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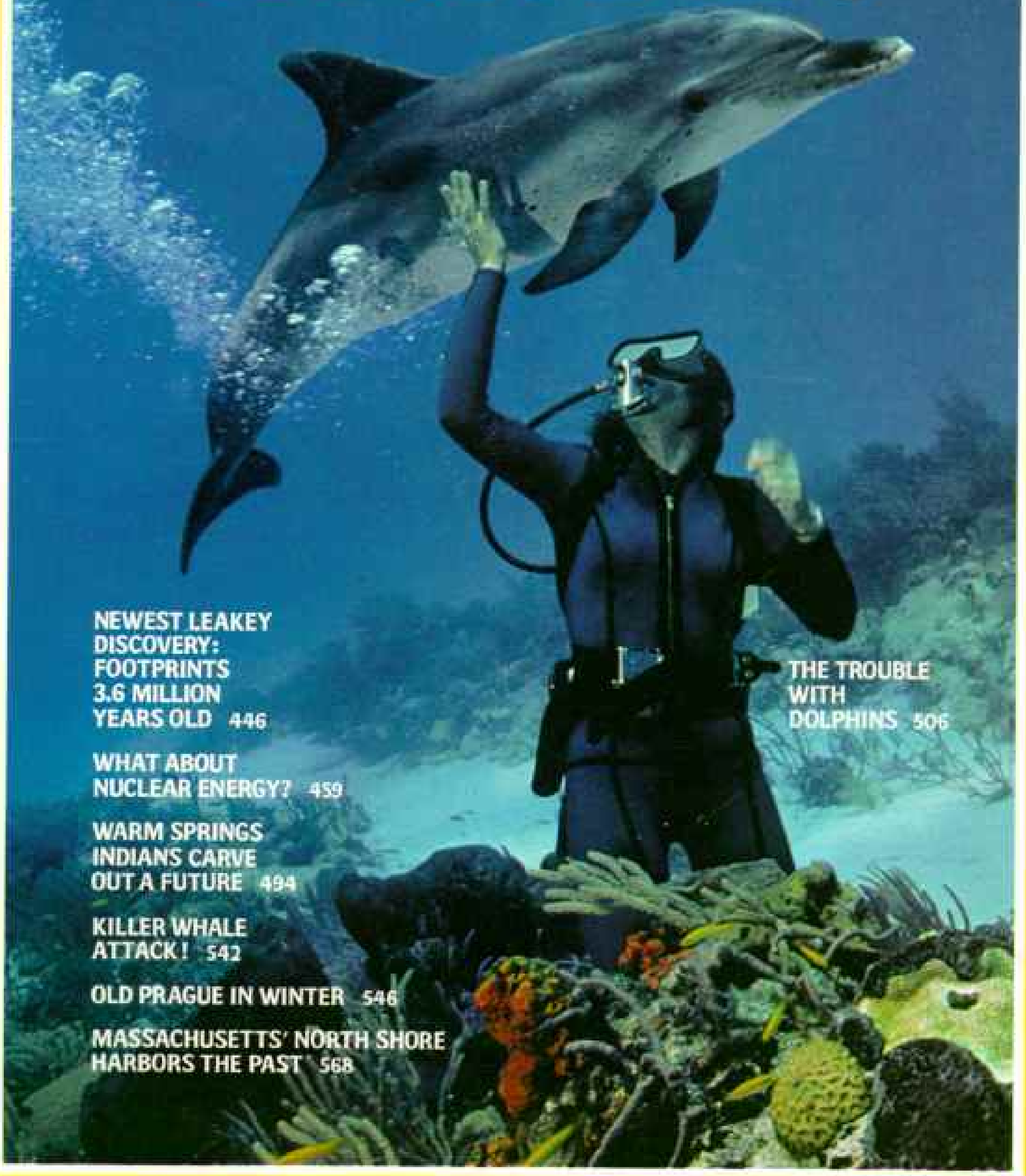

NEWEST LEAKEY DISCOVERY: FOOTPRINTS 3.6 MILLION YEARS OLD 446

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PERHAPS THE BEST KNOWN of the stories of *The Thousand Nights and a Night* is that of the fisherman who finds a cucumber-shaped bottle in his net. He removes the lead cap and a cloud of smoke issues forth, resolving itself into a fearful jinn. The fisherman tricks the jinn back into the bottle and finds that he has command of an awesome servant with the power to grant his wish.

