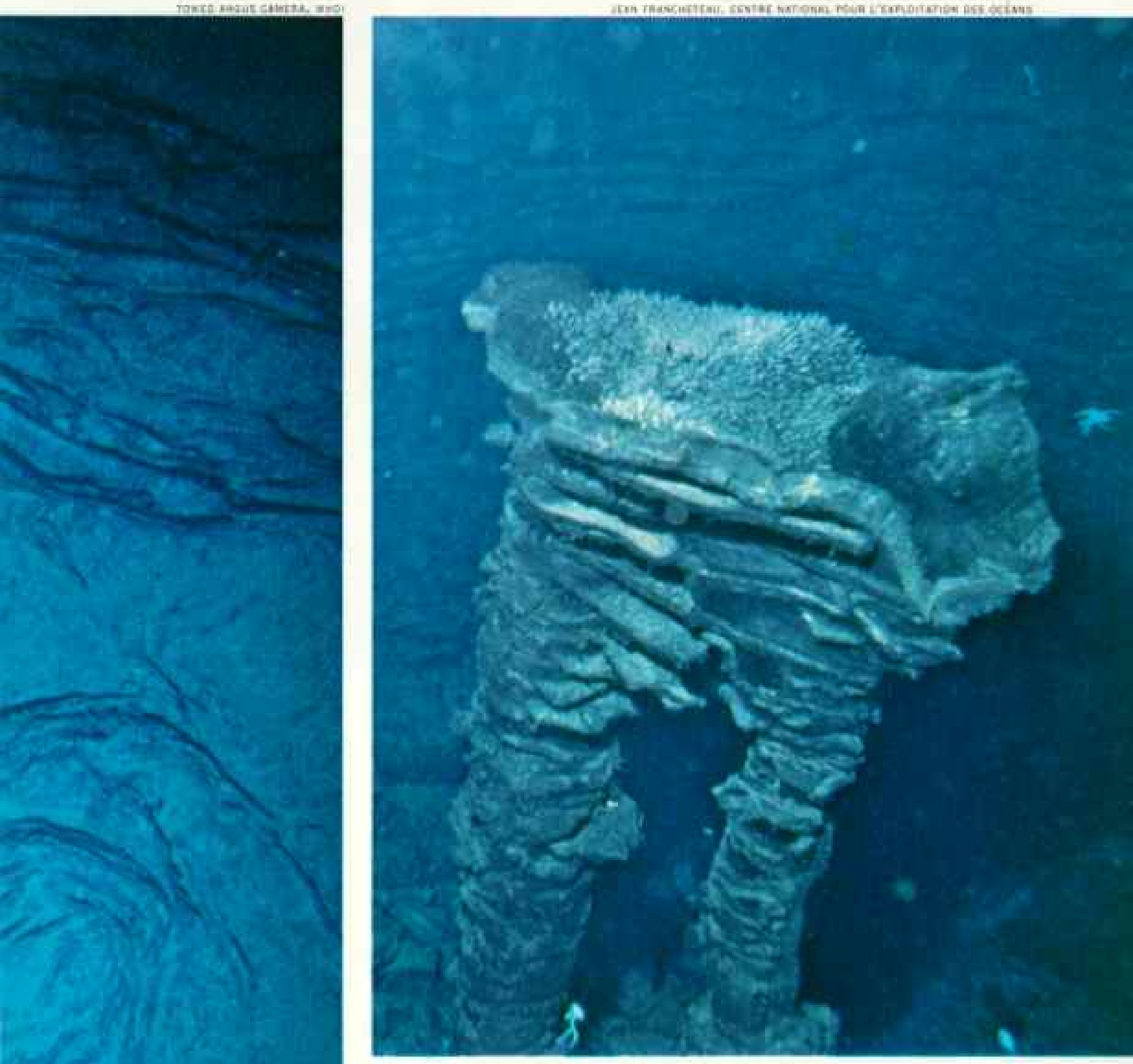
Quiet for now, the ocean-floor crust will undergo intermittent rifting and eruption on a cycle of about 10,000 years. With time the lava cracks, and water circulates down and up again, creating new vents. When cracks go deep enough, magma will again be released, and the cycle will repeat.

Our findings clear up major mysteries about the composition of ocean water. We once assumed all its minerals had to come from river runoff. Yet the elements in the ocean were out of balance—not enough magnesium and too much manganese. Direct sampling of vent water proves that during circulation deep in the ocean crust, seawater drops off magnesium and picks up manganese. John Edmond, geochemical leader of the Galapagos II expedition, calculates that all the world's oceans circulate through the crust once every ten million years.

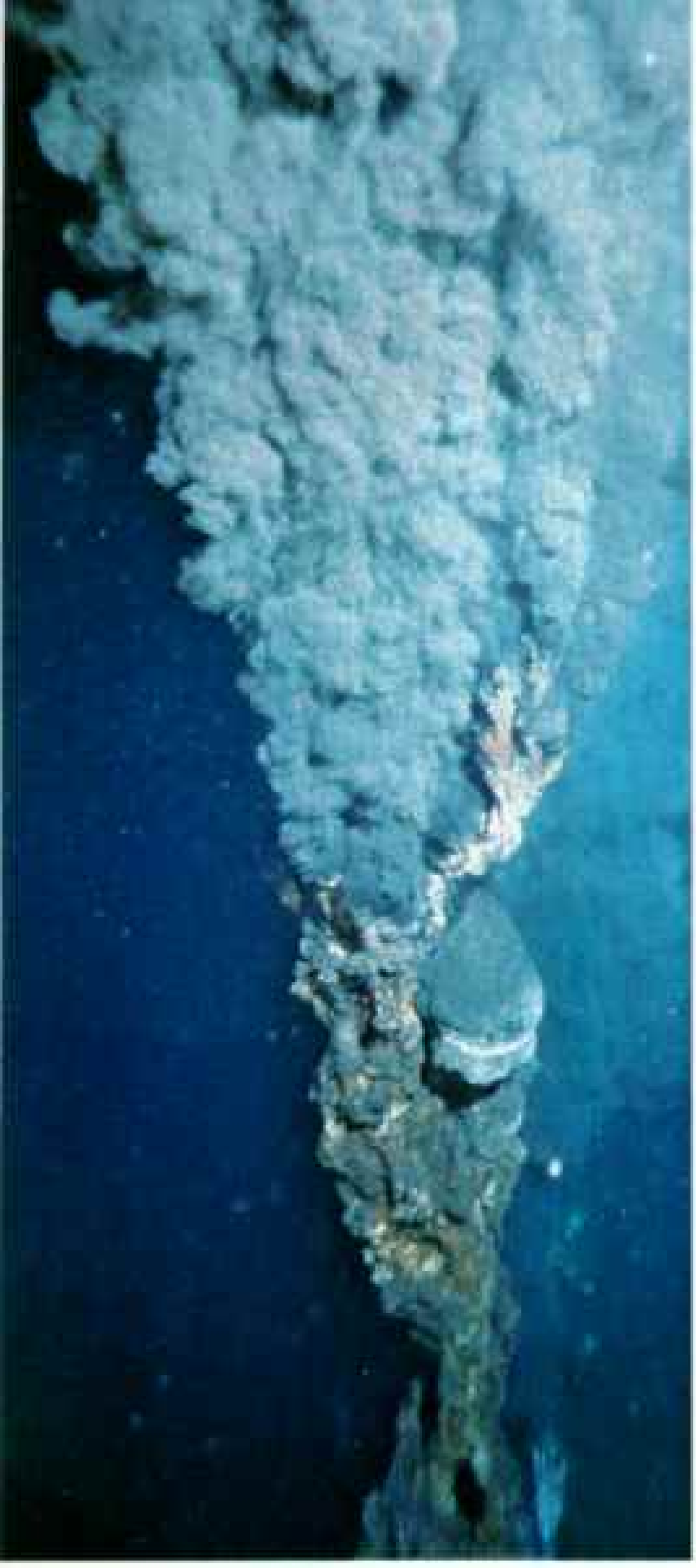
TOKEO ANGUS CAMERA, WHOI

JEAN FRANCHETEAU, CENTRE NATIONAL POUR L'EXPLOITATION DES OCEANS





Lava lakes and frozen pillars



LIKE A FACTORY at full throttle, a submarine chimney at 21° N belches hot mineral-laden water that rises through cold seawater pressing down at nearly two tons per square inch (***upper left***). As the solution mixes with the near-freezing water, it precipitates yellow, ocher, and reddish brown deposits of iron, copper, and zinc sulfides (***above***). When *Alvin* breaks off and

Minerals erupt at hot spots

ROBERT D. BALLARD, WHOI (ABOVE AND FAR LEFT); EMORY KRISTOF (CENTER AND LOWER LEFT)

retrieves a fragment (***left***), we learn its dull exterior is sphalerite, a zinc sulfide, while its bright interior is chalcopyrite—fool's gold.

With *Alvin*'s claw, we insert a temperature probe vertically into a "black smoker." The readout inside the sub spins off scale. Later we determine that the water must be hotter than 350°C (650°F). But only one end of the plastic rod has melted (***above, center***). The far end is unaffected, showing that the solution cools instantly as it mixes with seawater.

As Mid-Oceanic Ridge exploration has shifted from relatively quiet spreading centers in the Atlantic to the Pacific's more active rifts, our anticipation has grown. Will we finally actually see molten lava erupting, and more exotic animals thriving, when we dive to the fastest spreading center known, off Easter Island on the East Pacific Rise? □

EMORY KRISTOF

AMADEO BATILE

Rescue of a camera

SHOOTING by remote control, this motion-picture rig performed perfectly. Its 16-mm camera recorded the eerie spectacle of Alvin*'s approach* (right). *Then on command the rig released weights, and glass floats provided lift. But 150 meters from the surface, it disappeared. Sixty-six days later, 490 kilometers north, tuna-boat Capt. Andjelko Valcic* (left) *spotted a float on the surface. Here he returns the camera to National Geographic photographer Emory Kristof, its film miraculously intact.*

EMORY KRISTOF AND ALVIN M. CHANDLER

AL GIDDINGS, SEA FILMS, INC.

A new undersea eye

ON ITS FIRST deep-sea mission, a lightweight color video system produced close-ups of unusual clarity. Inside the four-inch-diameter pressure housing from Benthos, Inc., a camera developed by RCA carries three integrated circuits. These charge-coupled devices, or CCD's, convert reflected light directly to electrical signals that can be viewed and taped inside Alvin. *Later, images can be enhanced for study. Assisted by a Society grant, this TV camera becomes a permanent tool of* Alvin.

Hong Kong's Refugee Dilemma

By WILLIAM S. ELLIS
NATIONAL GEOGRAPHIC SENIOR WRITER

Photographs by WILLIAM ALBERT ALLARD

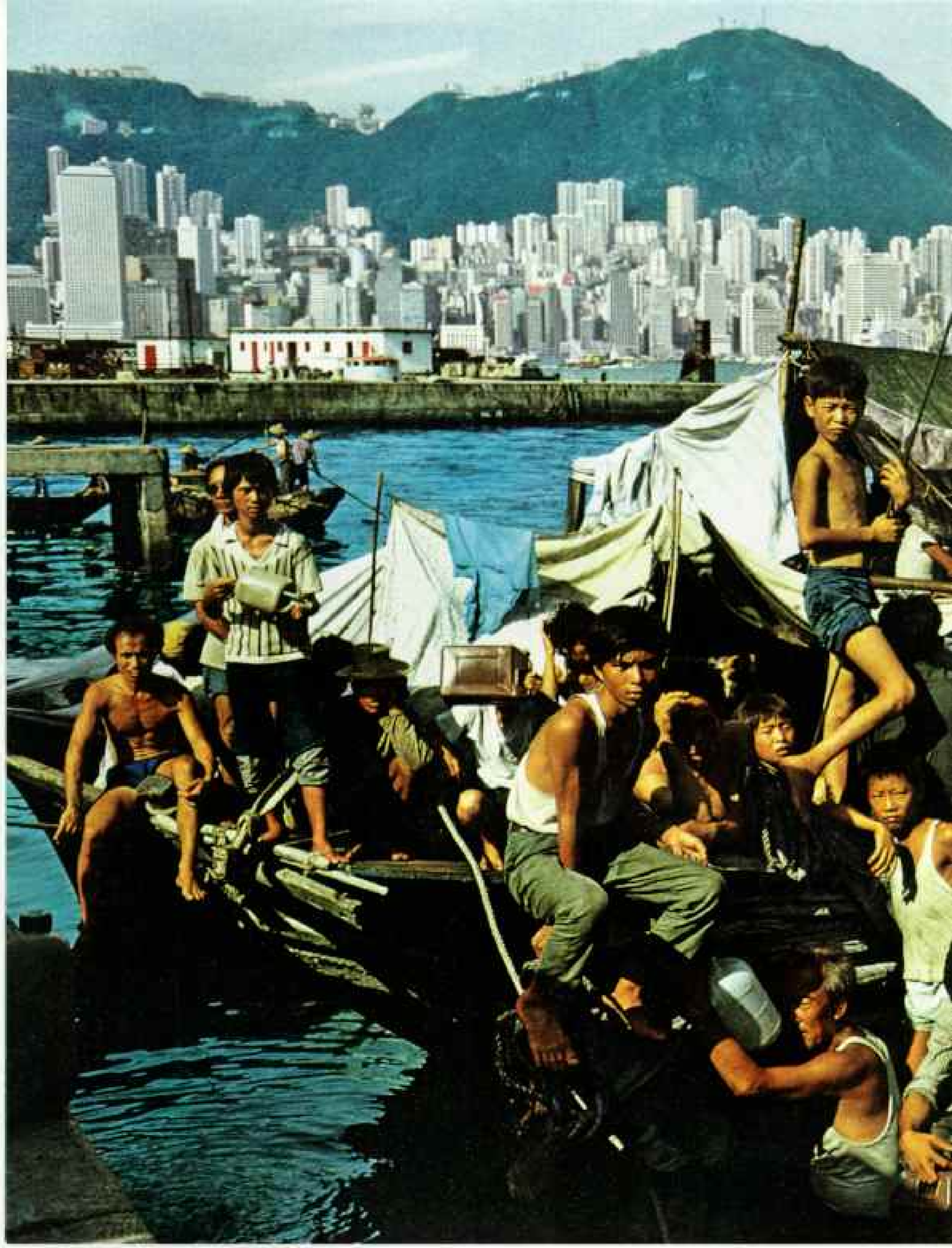
OUT OF HAIPHONG they were, 182 of them crowded into a shameful boat that had run under sail before the southwest monsoon. For five weeks they had been at sea, and when the voyage came to an end, in the saffron glaze of a summer noonday in Hong Kong, no cheers were raised.

None of that—not with the tight grip of sickness and fear on the bodies and souls of these people. It was in the eyes that the fear showed most, eyes that followed the approach of a marine police launch like radar locked in on a target.

The warning given by an officer on the launch was but a formality. They were there illegally, he was obliged to say, and must depart Hong Kong waters. That done, he began the process whereby the British crown colony would become the first port of refuge for yet another group of "boat people" from Vietnam.

All but one of the 182 were ethnic Chinese. They ranged in age from 70 years to the 3-month-old girl who lay in fitful sleep while her mother whipped the sultry air around the infant's head with a fan. The boat was no more than 60 feet long and 15 feet wide. To raise an arm was to commit an act of rudeness; such

Citizen of nowhere: *An old woman awaits asylum at Hong Kong's Government Dockyard Transit Centre, where a tide of humanity overwhelms a warehouse (**overleaf**). She is among nearly 300,000 "boat people," mostly ethnic Chinese, who by last summer had successfully fled from persecution in Vietnam. Streaming into Southeast Asian ports, the homeless hoped for resettlement wherever compassion might be found. And compassion was found. A United Nations conference in July won pledges of help from around the globe —and Vietnam's promise that it would consider measures to ease the problem.*



Across the harbor and a world away, *the white towers of Hong Kong beckon from the business heart of the British crown colony, but lie beyond the reach of refugees confined to the dockyard camp. Some, like these, lived packed aboard boats for weeks. Yet*

they are all the lucky ones—the survivors. Perhaps half of those who left Vietnam by sea never again saw land. Desperately overcrowded on unseaworthy boats, they died of exposure or drowning, or at the hands of murderous pirates in the South China Sea.