Nuclear energy appeared much the same way just a few decades ago. The cloud was mushroom shaped, and the power it represented was indeed fearful. But once trapped in the safe containers of commercial nuclear plants, the jinn promised unlimited amounts of efficient, safe, inexpensive, and clean energy.

But the jinn has proved less tractable than imagined. Its energy comes at a price, as does all energy, not only in inflating costs but in environmental consequences as well. As coal and oil pollute the air we breathe, so nuclear energy produces radioactive waste. Not to mention the feared by-product of one process—nuclear weapons available to dozens of nations.

The exclusivity once held by the U. S. has long since vanished. The world has been steadily filling with nuclear power plants—some 540 are now licensed, under construction, or on order. For the world at large, there is no turning back on the nuclear road.

Add to this the increasing uncertainty of Middle East oil supplies, rising OPEC prices, the distance between Alaska supply and U. S. East Coast demand, the increased estimates of Mexican oil reserves, and the ongoing struggle in our western states between environmentalists and coal companies. The stage seems set for one of the great debates of public policy in the decade ahead.

The promise of virtually unlimited energy through nuclear fusion is many years from fulfillment. Despite an ultimate cost of more than 18 billion dollars (the present rate of outlay is 500 million a year), it may be the year 2025 before fusion is a practical energy alternative, if then.

So we fully expect science editor Ken Weaver's report in this issue to be followed by others in the years ahead. As we confront this mighty jinn, out of the bottle forever, we are not quite sure what questions to ask of it.

Gilbert M. Grosvenor

NATIONAL GEOGRAPHIC

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Footprints Frozen in Time 446
Paleontologist Mary D. Leakey describes a startling discovery in East Africa—tracks left in hardened volcanic ash by hominids that walked upright at least 3.6 million years ago.

The Promise and Peril of Nuclear Energy 459
For years the power of the atom was hailed as the answer to man's fuel shortages and pollution problems. Now bitter debate rages over radiation hazards, economic pitfalls, and weapons proliferation. Science editor Kenneth F. Weaver and photographer Emory Kristof report in depth on nuclear pros and cons.

Warm Springs Indians Carve Out a Future 494
Business is booming on an Oregon reservation where a tribally owned resort and a thriving forest-products industry help turn poverty into prosperity. Article and photographs by David S. Boyer.

The Trouble With Dolphins 506
Senior editor Edward J. Linehan learns close up what scientists now know—and don't know—about porpoises, those cavorting, companionable, and perhaps most intelligent creatures of the seas. Photographs by Bill Curtsinger.

Killer Whale Attack! 542
An unprecedented series of photographs documents a savage, wolflike assault on a blue whale by a pack of the largest dolphins—killer whales. With text by Cliff Tarpy.

Old Prague in Winter 546
Peter T. White and Nathan Benn find a compelling, captivating sense of history pervading the heart of Czechoslovakia's capital.

Massachusetts' North Shore Harbors the Past 568
Boston Brahmins and Sicilian fishermen, artists and clam diggers, horsemen and boatbuilders share a rugged coast where tradition still rules. By Randall S. Peffer, photographs by Nathan Benn.

COVER: *A wild spotted dolphin befriends marine biologist Sylvia A. Earle in the Bahamas. Photograph by Al Giddings, Sea Films, Inc.*

3.6 MILLION YEARS OLD

Footprints in the

IT HAPPENED some 3,600,000 years ago, at the onset of a rainy season. The East African landscape stretched then, much as it does now, in a series of savannas punctuated by wind-sculptured acacia trees. To the east the volcano now called Sadiman heaved restlessly, spewing ash over the flat expanse known as Laetoli.

The creatures that inhabited the region, and they were plentiful, showed no panic. They continued to drift on their random errands. Several times Sadiman blanketed the plain with a thin layer of ash. Tentative showers, precursors of the heavy seasonal rains, moistened the ash. Each layer hardened, preserving in remarkable detail the footprints left by the ancient fauna. The Laetolil Beds, as geologists designate the oldest deposits at Laetoli, captured a frozen moment of time from the remote past—a pageant unique in prehistory.

Our serious survey of the beds, which lie in northern Tanzania 30 miles by road south of Olduvai Gorge (map, page 450), began in 1975 and gained intensity last summer after the discovery of some startling footprints. This article must stand as a preliminary report; further findings will almost certainly modify early interpretations.