0 KILOMETERS 350

0 STATUTE MILES AT EQUATOR 350

DRAWN BY JOHN G. WEBER
COMPILED BY PATRICIA J. HARRISON
NATIONAL GEOGRAPHIC ART DIVISION

A daily influx of illegal immigrants from China compounds Hong Kong's problem of overcrowding. As many as 100,000 may have entered in the first half of 1979.

The People's Republic of China claims to have repatriated 236,000 ethnic Chinese from Vietnam.

CHINA

Taipei

Taiwan

BURMA

MACAO
(Portugal)
3,300 IN CAMPS

HONG KONG
(United Kingdom)
66,400 IN CAMPS

2,600 TO MACAO

Hanoi
Haiphong

Quang Yen

Gulf of Tonkin

Hainan

65,200 TO HONG KONG

LAOS

Vientiane

THAILAND

Thailand shelters 9,200 Vietnamese, 147,900 Laotians, and 18,200 Kampucheans.

Da Nang

PHILIPPINES
5,500 IN CAMPS

Manila

5,900 TO THE PHILIPPINES

Bangkok

VIETNAM

KAMPUCHEA
(CAMBODIA)

Phnom Penh

South China Sea

9,500 TO THAILAND

Ho Chi Minh City

Resettlement of Southeast Asian refugees since mid-1975:
United States — 233,300
France — 53,700
Australia — 23,500
Canada — 16,400
West Germany — 4,000
United Kingdom — 3,100

49,600 TO MALAYSIA

1,900 TO SINGAPORE

46,500 TO INDONESIA

Bandar Seri Begawan

BRUNEI
(U.K.)

When growing numbers of Vietnamese refugees threatened Malaysia's stability, authorities refused entrance to further waves of boat people.

Kuala Lumpur

M A L A Y S I A

66,200 IN CAMPS

SINGAPORE
1,100 IN CAMPS

Borneo

EQUATOR

Sumatra

I N D O N E S I A

48,200 IN CAMPS

Celebes

Asia's homeless people

100°

120°

"Boat people" figures represent January–July 1979 migration. Camp statistics show July 31 populations.

was the allocation of space on the boat.

For more than a year a massive movement of people had been taking place in Southeast Asia. It included the flight of tens of thousands of people into Thailand from Kampuchea (formerly Cambodia) and Laos; countless other thousands continually filter across the frontier from China into Hong Kong.

It was in the South China Sea and the Gulf of Tonkin, however, that the movement took on high drama, for there it was scored with a terrible mortality. The refugees departing Vietnam put out in decrepit junks and fishing boats with motors that sputtered and spewed oil in fits of outrageous engineering. It is possible that as many as half of them perished at sea.

It was a major tragedy, and, more the shame, a tragedy given to the marketplace. The Chinese fleeing Vietnam had to pay a fee for their chance to joust with death.

The High Price of Escape

"The Vietnamese took our money and told us to leave."

As he talked, Wu Nan-ying kept a hand on the tiller of the boat. He was the only experienced seaman among them, he said, and had taught some of the men to steer and handle the sails even as the swells were rolling over the low gunwales to send water racing through the tangle of humanity on deck.

"Among us we had to raise forty thousand dong to pay the authorities for this boat," Wu said. In U. S. currency that's almost $19,500. And that for a vessel with a whipcrack voice of tattered sails and a body of planking riddled with rot. Even so, they got away cheaply: The average cost to a Chinese leaving Vietnam is two thousand dollars. Humans, it has been said, have become the country's leading export earner.

Certainly it didn't seem to matter—the economics of it—as I watched those apprehensive stares begin to soften when the people on the boat came to realize that they would be allowed to stay in Hong Kong.

By early summer 1979, 55,000 to 70,000 men, women, and children were reaching foreign havens each month. Some 65 percent of them were ethnic Chinese. They sought temporary refuge in Malaysia, Singapore, Thailand, Indonesia, Macao, Hong Kong, and the Philippines. But only Hong Kong took all comers. In contrast, Malaysia—its camps crammed with 75,000 exiles—turned thousands of boat people back to sea.

When I arrived in Hong Kong to spend a month last summer, its refugee population stood at more than 50,000. They were being housed in factory buildings, warehouses called godowns, prisons—wherever space could be found. The burden grew heavier each day for this already incredibly overcrowded colony. By the end of the year, thousands more may be in Hong Kong waiting for permanent settlement in any country that will have them.

From Haiphong, Wu and the others had limped east in the boat to thread the strait between the Chinese mainland and Hainan island, and then north with the winds, along the coast. The sea beat on that fragile boat for days on end. It listed and shipped water, and the rats sought high ground on the chests of babies. Few slept, for the nights were filled with the hellish sounds of

Long a haven *for those fleeing China, tiny Hong Kong Island* ***(left)*** *was ceded in perpetuity to Britain in 1842, as was the Kowloon Peninsula in 1860. Additional land, the New Territories, was gained in 1898 under a 99-year lease.*

Pawn of politics, *a small child naps in the stifling gloom of a dockyard warehouse* ***(following pages)****. Quotas and entrance requirements will decide his future—even to the very continent on which he lives—as surely as violence has shaped his present.*

seasickness. The fresh water ran out, and they gagged on the taste of the sea. They wept, and, with the tears still in their eyes, they saw Hong Kong.

They anchored eight miles southwest of Kowloon, and there they waited as their first night in asylum fell. They watched as the colony came ablaze with lights, and, finally, there was an open joy among them.

Someone aboard remembered how it was in Quang Yen. Everyone on the boat was from that coastal city north of Haiphong, and their families before them had lived there for a century or more. These were the poorer among members of the large ethnic Chinese community in the city. Others were entrepreneurial, shop owners who tallied their gold at the end of a day's work, tailors who fussed with hems in their dazzling cocoons of silks and woolens, restaurateurs who stood sentry at the cashbox while armies of cousins dished out the fish sauce. Poor or rich, they were a community, bound by language, tradition, and a certain isolation from non-Chinese residents of the city.

Following the fighting between China

A long step up *from "first asylum" at the dockyard, the United Nations' Sham Shui Po Temporary Transit Centre offers refugees freedom of the city from 5 a.m. until midnight. Many earn enough from jobs there to brighten life with a few amenities. While a few émigrés managed to leave Vietnam with some money or valuables, extortion by profiteers and the Vietnamese Government ensured that most departed penniless.*

and Vietnam early this year, the Chinese in Quang Yen were told they would have to move to rural labor camps or leave the country. For those who could afford it (eight taels of gold, or about $2,800), space would be made available on a motorized boat; otherwise it would be something with sail and an even greater risk of death. The rich left quickly, while the poorer took longer to raise the money. But they left too, and today few, if any, Chinese remain in Quang Yen.

Vietnamese Promise a Slowdown

"Everything that has happened stems from the decision of the Vietnamese to get rid of their Chinese ethnic minority in that particular way," said Sir Murray MacLehose, Governor of Hong Kong. "Now if the Vietnamese Government could only be persuaded to provide orderly departures to assured destinations, the problem would be a very long way toward being solved."

Indeed, in late July, at a 65-nation conference convened by the United Nations in Geneva to deal with the refugee problem, Vietnam announced that it would take measures to slow the exodus. The Philippine Government agreed to make a site available for the processing of 50,000 people. Earlier President Jimmy Carter had said that the U. S. Seventh Fleet would be deployed to aid refugees in trouble at sea.

And in Washington, D. C., folksinger Joan Baez appeared in a benefit concert for the refugees, once again pointing up the possibility that in tragedies in our time, the guitar has become the tolling church bell, and mournful lyrics the sermon of the day.

Of the Vietnamese pledge, skepticism ran high. For one thing, the delegate said the curb would be "for a reasonable period," or temporary. For another, it is believed that Vietnam's decision to rid the country of its Chinese population is unalterable.

There were probably close to one and a half million ethnic Chinese in Vietnam, most of them in the south. The number remaining is not known. Apparently the Vietnamese Government, looking to the possibility of future troubles with China, viewed the minority as potential fifth columnists. Also, there has always been a rather high level of antagonism between the Chinese and Vietnamese.

Finally, this: It is in the nature of newly installed socialist regimes to turn against the shopkeepers and others whose role in the so-called wars of liberation was less than fully active. Thus, Hanoi makes the claim that the ethnic Chinese are simply escaping from what is now demanded of them, that being a willingness to work for the success of socialism in the country.

Vietnam stands to make as much as two billion dollars by sending all its Chinese to sea. Hong Kong, meanwhile, continues to bear the pressure with great compassion.

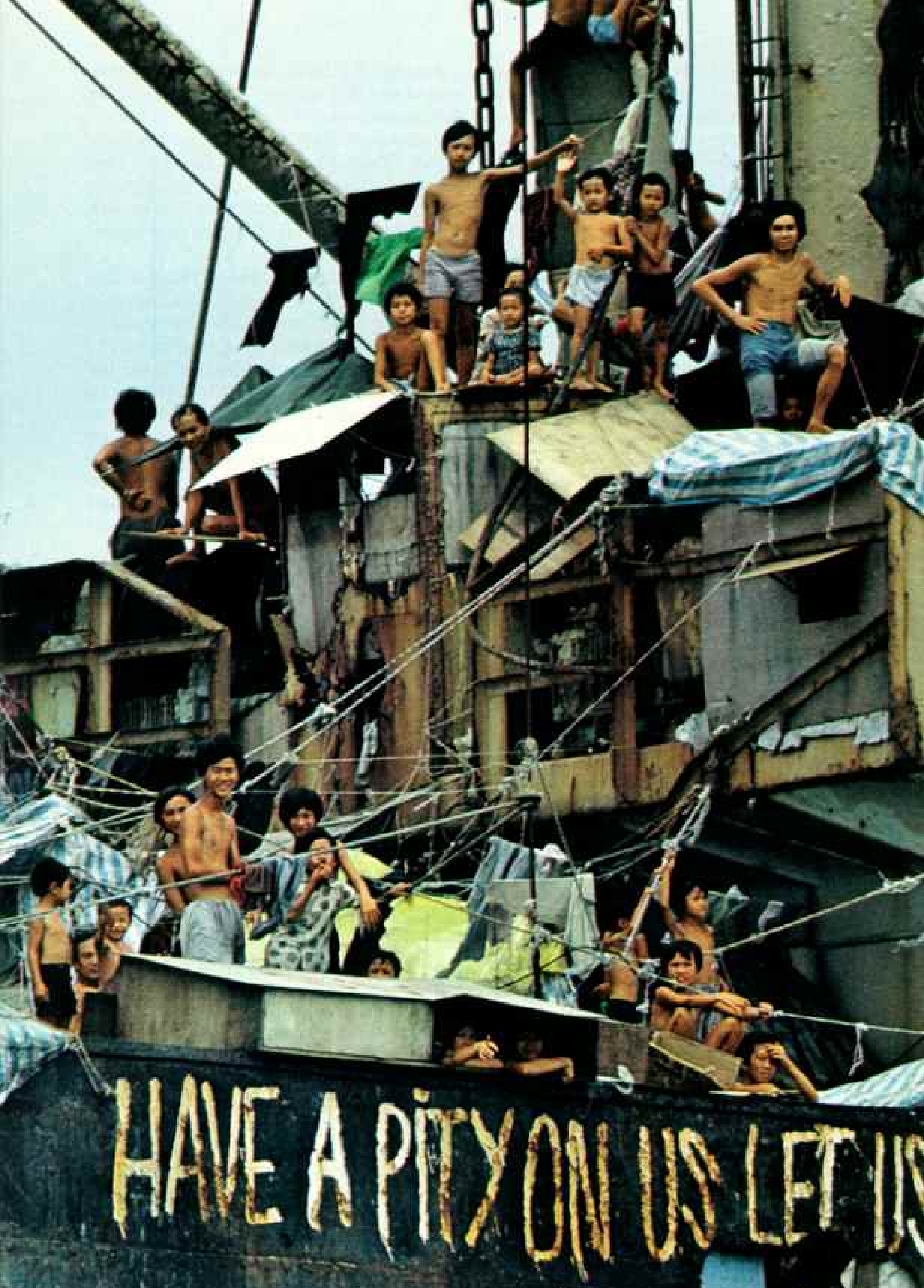
Marine police told Wu Nan-ying and the others on the boat that they would have to stay at their present anchorage until a tow to the staging area of Discovery Bay could be arranged. There were 3,500 people waiting on boats in Discovery Bay when I was there in June. "But that's not too bad," said John Turner, deputy district commander of marine police. "Two weeks ago we had 9,000 waiting to come ashore."

From the staging area the boats were towed to the Government Dockyard Transit Centre. There the people were housed in godowns until there was room for them in one of the eight camps operated by the government. The next move was to a U. N. camp, where they awaited selection by a country of permanent asylum.

This human assembly line, on which hope was bolted to the soul, was a long process, one that could take months to complete.

"It took two and a half weeks to get here from Discovery Bay," a woman told me as she laid out a straw mat, three feet by six, on the floor of the godown. That was not only her bed, but her full living area as well. On that particular day there were 10,299 refugees lodged in the dockyard, and yet there was a surprising orderliness to the place. There was no great din of voices, no sense of chaos, no overwhelming presence of suffering. My thoughts were given to the refugee camps I had known in Bangladesh and the Middle East, and I wondered why this one was so different.

Because, for one thing, the instinct for survival among these people had been honed to sharpness during the weeks at sea. Whatever followed would be better. They would make it better. They would keep their bodies clean, washing under the water taps


HAVE A PITX ON US LET US

installed on the dock, then soaping and rinsing, and doing it all over again. They worked together in committees for the common welfare. When they lined up twice a day for rations—a bowl of rice, fresh vegetables, bread, meat or fish, an orange—there was no shoving, no panic, for the worst was behind them. They were ashore, and, crowded as they were, they knew they could not drown in the reassuring solid concrete of the floor.

Still, there were horror stories to be heard.

"There were 282 on my boat when we started out. One hundred of them died at sea. Most of them were old. We put the bodies in the water." He was 26 years old, and from a province in the north. Of Vietnam, he said simply, "Life is very difficult there." He wanted to settle in Canada.

I talked to a man from Da Nang, a man formerly of means. He and 15 others came to Hong Kong in a small motorized boat. It cost them nearly $4,000 apiece. When the motor developed trouble, they put into China's Hainan island, where repairs were made. The Chinese gave them gasoline and food. In Macao they needed more repairs, and, that done, the people there gave them a map with the route to Hong Kong penciled in.

Messages Passed Surreptitiously

Camp rules prohibited refugees from passing messages out through visitors, but later I found that scraps of paper had been stuffed into my pocket. One was addressed to someone in Paris: "We, nine brothers, arrived in Hong Kong. Please come, help and take us out." Along with the signature was a number; theirs was the 637th boat to arrive.

There were few elderly people in the dockyard, for few could have survived the voyage. But there were many children—fat babies with rashes on their skin, undernourished babies pulling on dry breasts, 5- and 6-year-olds burning with fever.

"The danger of cholera and plague is our

Life in floating limbo *lasted 23 weeks for 2,664 passengers on the freighter* Skyluck. *Quarantined offshore for most of that time, the ship drifted aground after its anchor chains were cut. Authorities then made room ashore for her human cargo.*

major concern," Dr. S. F. Lam, acting health director for the Hong Kong Government, said. "Of those two, we pay special attention to plague. We try to keep the rats from coming ashore; that's one reason for holding the boats in Discovery Bay for a time. If we find that many rats have died, we become concerned. The fleas that carry plague need warm blood, and when the rats die, the fleas will seek out humans.