Still, what we have discovered to date at Laetoli will cause yet another upheaval in the study of human origins. For in the gray, petrified ash of the beds—among the spoor of the extinct predecessors of today's elephants, hyenas, hares—we have found hominid footprints that are remarkably similar to those of modern man. Prints that, in my opinion, could only have been left by an ancestor of man. Prints that were laid down an incredible 3,600,000 years ago!

My late husband, Dr. Louis S. B. Leakey, and I had first explored the Laetolil Beds in 1935. In that year we were searching for fossils in Olduvai Gorge when Masai tribesmen told us of the rich remains at Laetoli, which in their language refers to the red lily that grows there in profusion. When heavy rains ended the Olduvai excavation season, we made the difficult, two-day journey south.

We did find fossils, but they were much more fragmented than those of Olduvai. At that time, accurate dating was impossible. So we left the site. A German expedition combed the beds in 1938-39, and we ourselves returned twice with indifferent results. But I could not help feeling that, somehow, the mystique of Laetoli had eluded us.

Then, in 1974, two things occurred. I was drawn back once more to these ancient volcanic deposits, and one of my African associates, Mwongela Mwoka, found a hominid tooth. Analysis of the lava that overlies the beds assigned the tooth an age of at least 2,400,000 years. Since this is older than anything at Olduvai, I decided to concentrate my efforts at Laetoli. In 1975, with National Geographic Society support and the cooperation of the Tanzanian Government and its director of antiquities, A. A. Mturi, I mounted an intensive campaign.

For almost two field seasons we diligently collected hominid and other fossils. Then, as is so often the case in pivotal discoveries, luck intervened. One evening Dr. Andrew Hill of the National Museums of Kenya and several colleagues were larking about on the beds, pelting each other with dry elephant dung. As Andrew ducked low to avoid one

Here they walked, and here primitive manlike creatures left footprints on an ash-blanketed plain. A freakish concurrence of weather and geology preserved the tracks for 3.6 million years at Laetoli, near Tanzania's Olduvai Gorge. Studies of the recent discovery, led by Dr. Mary D. Leakey (**right**), signal that the hominids walked erect—half a million years earlier than indicated by previous fossil evidence.

Ashes of Time

By MARY D. LEAKEY

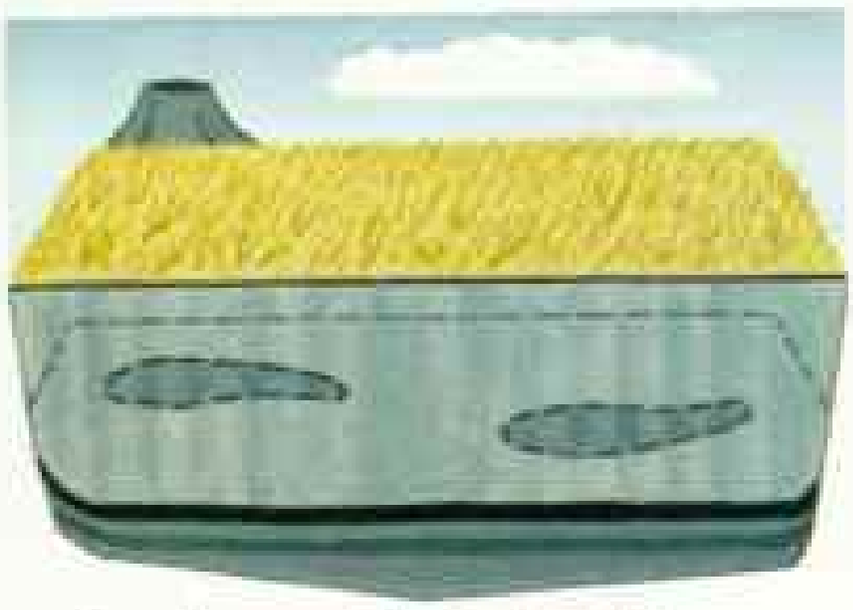
BOB CAMPBELL

Sadiman booms and ash rains, as animals browse without fear and hominids travel northward beneath the volcano's cloud. Acacias, including whistling thorns with ant-infested galls, stud the plain. The ash, dampened by the rainy season's first showers, captures the double trail of hominid tracks as well as those of elephants, guinea fowl,