In a place called Jubilee, *a young girl earns a few dollars stringing cotter pins for one of Hong Kong's thousands of small factories. Jubilee is a former army barracks; other refugee quarters range from prisons to a World War II POW camp to high-rise factory buildings.*

"As of now, we can say that the general state of health is satisfactory. The strain on medical facilities in Hong Kong is heavy, but so far we have managed to cope."

The strain. Hong Kong has known that before, especially at times of troubles in China, when tens of thousands have streamed across the 17-mile fenced frontier. In 1962, for example, when border controls were relaxed, more than 60,000 Chinese moved from the mainland into the colony over a period of just six weeks.

This year, too, the press of illegal immigrants from the north onto this small piece of rocky, hilly real estate—scarcely four hundred square miles—has been heavy. Unlike the boat people, those who slip in from China are not welcome in Hong Kong. If caught, they are returned. Many *are* caught —nearly 46,000 in the first half of this year alone. But at best, only one out of three was being apprehended.

The strain.

"There could be well over 750,000 squatters in Hong Kong now," said John Heywood, a deputy director of the Hong Kong Housing Department.

Many of the illegal immigrants move into squatter camps in the hills. "There's no immediate evidence they are there," Heywood said, "because they pack in with friends and relatives. You can see them when there is no room left and they burst out into the streets. And a fire can make them visible, such as the one in a squatter camp in 1953. It left between 50,000 and 60,000 people homeless in one night."

Chinese Risk Border Patrols

I was on a hill with a four-man ambush patrol of the Royal Green Jackets of the British Army. The frontier was a mile away; the road fifty yards to our left was a popular infiltration route. Rifleman Dave M. Smith scanned the area with an infrared device that intensifies the faint light of the night skies. We spoke in whispers and sweated in our nylon camouflage jackets.

The night passed. Rain beat on us with drops the size of acorns. The ambush failed. "Some nights we catch a dozen illegals, others, like tonight, none," a soldier said.

At dawn I was in a British Army Air Corps helicopter that bumped over and

around the mountains as we followed the border and the Sham Chun River west to the Mai Po marshes.

We arrived as members of the Sixth Queen Elizabeth's Own Gurkha Rifles were bringing in their catch for the night. They walked single file on the dikes of the fishponds, a hundred yards distant, set against a rising fireball of a sun.

"We've been averaging seventy to eighty apprehensions a night in this area lately," Maj. Patrick Gouldsbury told me. "They use everything for floats to get across the water. Bags filled with Ping-Pong balls, inner tubes. . . ."

The Gurkhas marched their handcuffed captives to a clearing, where they hunkered down. Among the forty or so brought in that morning was a 20-year-old woman with hands bleached and wrinkled from a long stay in the water. She said her name was Lau Ying Siu (pages 724-5), and that she was from a village in southern China. For nine days she had traveled to reach the border, along with her brother. He was not among the captives. She said she wanted to go to Hong Kong to get a job.

Lau Ying Siu did not have to swim back to China. They took her back in a truck.

They were young, those caught that night, and the youngest of them all was 13. Four feet tall and weighing no more than seventy pounds, Cheng Tong came across with nothing but the clothes he wore—a blue T-shirt, shorts, sneakers far too large, green socks. Fear had drained him of talk and emotion, but in one respect he could have been a 13-year-old in, say, Waco, Texas: The zipper on his shorts was broken.

The British Army has 1,800 troops stationed along the border between Hong Kong and China. That includes reinforcements brought in this year when crossings soared to new and intolerable highs. The 17-mile fence was repaired and lighted. Still they came. In May alone, 8,141 were apprehended crossing the border by land. Others were pulled out of Mirs and Deep Bays, some with their bodies torn by sharks.

A massive, sinister pompadour of barbed wire tops the fence for most of its length, and it is difficult to visualize anyone getting over it. But they do. One who didn't was a teenage girl, probably about 14, who carried a knapsack hung from a strap around her neck. The strap caught in the wire. She was found in the morning, her feet six inches from the ground, dead by hanging.

In the town of Sha Tau Kok, where the border cuts right down the middle of the main street, Lt. Col. Tom Blackford, commander of a Gurkha battalion, asked me to go with him to the roof of the police station. There he looked out, pointed, and said, "That's China Mountain."

The true name of the 2,982-foot border landmark is Wutong Shan, or Chinese Parasol Tree Mountain. Many thousands of Chinese have gone to the top of that mountain, gone up there because they've been told that's the best place to pick out a spot for crossing. They get to the top and look out, and if night is coming on, they can see the great glow of Hong Kong's lights oozing through the fingers of black hills.

They see that and they are driven. They come down from that mountain and, with the dirt of the communes' fields under their fingernails, they remember what they have heard. Their relatives, the legal immigrants who return from Hong Kong for visits, bearing gifts of radios and television sets, tell them. That Nathan Road is a festival of life with shops selling everything they could want. That it's possible to start out selling litchi nuts from a cart and end up as a captain of industry. That there is a grand hotel where a quartet of Chinese musicians plays such tunes as "Nearer, My God, to Thee" at teatime. That there are bars in Hong Kong where the waitresses are dressed from the waist up just as they were when they came into this world.

Yes, spirits take fire on the heights of Chinese Parasol Tree Mountain.

A Landlord-Tenant Relationship

Hong Kong is not in a position to demand that the flow of illegals be stemmed. In more than one way, the colony exists at the whim of China. All of Hong Kong territory north of Boundary Street in Kowloon is owned by China and is under lease to Britain until 1997. Also, much of Hong Kong's fresh water is obtained from the mainland. It is thought best not to antagonize the landlord.

Nevertheless, representations were made to China concerning the situation, and they

produced results. The Chinese 42nd Army was returned to border patrol following action against Vietnam early this year. China also started to punish returned illegals with terms of hard labor. The crossings declined.

Still, perhaps 150,000 illegals will enter Hong Kong this year. The population of nearly five million could increase by 10 percent in the next 12 months.

"We can solve the problem of the illegal immigrants," a government official told me, "but we can't cope with the boat people too. Hong Kong is very resilient—we've worked many miracles in the past—but this influx from Vietnam is too much. Our facilities are stretched to the limits, and our patience, I'm afraid, is drawing thin."

The strain.

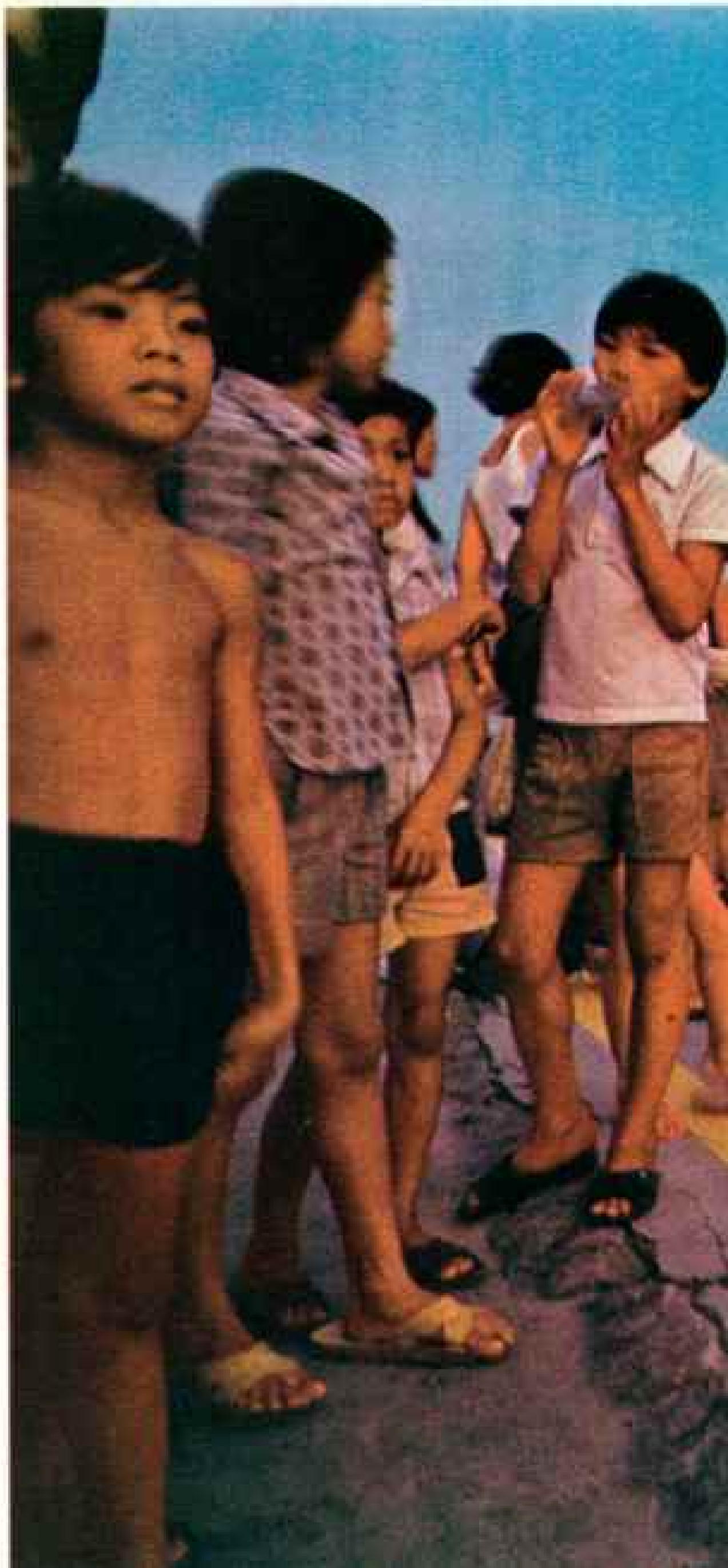
Hong Kong's patience is at its lowest with the larger refugee ships. More often than not, their voyages are organized by racketeers in Vietnam, who make a handsome profit. Such a vessel was the *Huey Fong*, which arrived in Hong Kong waters on January 19 this year with 3,318 refugees. Charges of fraud and seafaring violations were brought by the Hong Kong Government, and the master and six crewmen were convicted.

Testimony revealed that hundreds of thousands of dollars had changed hands for the charter of the ship, and that the government of Vietnam was deeply involved. The cost to those aboard was 12 taels of gold for an adult, and one and a half taels for those between the ages of 5 and 15. Those under 5 could ride for one tael.

In addition to paying the gold, the refugees had to sign all their property over to the government. They boarded the *Huey Fong* not knowing where they were headed, not knowing, either, that the ship's crew had instructions to tell Hong Kong authorities that the refugees had been picked up at sea.

The 3,500-ton *Skyluck*, a rusty freighter under Panamanian registry, arrived in February with 2,664 refugees. They were not allowed to disembark, and for twenty weeks they lived on the vessel. The people were fed and provided with medical services, but they grew restless. Finally, in late June, as heavy winds and rough water pounded the *Skyluck*, someone aboard cut the anchor chains. The vessel drifted to nearby Lamma Island, where it beached on the rocks. Many of the refugees jumped overboard and fled into the hills, but they were later rounded up and put into a camp.

I spoke to John Fortune, director of Hong



Born of two worlds, *a boy of American and Vietnamese parentage, right, finds complete acceptance in neither. Suffering in Southeast Asia seems an unending cycle, but aid from the United States, in picking up victims at sea and increasing immigration quotas, now spearheads help from the international community.*

Kong's Civil Aid Services, the organization that distributes food and provides other services in the government camps.

"There was a boat that came in with more than 1,400 refugees aboard," he recalled. "It managed to run a naval blockade that had been set up. The master went over the side after putting the vessel on a course for one of the colony's islands. He escaped to Macao, and the boat beached on the island. We had to put those 1,400 people in a godown with room for only 600."

Fortune directs some 3,000 workers, all of them volunteers; their service to the boat people is nothing less, certainly, than one of the great humanitarian efforts of our time.

Because he is often the first one to a boat when there is need for immediate action to relieve suffering, Fortune has seen some of the grimmest aspects of this tragedy. A boat with four decks, and no more than three feet of headroom between them, and the refugees stacked in like cordwood—he has seen that. And the pain frozen on the faces of those who have attended kindred death. He has seen that, too.

"I try not to get emotional about this," he said. "The

(Continued on page 732)

Another flood of immigrants: the China factor

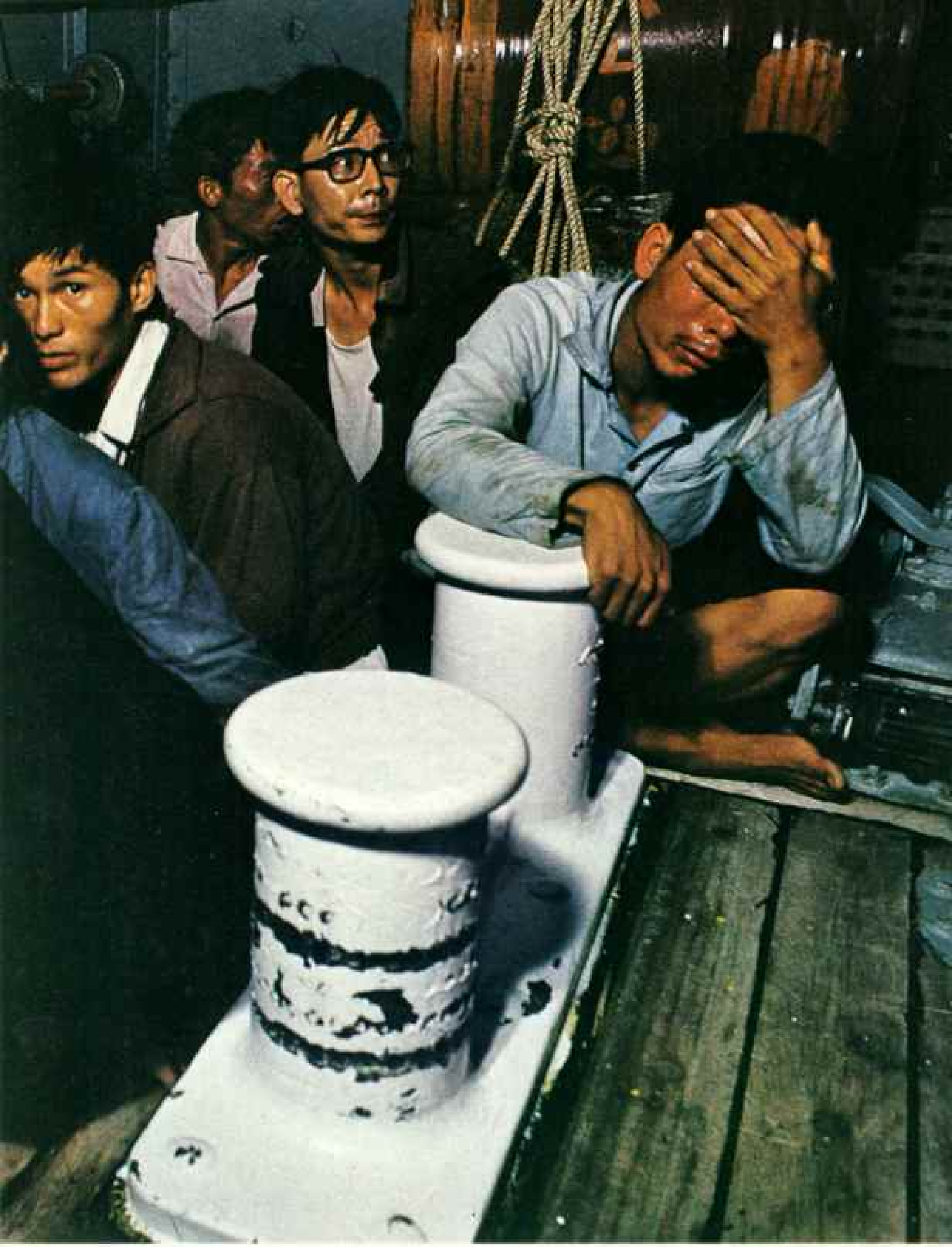
HER NAME is Lau Ying Siu. Her age, 20. She has walked for nine days through Guangdong (Kwangtung) Province in China to reach its 17-mile-long border with Hong Kong. Beyond lies her hope of a seamstress's job. Beyond, a sister waits. Just hours earlier, her brother made it across. She has not.

And now she huddles like a frightened doe, wrists pinioned, waiting to be returned to China. To her Hong Kong captors, she is just another "I-I"—an illegal immigrant.

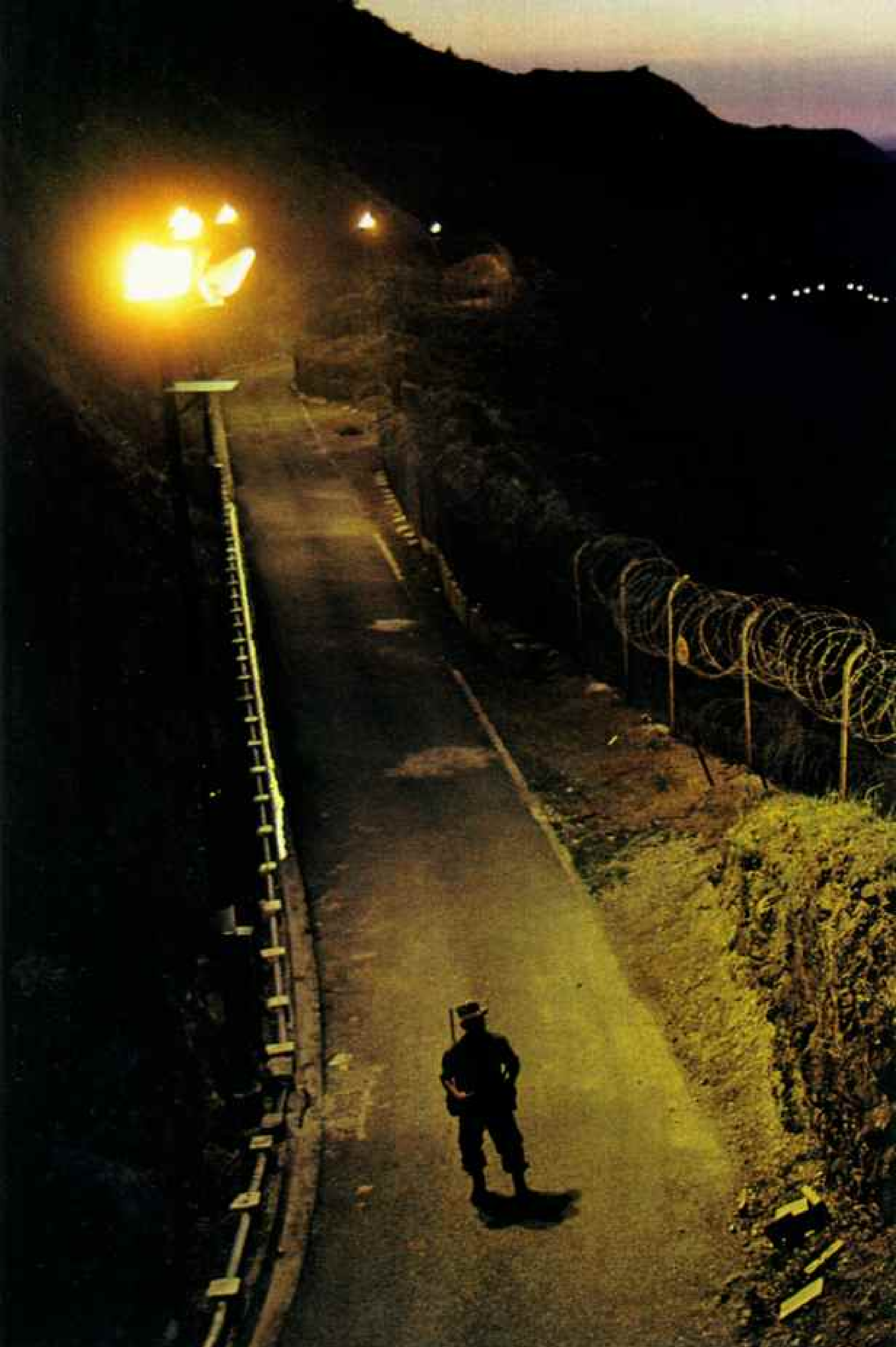
For the people of China, Hong Kong is an old sanctuary. The first influx of Chinese fleeing upheaval came in the 1850's during the Taiping rebellion. More waves followed during a revolution in 1911, the Sino-Japanese war of the 1930's, and after the proclamation of the People's Republic in 1949. Within six weeks after Chinese guards on the border relaxed travel restrictions in 1962, more than 60,000 Chinese poured into Hong Kong, seeking its bright lights, better jobs, and material goods scarce at home.

In 1974 Hong Kong put its foot down and began formally repatriating all Chinese crossing the border without a permit. Gurkhas, the diminutive soldiers of Nepal who have long stood tall in the British Army, patrol the frontier. They often flush bedraggled I-I's from hiding, especially around the Mai Po marshes (**following pages**). *During the first half of 1979, 46,000 were arrested and sent home. But for each one caught, two others probably eluded the dragnet.*

Faces of failure *crowd the afterdeck of H.M.S.* Wolverton, *a patrol boat that intercepted a sampan attempting to smuggle these twenty Chinese through Mirs Bay into Hong Kong. Efforts by mainlanders to reach the colony are as desperate*



by sea as by land. Relates photographer William Allard: "One night the Royal Navy picked up a pregnant woman and a child, floating in a couple of inner tubes. The husband was swimming behind, pushing them through shark-infested waters."



EERIE GLOW bathes a lone Gurkha sentry on a road near Sha Tau Kok, a town split by the China-Hong Kong border. The colony has spent six million dollars U. S. to bolster the concertina wire fence that runs the length of the boundary. Newly installed floodlights are more effective deterrents than the barbed wire itself, often draped like a clothesline with garments left by Chinese as they climb over.

Urgent negotiations between Hong Kong and Beijing (Peking) have relieved a separate aspect of the problem—the flow of legal immigrants. China has begun issuing fewer permits, perhaps worried that an overswamped Hong Kong could threaten its many commercial interests there; the colony is China's chief source of foreign exchange. The average number of immigrants legally entering Hong Kong slowed from 365 a day in December 1978 to 250 a day last June.

On its own side of the fence, China began patrolling for illegal emigrants with its elite 42nd Army. Nevertheless, Hong Kong's Governor Sir Murray MacLehose fears that by the end of 1979 the colony will have absorbed a total of 300,000 Chinese—legal and illegal—over a two-year period. And while most of its burden of Vietnamese refugees will ultimately be assumed by other nations, the Chinese mainlanders are there to stay, further taxing an already overtaxed social structure.

On the roof of the police station in Sha Tau Kok, large binoculars are trained across the border at a peak locally called China Mountain. Over its ridges and spurs wind what appear to be broad trails created by livestock or wagons. In reality they have been carved by thousands upon thousands of Chinese feet. From China Mountain all roads lead to Hong Kong.

(Continued from page 723) job has to be done, I know, but sometimes I find I just have to walk away."

He comes back, however, for there are other camps to visit, more food to be distributed, more fans to be handed out to stir up some breezes in the hot, stinking gumbo of air that hangs in the camps.

Even Bad Conditions Are Better

Chunk Kam Kut could have been a curveballer, the way she snapped her wrist to get the piece of cardboard she used for a fan from one side of her face to the other. At the age of 80 she boarded a small boat in Vietnam with 299 other Chinese and set sail for Hong Kong. Now, sitting on a mat in a 23-story factory building in the New Territories, she was smiling, revealing a tooth count of three, all small and brown and set in her lower gum like cloves in a ham. I asked her how she felt, and she replied in Cantonese, "Not bad." Then she started to fan me.

"The life in Vietnam, where I came from two months ago, is terrible," she said. "We haven't had one piece of new clothing since the Communists came."

More than 10,000 boat people were housed in the factory building on the day I was there. Some were assigned two hundred to a room, and a casual stepping off of measurements showed a living space of about 11 square feet per refugee.

Those in the factory building are allowed to work outside, in some of Hong Kong's 40,000 factories. It is a way of making a little money for the family while waiting for a permanent refuge.

The United States, by far, is the leading choice of the boat people. Committed last summer to taking in 14,000 a month, the U. S. is and always has been the most receptive nation for the homeless Indochinese.

"In considering a refugee for settlement in the U. S., we give the highest priority to reuniting families," said the Reverend Richard L. Shinn, the representative in Hong Kong for a joint agency composed of nine voluntary resettlement groups. "For those without relatives or a previous U. S. association, processing will take longer."

Refugees accepted by the U. S. are sponsored by one of the nine groups. Interviews are conducted by members of Pastor Shinn's staff, and the results are forwarded to the groups for consideration.

"Many, many families are being broken up in the flight from Vietnam," Pastor Shinn said. "They leave on different boats and fail to get back together. Someone's always missing. We're in the middle of one of the greatest tragedies of our time."

Even with the increased quotas set by the U. S. and other countries, and even if Vietnam does honor its vague agreement to slow the expulsion of its ethnic Chinese, it may well take years for Hong Kong to recover.

It's the strain, the terrible strain that has reached the very nerve ends of patience here. It is generally thought in Hong Kong that the world ignored the problem too long.

"Imagine what the reaction would have been," a Hong Kong newspaper reporter told me, "if all those people who died at sea were Norwegian, or German, or Dutch. What has happened borders on genocide. As usual, the United States is doing more than any other country, and it may not be fair to say this, but it would have been wonderful if they had moved the Statue of Liberty to San Francisco when this terrible thing began."

And Now, a New Future

One afternoon last June, a 63-year-old former Vietnamese university professor and I sat on plastic stools in the Sham Shui Po refugee camp run by the U. N. We drank warm soda pop and talked about the trip he and his five daughters would be making the next day. They had been accepted for residence in the United States.

He wanted to know about New York City because that was where they would be going. I told him what I knew, and I suggested that he prepare to eat his Peking duck with plum sauce because that is the way it is often served in the States. He said that would be all right; he'd eat it with horseradish as long as he could eat it as a free man.

Not far from where we sat, there were half a dozen boys whacking marbles out of a circle scratched in the dirt. One stood out from the others because his hair was blond. I pointed this out to the professor, and he said, yes, that boy was a refugee from Vietnam.

I didn't ask where in Vietnam. It was enough to know that it was a place his father had passed through on his way to war. □

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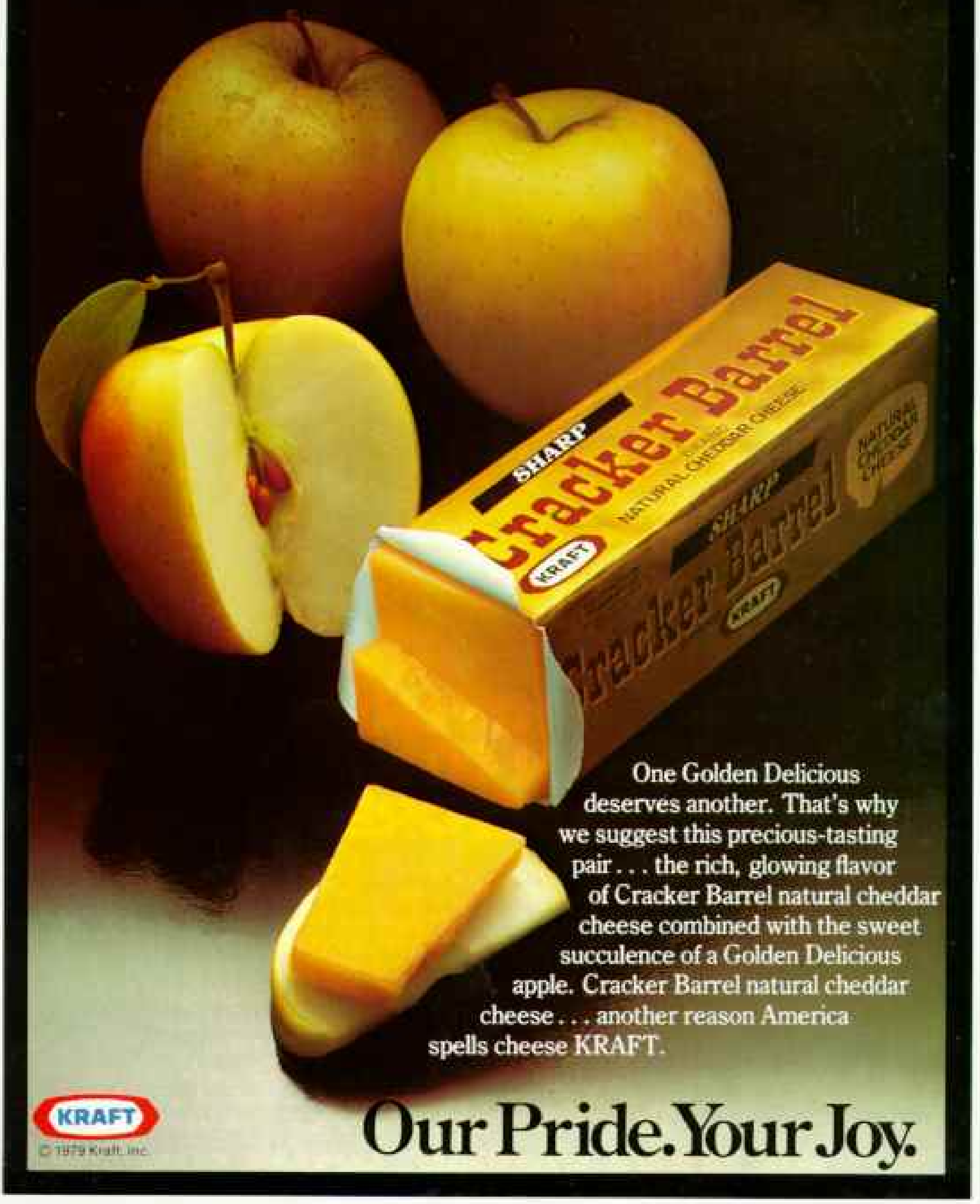

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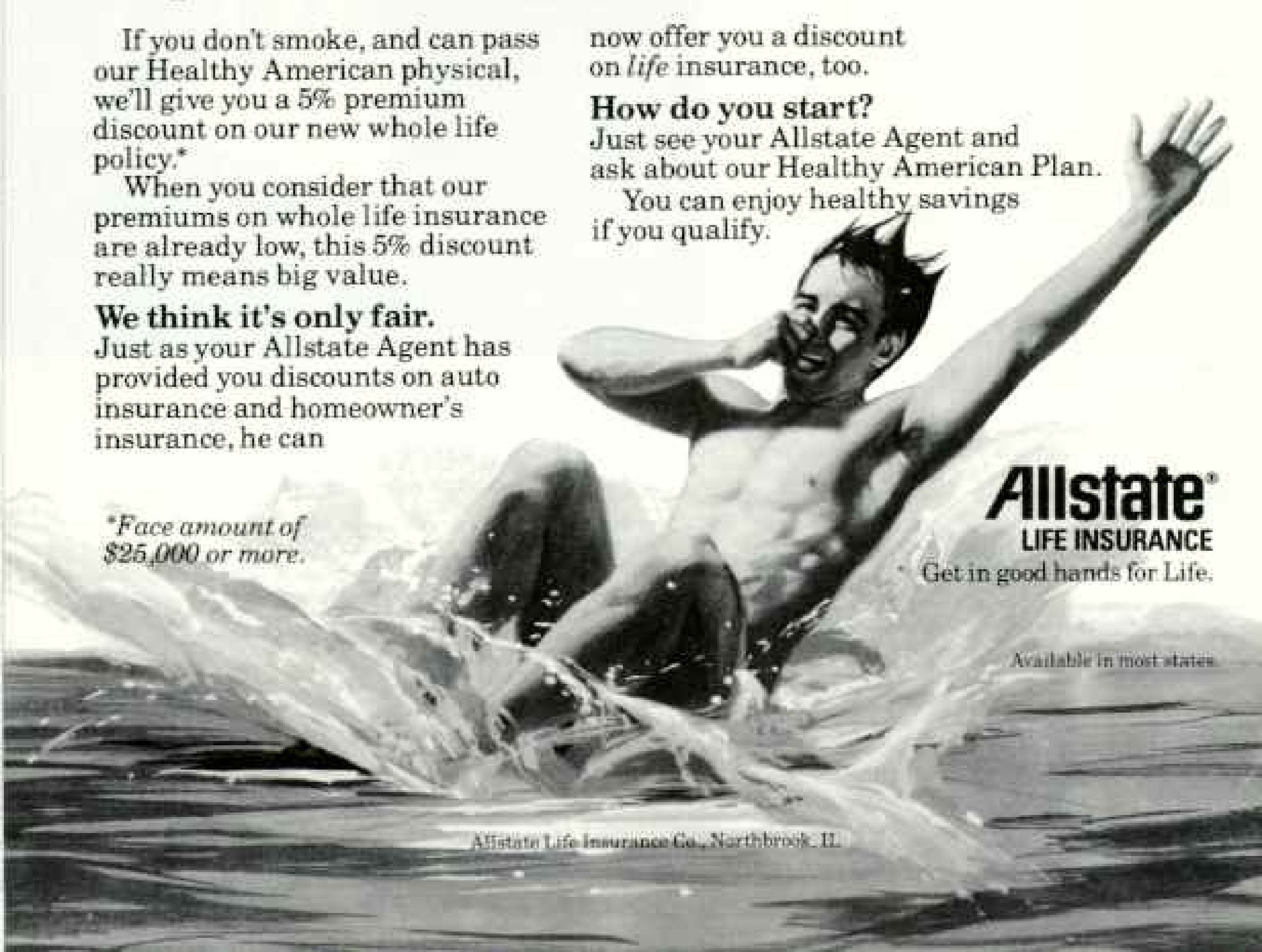

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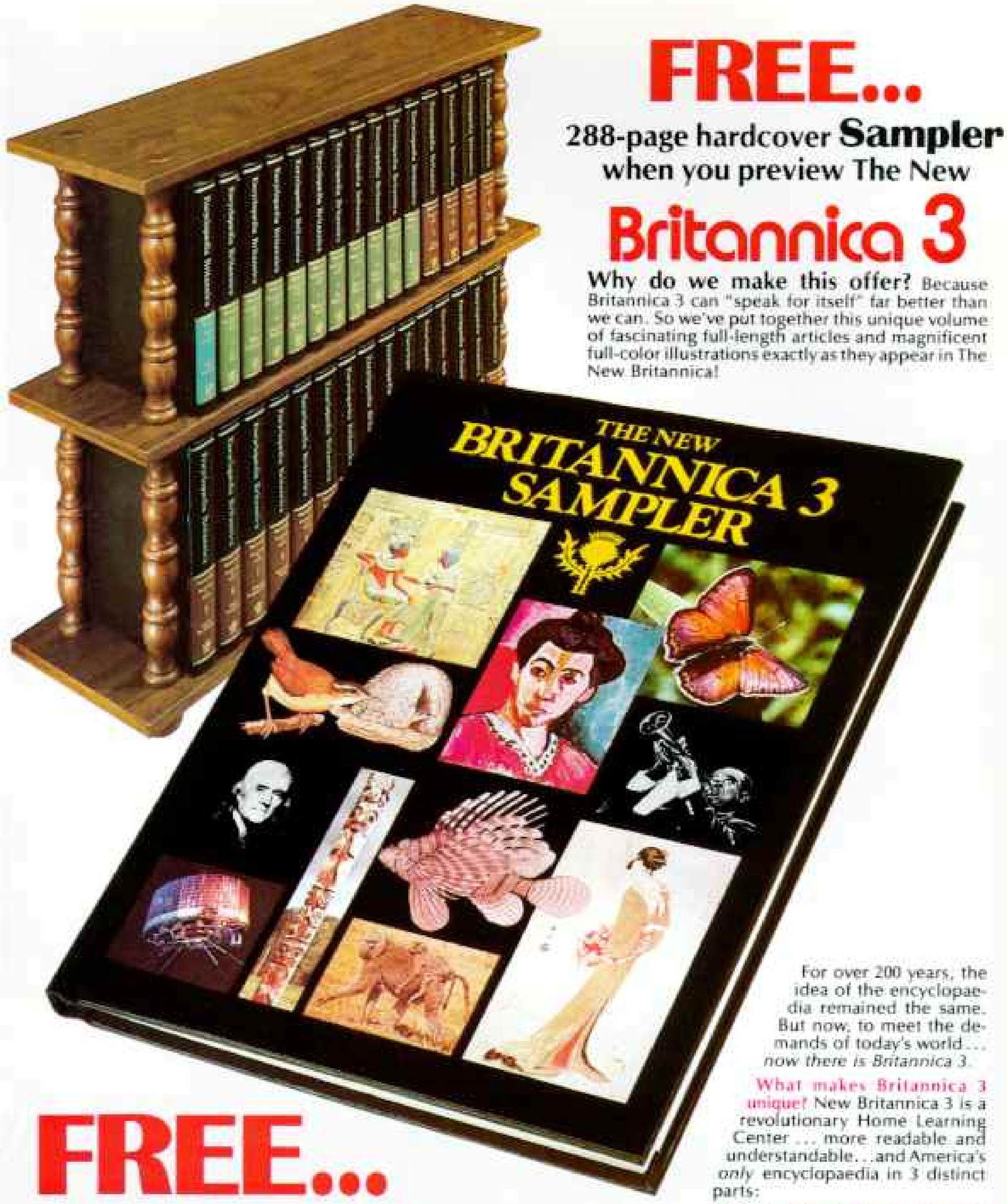

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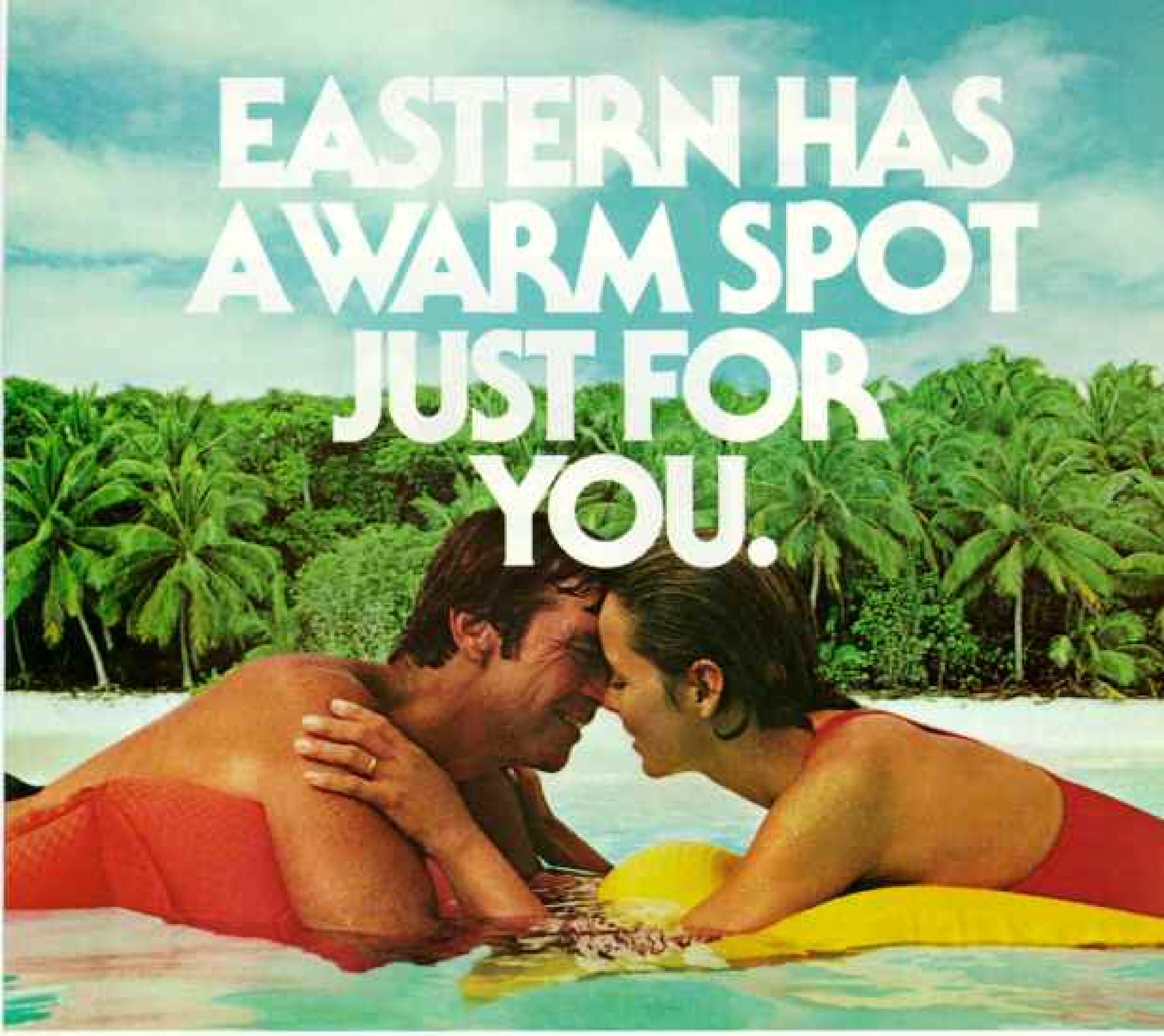

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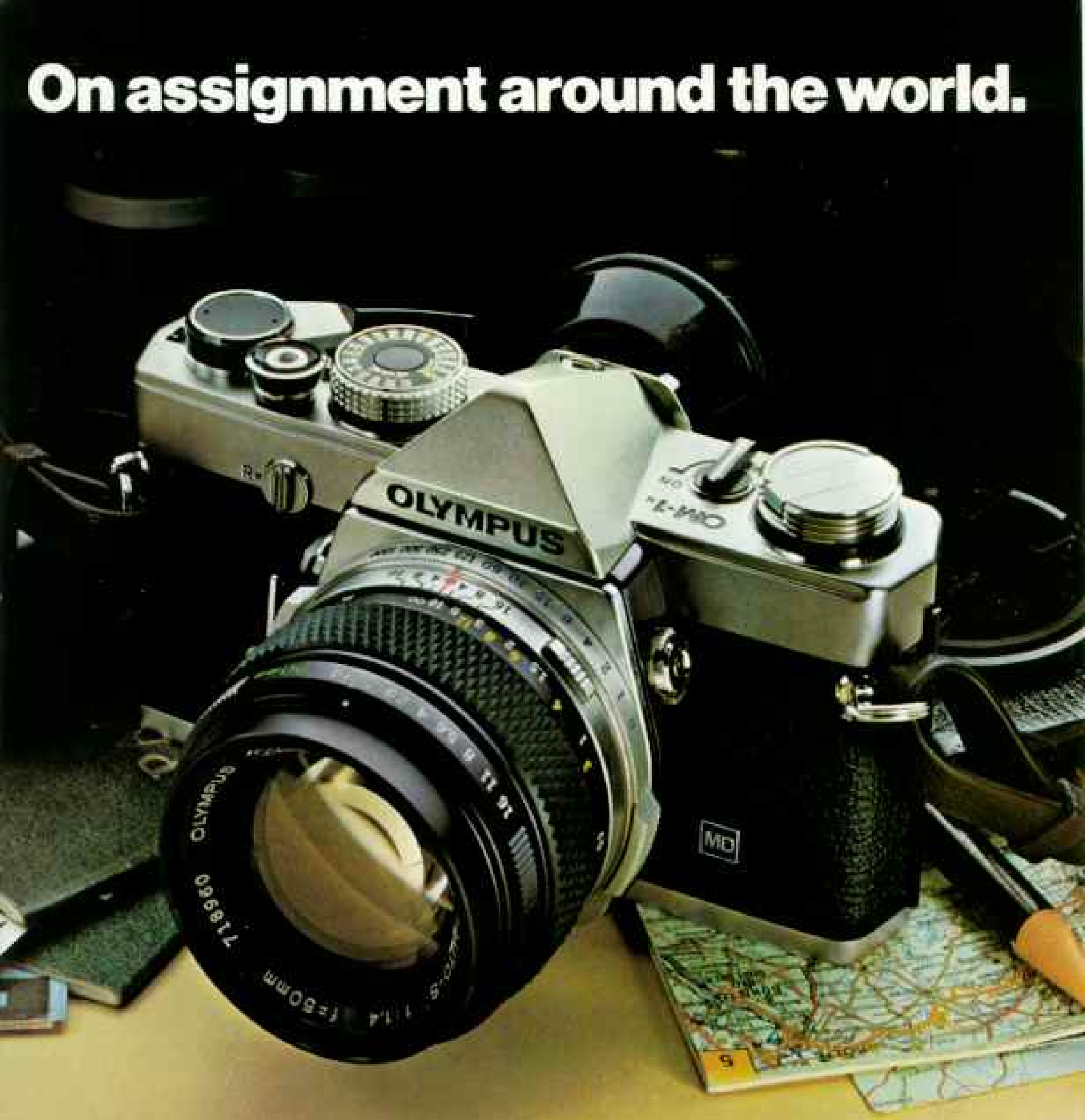
On assignment around the world.



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 dilettante 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

"We weren't seriously thinking of replacing our stereo. Then we heard Yamaha."

"There was a noticeable difference in sound quality. Enough of a difference to convince us to own Yamaha now."

For almost a century, the Yamaha name has graced the best musical instruments in the world. It is also synonymous with audio components that set unmatched industry standards.

Take the components shown—the CR-640 receiver, the YP-B2 turntable, and the NS-244 speakers. Each is built with the most advanced technology and highest quality craftsmanship. Their visual beauty is rich and warm. Their sound is distinctly natural and truly adds to the enjoyment you expect from listening to music. And the price is surprisingly affordable.

If you already have a stereo, and it's not Yamaha, you owe it to yourself to give Yamaha systems and components a listen. Now is the time to own Yamaha.

Plan to visit your Yamaha Audio Specialty Dealer this weekend and discover the difference for yourself. He's listed in the Yellow Pages.

YAMAHA

Yamaha International Corporation,
P.O. Box 6600, Buena Park, CA 90622
Also available in Canada.

Free for the listening!

The Session II album, valued at more than $15.

Hear today's hot studio musicians play the sounds of tomorrow on this lavishly produced album. You can't buy the Session II record, but you can get it free with a demonstration of this Yamaha CR-640 component system at your Yamaha dealer.

Recorded with state-of-the-art techniques for astonishingly live ambience, Session II is destined to become a Collector's Item. Quantities are limited, so don't delay! See the Yellow Pages for the name of your Yamaha Audio Specialty Dealer. Offer good thru Dec. 15 at participating dealers. Offer limited to one per household.

HOME STEREO 11 ENERGY EFFICIENT ENTERTAINMENT

YAMAHA

Nippon Gakki Co., Ltd., Japan

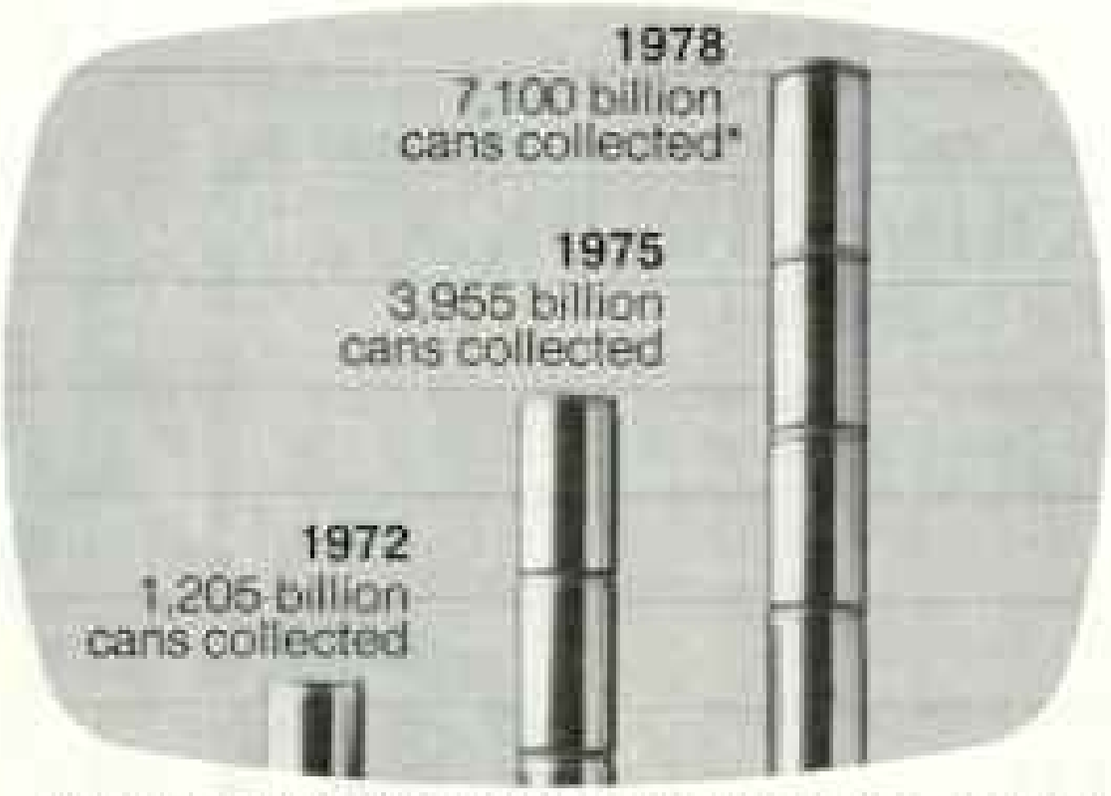
Recycling. The more you look at it the better it looks.

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, 359L Alcoa Building, Pittsburgh, PA 15219.

$25 Pre-Christmas Discount on a Maytag Jetclean™ Dishwasher.

Out-cleans 'em all in the regular cycle.

WC700 WU900

Now more than ever, it pays to invest in Maytag quality. Buy a Maytag Jetclean™ Dishwasher—built-in Model WU900 or convertible Model WC700—and get a $25 discount from participating Maytag Dealers. Look for the $25 Pre-Christmas Discount display.

The Maytag Jetclean™ Dishwasher out-cleans the other leading brands in the regular cycle. Out-cleans 'em all! And it's built as only the dependability people build them. ***Quantity is limited; offer good only while supply lasts.*** So take certificate below to your participating Maytag Dealer. Order now for Christmas delivery.

The Maytag Company, Newton, Iowa 50208

$25 PRE-CHRISTMAS DISCOUNT CERTIFICATE

Take now to your participating Maytag Dealer.

Buy a Model WU900 or WC700 Maytag Jetclean™ Dishwasher now and get a $25 discount from your participating Maytag Dealer's regular price. Quantity is limited; offer good only on Model WU900 or WC700, and only while supply lasts. This certificate may not be reproduced and is not transferable. Valid only in the USA and Canada. Void where prohibited by law. Limit: one $25 Pre-Christmas Discount per customer.

Redeemable only at participating Maytag Dealers.

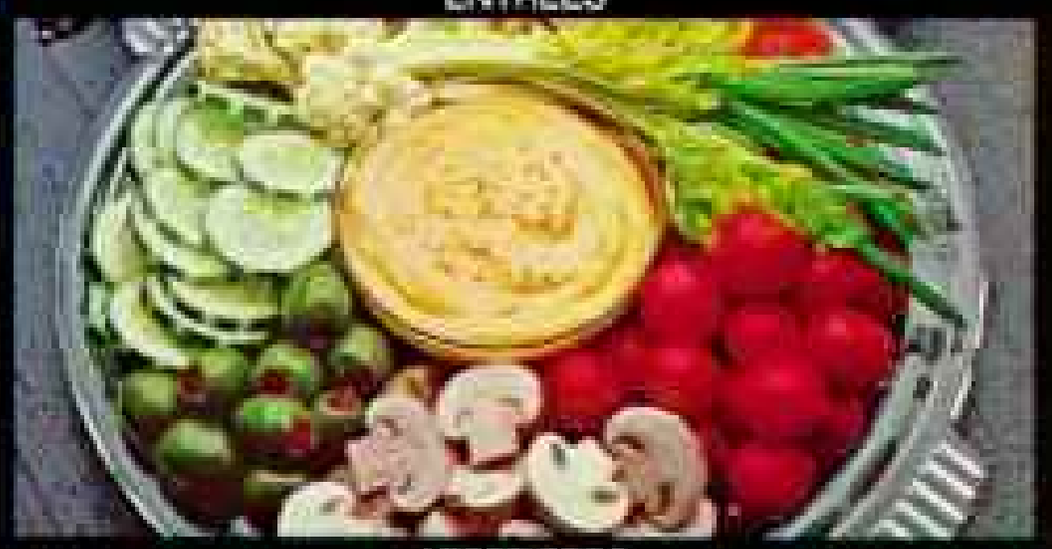
MAYTAG
JETCLEAN™ DISHWASHER

SANDWICHES

VEGETABLES

SALAD DRESSINGS

ENTREES



APPETIZERS

SAUCES

SALADS

BAKED GOODS

Open up to the amazing world of Hellmann's®!

Send for this versatile new cookbook today!

Hellmann's Real Mayonnaise does it all!...from soups to entrées, from appetizers to baked goods. Now you can enjoy the delicious versatility of Hellmann's in a wonderful new cookbook entitled: **That Amazing Ingredient: Mayonnaise!** This handsome 128-page hard-covered cookbook contains 156 kitchen-tested recipes, with 88 recipes photographed in full color. Send for your copy today and introduce yourself to the amazing world of Hellmann's.

Mail to: **Mayonnaise Cookbook**
Dept. AI-W
P.O. Box 307
Coventry, Ct. 06238

Please send me _____ copies of **That Amazing Ingredient: Mayonnaise!** I enclose a ☐ check, ☐ money order for $3.50 plus one label from any size jar of Hellmann's Mayonnaise, or $5.95 and no label.
Check or money order payable to: Mayonnaise Cookbook

NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

This offer may be changed or withdrawn at any time without prior notice. Offer void where taxed, prohibited or otherwise restricted. Connecticut residents add 7% sales tax.


GM
Eldorado 1980
BY CADILLAC...

The car behind the mystique.

There are great road cars. There are great luxury cars. Eldorado 1980 is both. On one hand, there's the mystique of Eldorado. Like that of the Eldorado Biarritz shown. The excitement. Flair. Pleasure. And pride. On the other hand, there's the car behind the image. A superbly designed, front-wheel drive automobile built to pull you through—in rain, sleet or snow. Altogether, one of the best engineered cars in the world. And even more so for 1980.

New Digital Electronic-Fuel-Injected Engine that eliminates conventional tune-ups. Only spark plug changes are required. Nerve center of this new engine is a sophisticated new form of EFI called Digital EFI, a Cadillac exclusive. Operating with digital accuracy, two electronically controlled injectors meter a precise mixture of fuel and air to the engine. For California, 5.7 liter EFI engine is standard.

New, on-board computer diagnostics to help take the guesswork out of servicing. This system, again a Cadillac exclusive, enables a Cadillac service man to find and correct a number of possible problem areas quickly. Activated by two push buttons, the diagnostic system displays a coded number for the area needing attention. Standard with Digital EFI.

New Electronic Climate Control System with digital accuracy. With a touch of a button, you can change temperature setting as precise as one degree. The system itself has one of the highest cooling capacities found anywhere on any car.

To help make you a more efficient driver . . . Another Cadillac digital feature for 1980 is the MPG Sentinel—standard with Digital EFI. Instantaneous miles per gallon is shown continuously to the nearest mpg. Push a button and it displays your average mpg for your trip, to the nearest 1/10 of a mile.

Almost every advanced electronic convenience is standard. Utilizing electronics, Eldorado seems to respond to your every need . . . your every wish. Almost anticipating them. From new Digital Electronic Fuel Injection to Electronic Level Control. From the Digital Electronic Climate Control System to Twilight Sentinel that automatically turns lights on and off in response to outside lighting conditions. And on it goes . . .

Front-wheel drive for traction and added roominess. Eldorado, one of the cars that pioneered modern front-wheel drive in the U.S., is still one of its finest expressions. Because the engine's weight is over the wheels that drive the car, there is impressive traction in a wide variety of weather conditions. And since the floor is virtually flat with front-wheel drive, there's added roominess, too.

World-class in engineering. Almost every system —every detail—contributes to the world-class status of Eldorado 1980. Including four-wheel independent suspension for ride control. Four-wheel disc brakes that adjust automatically with every application. Quick ratio power steering that contributes to maneuverability in city driving and parking. Permanently sealed wheel bearings that never need lubrication. And much more. Even side window defoggers are standard.

If Diesel-power intrigues you . . . a 5.7 liter fuel-injected Diesel V8 is available. (In Calif., Diesel not available at time of printing.) So you can equip your 1980 Eldorado to best fit your driving needs. There's even a new Sport Handling Package available that includes a firm, sports car-like suspension and larger steel-belted radial tires. Eldorados are equipped with GM-built engines produced by various divisions. See your Cadillac dealer for details. And to buy or lease the Eldorado of your choice.

...one of the best engineered cars in the world.

"Chew on the bark of 2 willows and call me in the morning."

At the time of Hippocrates and for two thousand years thereafter, people turned to nature whenever they suffered pain. Thousands of remedies were concocted from herbs, berries and bark.

Today, we have a pain-relieving chemical that's called acetylsalicylic acid (aspirin). Surprisingly, it's chemically related to the same natural remedy that Hippocrates himself used to prescribe: the bark of the willow tree.

And for people who prefer another pain reliever, we have a relative newcomer, acetaminophen.

Whether made by nature or by man, chemicals have always played a major role in reducing pain and improving the quality of life.

No chemical is totally safe, all the time, everywhere. The challenge is to use chemicals properly. To help make life more livable. (And less painful.)

For a free booklet explaining the risks and benefits of chemicals, mail to: Monsanto, 800 N. Lindbergh Blvd., St. Louis, Mo. 63166. Dept. A3NA-NG 5

Name _____

Address _____

City & state _____ Zip _____

Monsanto

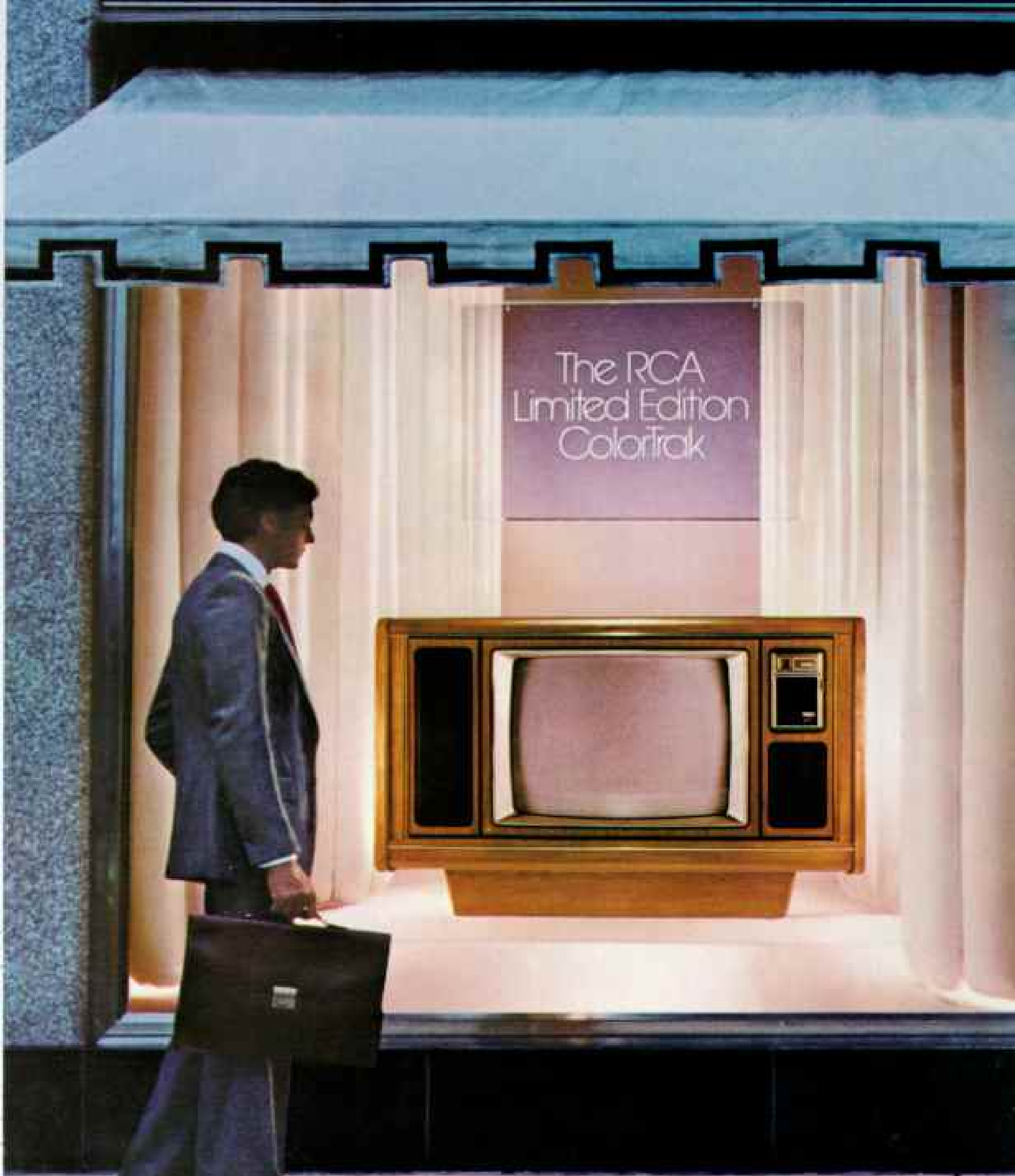
Without chemicals, life itself would be impossible.

New, ready-in-a-flash cameras from Kodak.

Make it a ready-in-a-flash Christmas with three brand-new Kodak Ektralite cameras! The built-in, flip-out flash means you're always ready in a flash. Some models come with the telephoto lens, and even automatic exposure. The brand-new Kodak Ektralite cameras for a ready-in-a-flash Christmas.

OFFICIAL PHOTO CONSULTANT TO THE 1980 OLYMPIC WINTER GAMES.

Kodak gifts say **"open me first"** ...to save Christmas in pictures.



Set shown is "The Couture." Model GD2608SE. Its cabinet is made from genuine European veneers and Philippine solids. One of 4 consoles. Additionally, two table models will be available.

The picture is more like the movies. The sound, closer to stereo. Yet, only a handful of people will get to own one.

Introducing The Limited Edition ColorTrak.

The Limited Edition ColorTrak is currently being demonstrated at many RCA Dealers.

It's worth seeing, even if you're not actively looking to replace your present set…just to find out where color television is going.

You'll see a color picture that is demonstrably superior—clearer, sharper, more precise—than any ever made by RCA. A picture that will bring you closer to the realism and excitement of the movies than we've ever been able to bring you before.

You'll also hear sound that far exceeds what you've come to expect.

Instead of listening to a single monaural speaker, you'll hear a wider range of sound sorted into five coordinated frequency ranges, then channeled into balanced pairs of two amplifiers and two separate speakers. In effect, the sound surrounds the picture.

Styling will be equally impressive. Consoles are offered in Mediterranean, French Country, Traditional and Modern. All are impressively slim-lined so the set fits gracefully against a wall.

Additionally, all consoles will include RCA's ChanneLock Remote Control.

Because only a limited number will be made (enough for just about one in every three thousand homes), we suggest you see the Limited Edition ColorTrak demonstration soon.

If you believe that you may be interested in owning one, then we attach even a greater sense of urgency to our invitation.

After all, we wouldn't want you to have to do without.

RCA

RCA is making television better and better.

"Sure I wanted a microwave oven, but I had no place to put it."

INTRODUCING THE NEW SPACEMAKER™ MICROWAVE OVEN FROM GENERAL ELECTRIC.

We designed it to install easily over your present range.

"Imagine, a microwave oven and range hood in one.

With my new GE Spacemaker oven I have the benefits of microwaving, and I haven't lost any

counter space. The Spacemaker oven fits in beautifully and has its own exhaust fan and light for my range below.

"I love the way it's changed my kitchen.

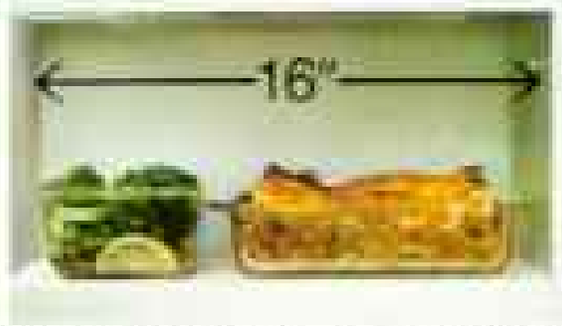
I never dreamed how simple it would be to give my kitchen a custom look. The wood tones blend in beautifully with the rest of my kitchen. And with the Spacemaker oven in combination with my range, I now have two ovens in one convenient location.

"It has all the microwave oven features I need.

I can cook by time or by temperature. And with the Microwave Guide and Cookbook that came with my Spacemaker oven, I'm whipping up meals I never realized I could microwave!

"My Spacemaker oven has an extra-wide oven interior.

It's spacious enough for my three-quart casserole dish or two dishes side by side."



For your nearest Spacemaker oven dealer, call toll-free **(800) 447-4700.** In Illinois only, call **(800) 322-4400.**

We bring good things to life.

GENERAL ELECTRIC

HOW TO MAKE EVERYONE ON YOUR CHRISTMAS LIST FEEL LIKE THEY'RE AT THE TOP OF YOUR LIST.

Making friends and family feel like you thought of them first is worth checking your list twice.

To make sure it includes Krementz 14Kt. Gold Overlay.

You see, we put as much care into making our jewelry as you put into giving it.

That's why every piece of Krementz 14Kt. Gold Overlay has more than 30 times the gold in costume jewelry.

And why everything from an intricate $55 bracelet to a simple $17 brooch is crafted by hand.

So this Christmas, give Krementz 14Kt. Gold Overlay. And put everyone at the top of your list.

Krementz®

SINCE 1866

WRITE KREMENTZ & CO., 60 CHESTNUT STREET, NEWARK, N.J. 07101 FOR A FREE COPY OF "UNIQUE—THE STORY OF KREMENTZ GOLD OVERLAY JEWELRY."
AND ASK FOR KREMENTZ 14KT. GOLD OVERLAY AT YOUR FAVORITE JEWELRY OR DEPARTMENT STORE.

Chevrolet Monte Carlo for 1980. You've never seen the likes of it before.

An impressive statement, you say?

Slip behind the wheel of the new Monte Carlo for 1980. Run your hand along its rich new look of vinyl woodgrain. Take in its elegant new upholsterings.

Then turn the key. Feel yourself propelled by a new standard 3.8 Liter (229 Cu. In.) V6 engine* with greater power output than last year's standard engine. A sensation you can multiply with the new available turbocharged V6 for 1980.

And, as you drive, remind yourself that automatic transmission and power steering are standard this year. And that it all comes together in a Monte Carlo with better EPA estimates† than Toyota Corona or Volvo 264.

CHEVROLET MONTE CARLO EPA estimated MPG	19
TOYOTA CORONA 4-DR SEDAN EPA estimated MPG	18
VOLVO 264 GLA EPA estimated MPG	17

REMEMBER: Compare these estimates to estimated MPG of other cars. Your mileage may vary depending on speed, trip length and weather. Monte Carlo is equipped with GM built engines produced by various divisions. See your dealer for details.

*Not available in California where a 231 Cu. In. V6 is standard.

†Comparisons based on standard engines with automatic transmission and on 1979 Toyota and Volvo. Mileage estimates do not apply in California.

The Chevy price makes it look even better.

Which is perhaps the most exciting aspect of Monte Carlo's impressive new features and driving delights for 1980. They all come to you for the price of a Chevrolet.

See your Chevy dealer about buying or leasing the new Monte Carlo. You've never seen a Monte Carlo quite like it before.

Monte Carlo's new Special Custom interior available for 1980. And underneath that, the quiet comfort of a cushion mounted full-perimeter frame.

TURBO

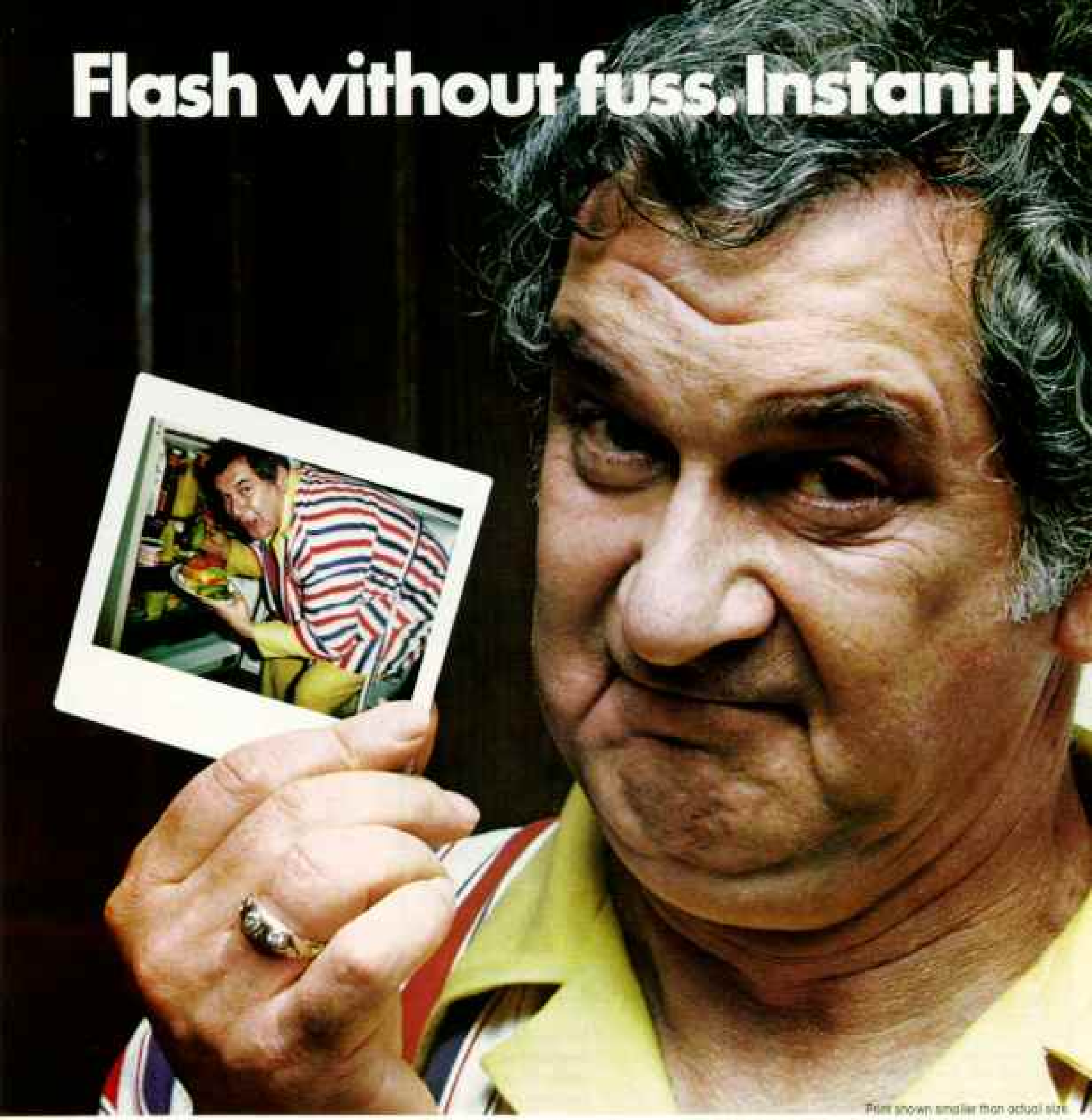
New available 3.8 Liter turbocharged V6 engine for passing acceleration on demand.

No other car looks quite like our Chevrolet Monte Carlo. Impressive new grille, new dual rectangular headlights continue that distinction for 1980.

GM

Chevrolet

Flash without fuss. Instantly.



Film shown smaller than actual size.

Introducing the Kodak Colorburst 250 instant camera with built-in flash.

You'll never have to look for another flipflash again.

Not with the new Colorburst 250 instant camera.

The flash is not only built-in, it's automatic. You can stop the action indoors or use the flash outdoors to fill in the shadows on close-up shots, all automatically. Just slide out the flash, aim and shoot.

The motorized camera delivers a rich color print that develops right before your eyes.

And there's never been a better time to buy the Colorburst 250 instant camera because for a limited time you can save up to $10.00 on all Colorburst cameras and Kodak instant color film.

See your photo dealer for details.

The more you take, the more you give.

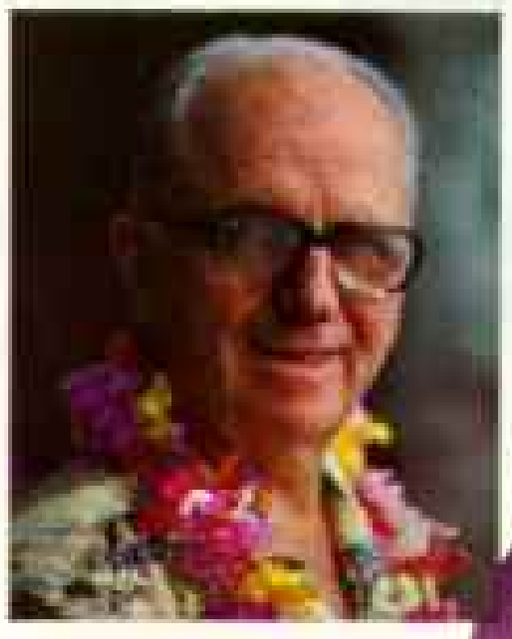
Kodak

™ OFFICIAL INSTANT CAMERAS FOR THE 1980 OLYMPIC WINTER GAMES

All the photographs of sunrises in the world cannot compare to seeing one in person, off the West Coast of Maui.

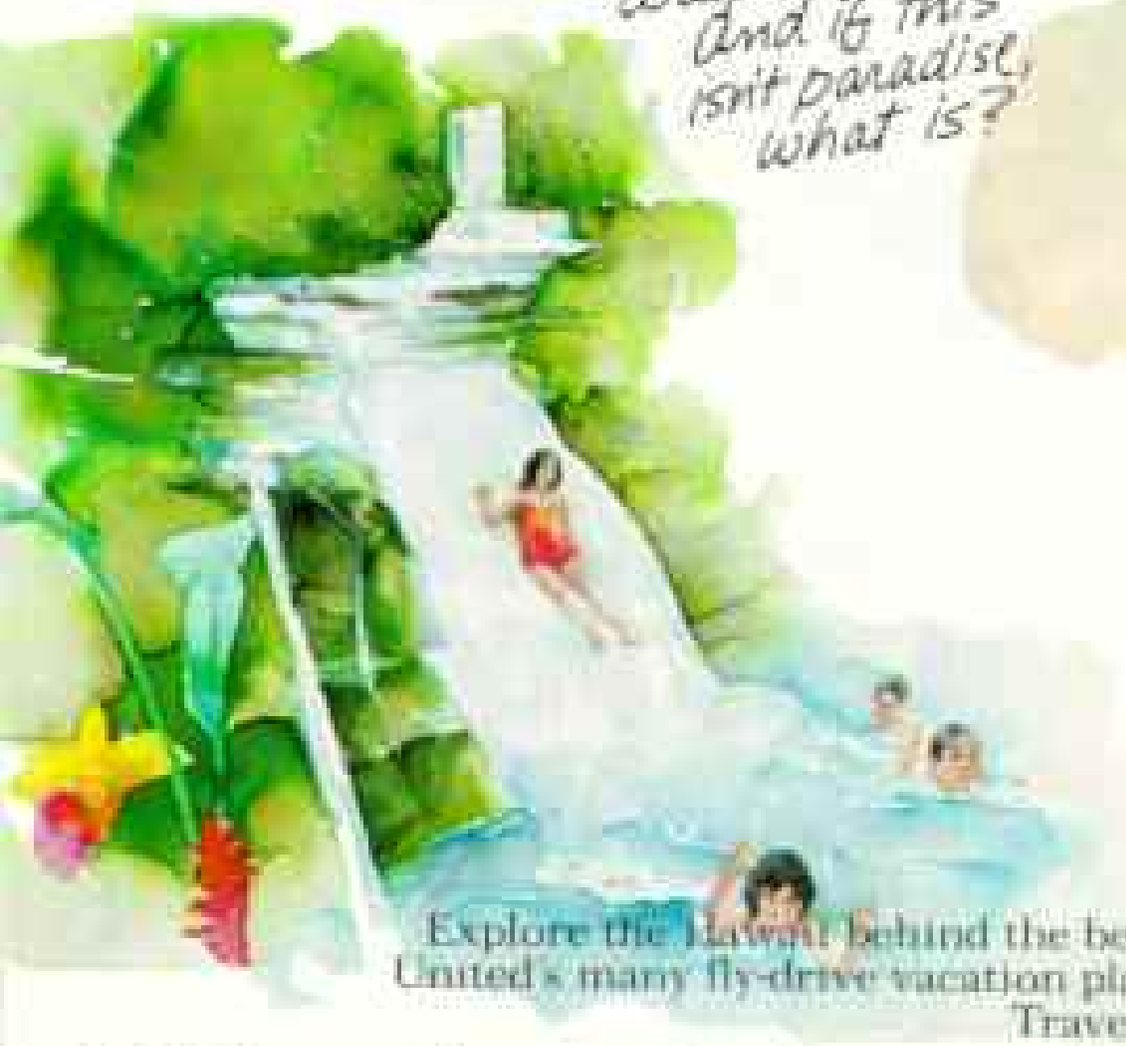
"Take a little car—and a little imagination—and discover your secret paradise in Hawaii."

James A. Michener



Hawaii is a very personal place. It's many different things to the many different people who travel here. Take a car and the time to explore it. And you can find a paradise you can call your own.

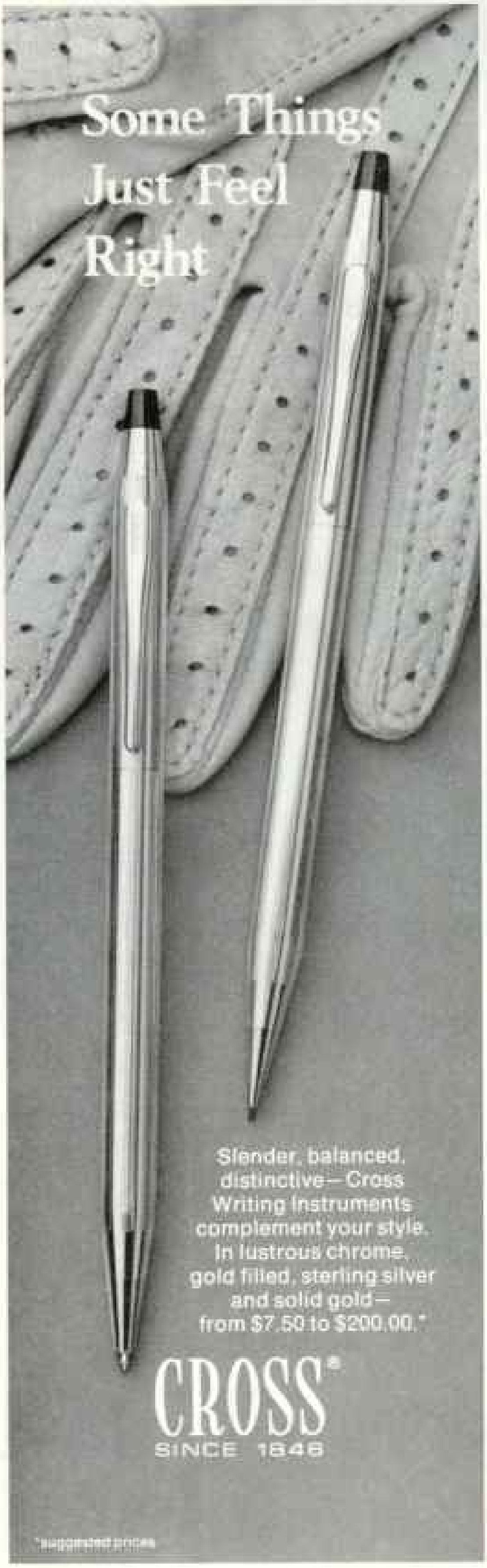
What joy! To slide down a waterfall into a tropical pool. You can do it at Waipahee Falls. And if this isn't paradise, what is?



From the lush green jungles of Kilauea Iki you can enter the cool darkness of the Thurston Lava Tube, a beautiful and eerie trail cut through the mountain eons ago by a river of hot lava.

Explore the Hawaii behind the beaches. There's no better way than with one of United's many fly-drive vacation plans. For information and reservations, call your Travel Agent or United.

Fly the friendly skies of United®



America's true colors come through on GE.

The rich green of Miss Liberty. The bright red of a football jersey. The vibrant yellow of a harvest moon. These are America's true colors—colors that come through vivid and lifelike on GE TV.

What's more, every GE VIR II color set adjusts those colors automatically. From channel to channel, program to program.

GE color TV. It brings America's true colors into your life.

We bring good things to life.

GENERAL ELECTRIC

Gulf is van pooling.
Because one van is worth 1,000 gallons.

"I'm full-time Program Administrator and part-time driver. Here's my group."

"Every morning, 1,441 Gulf employees who used to drive their own cars to work now make the trip in vans," says Gulf's van pooling Program Administrator Ken Sawicki. "And the energy savings are really amazing.

"Every van we operate saves 1,000 gallons of gas every 38 workdays."

"With 11 people to a van, making an average daily round trip of about 50 miles, we figure that each van saves a thousand gallons of gasoline every 38 workdays.

"With 132 vans now operating in eleven different Gulf facilities, we save 3,430 gallons of gasoline every working day!

"Gulf's tank-truck fleet is more energy-efficient, too. Gulf bought new fuel-efficient equipment, reorganized the routes, and gave the drivers some special training, so our 1978 fuel consumption was 12.9% below what it was in 1972.

"And Gulf refineries are saving energy even while they're making it: our eight refineries used about 20% less energy in 1978 than they did in 1972.

"Energy conservation is a tremendous challenge, but we have to meet that challenge if this country is ever to become less dependent on expensive imported oil. It's only reasonable that Gulf, as one of America's leading energy producers, should work just as hard at being one of America's energy savers. We wanted you to know we're doing our share."

Gulf

Gulf people:
meeting the challenge.

Gulf Oil Corporation

Long-range luxury. 1980 Ford LTD.

LTD Country Squire

Ford. The WagonMaster.

It began in 1929 with America's first mass-produced station wagon. Today, fifty years of Ford wagon technology come together in the 1980 LTD . . . versatile, good looking and practical. Consider, for example, LTD's excellent fuel economy.

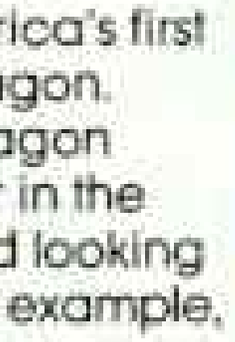
17 EPA EST. MPG **24** EST. HWY MPG

For comparison. Your actual mileage may differ depending on speed, distance and weather. Actual highway mileage will probably be lower than estimate. California mileage lower.

Compare LTD wagons.

Fold down the rear seats and LTD offers 89.7 cubic feet of cargo area. And when you're going to tow, you'll be able to bring along up to 6,000 pounds by adding the optional towing package.

Whether you buy or lease your LTD wagon, ask your Ford Dealer about the Extended Service Plan.



Better ideas for the road. FORD

FORD LTD

FORD DIVISION

340-Mile Est. Range; 480-Mile Est. Highway Range. Based on LTD's 20-gallon gas tank and EPA mileage estimates. Your range may differ. Actual highway and California range will probably be lower.

Automatic Overdrive Option. First automatic transmission with the benefit of overdrive on an American-built car.

LTD Luxury. Optional Interior Luxury Group shown with rich velour cloth, available in super-soft vinyl or optional leather.

Cargo Room. With the tailgate down, you can actually slide in a 4' x 8' sheet of plywood . . . flat.

3-Way Tailgate. Dual Facing Rear Seats. Tailgate swings open like a door or down like a platform. Dual facing rear seats, an exclusive Ford Motor Co. option, provides seating for two or an extra 7.7 cu. ft. of under-floor stowage (with seat cushions removed).

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.

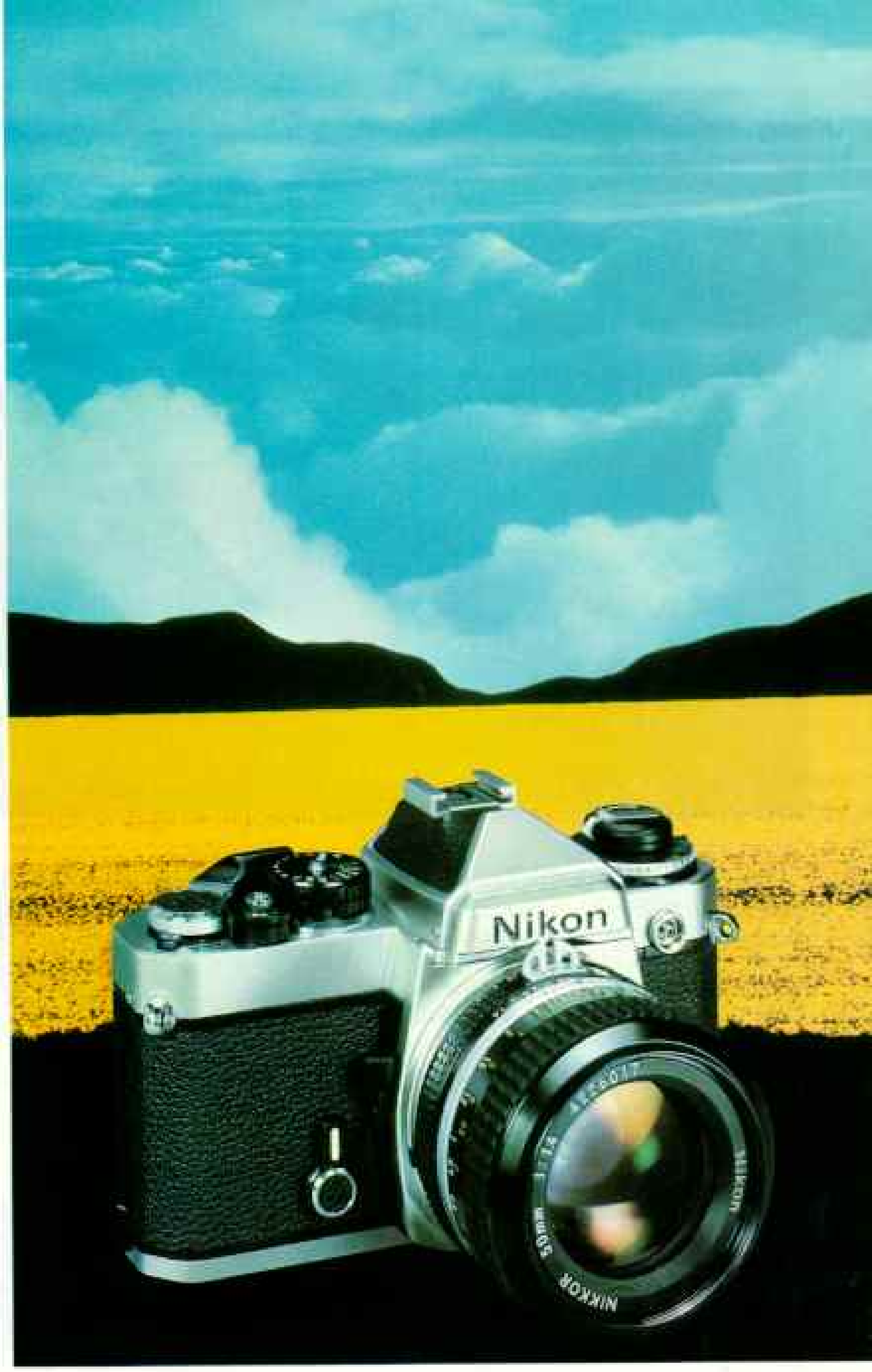
With the Nikon FE, you can simply focus and shoot... and rely on its Nikon electronics to give you sharp, magnificently exposed photographs, automatically. Or, switch to manual operation and enjoy complete creative control over every exposure, more easily than you ever thought possible.

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.

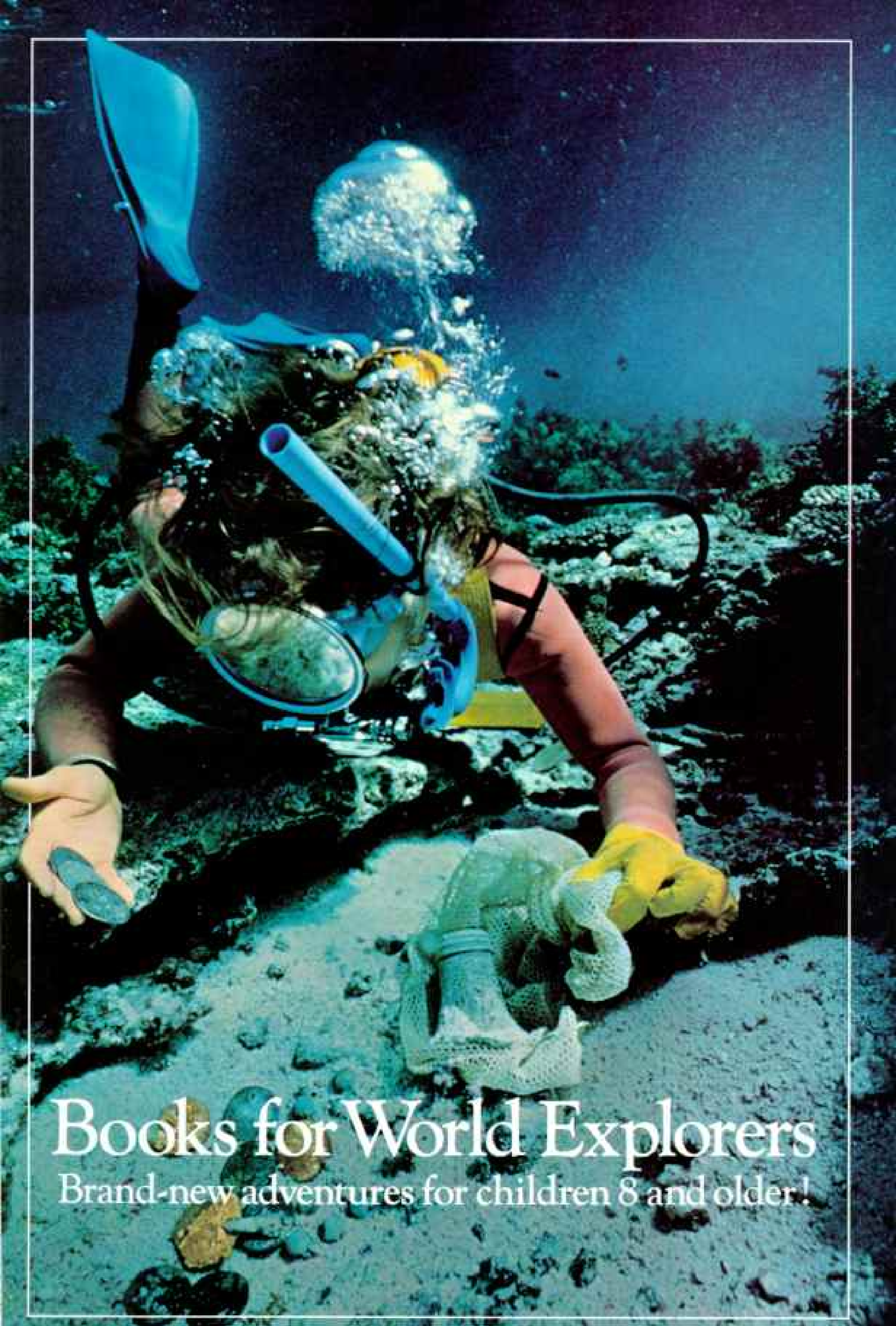
Nikon Inc., Garden City, New York 11530.
In Canada: Nikon Canada, Inc.



Experience a sense of perfection.

The Nikon FE.

Just in time for holiday savings —
$35 CASH REBATE WHEN YOU BUY THE NIKON FE.
See your Nikon dealer for details. Rebate offer from Nov. 1, 1979 to Jan. 31, 1980



Books for World Explorers

Brand-new adventures for children 8 and older!

In this exciting new series

Make fascinating discoveries in SECRETS FROM THE PAST

National Geographic presents a delightful introduction to the world of archaeology! SECRETS FROM THE PAST invites your children to look over the shoulders of scientists as they uncover clues to one intriguing mystery after another.

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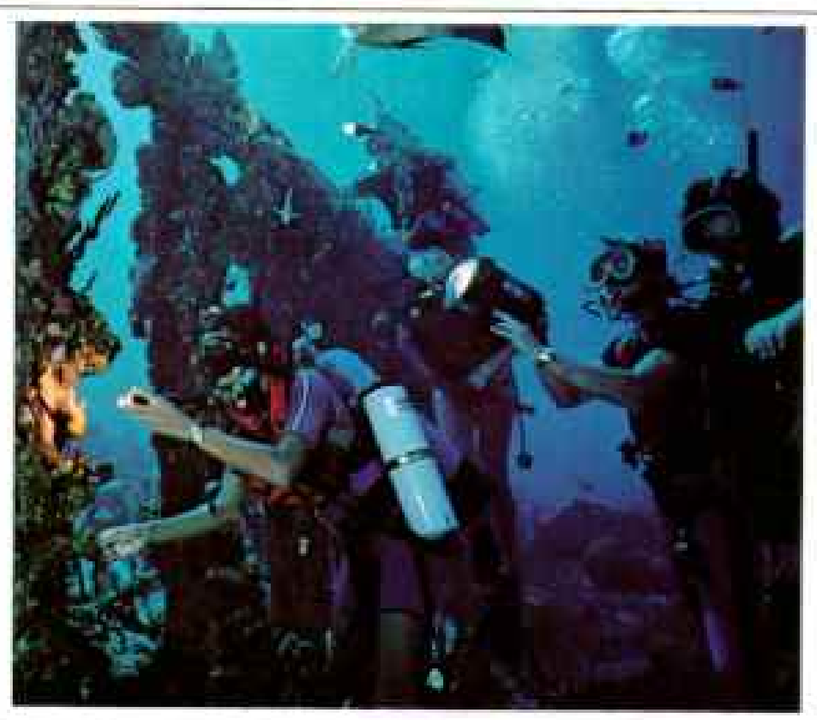

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