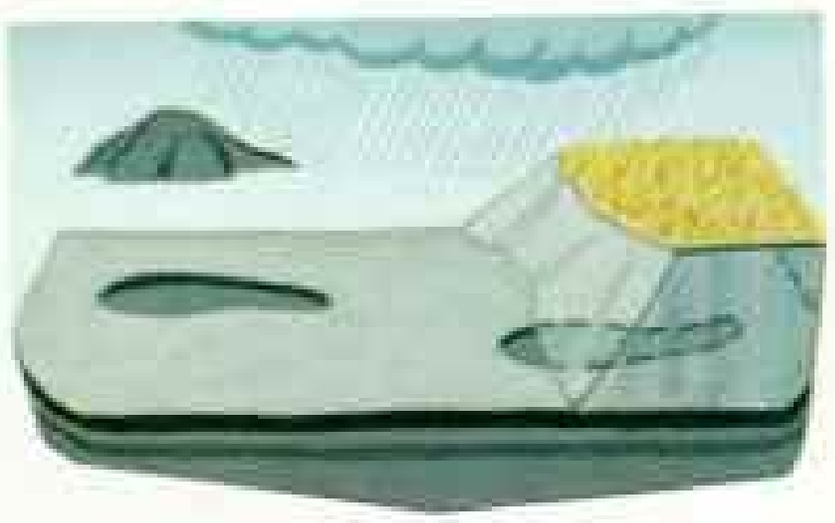
PAINTING BY JAY H. MATTERNES

giraffes, hares, and ostriches. In the tropical heat the tracks dry rapidly and are soon covered with another shower of ash. The hominid prints indicate heights of about four feet and four feet eight inches, possibly a female and a male. Although depicted here together, the individuals may have journeyed separately.

Prints in damp volcanic ash harden; later ashfall covers and preserves them.



Deposits over millennia bury the Laetolil Beds as much as 22 meters deep.



Erosion bares the ancient footprints — legacy of the now extinct volcano.

MAP AND DIAGRAMS BY ROBERT C. MAGIS
NATIONAL GEOGRAPHIC ART DIVISION

such missile, he noticed a series of punctures in the volcanic tuff. When close examination indicated that they were animal footprints, we commenced to study them in earnest.

In 1976 Peter Jones, my assistant and a specialist in stone tools, and my youngest son, Philip, noticed what they believed to be a trail of hominid footprints. After considerable analysis I agreed and announced the discovery the following year. Of the five prints, three were obscured by overlying sediment impossible to remove. The two clear examples, broad and rather curiously shaped, offered few clues to the primate that had trudged across the plain so long ago.

Nonetheless, the implications of this find were enormous. Dr. Garniss Curtis of the University of California at Berkeley undertook to date the footprint strata. These deposits possess relatively large crystals of biotite, or black mica. Biotite from ash overlying the prints, when subjected to potassium-argon testing, showed an age of about 3.6 million years; that from below tested at about 3.8 million years. The footprints had been preserved sometime within this span. Dr. Richard L. Hay, also of Berkeley, showed that the ash forming the layers fell within a month's time.

The hominid footprints attested, in my considered opinion, to the existence of a direct ancestor of man half a million years before the earliest previous evidence—fossils unearthed by Dr. Donald C. Johanson and his party in the Afar triangle of Ethiopia beginning in 1973.*

Faced with this, we largely abandoned our hunt for fossils and focused our three-month campaign of 1978 on the footprints—plotting and photographing them, making plaster and latex casts, and even removing certain specimens. While Dr. Paul Abell

*See "Ethiopia Yields First 'Family' of Early Man" by Dr. Johanson in the December 1976 GEOGRAPHIC.

Years of search end with the discovery of a single exposed print. "If cattle had passed there that morning, no one would ever have seen it," says team member Dr. Tim White of the University of California at Berkeley. Inch-by-inch excavation unearthed 77 feet of tracks; a test trench (**right**) showed that they continued, promising further discoveries. TIM WHITE

PETER JONES; TIM WHITE (BELOW)

"They looked so human, so modern, to be found in tuffs so old," says footprint expert Dr. Louise Robbins of the University of North Carolina, Greensboro. The best-preserved print (**left**) shows the raised arch, rounded heel, pronounced ball, and forward-pointing big toe necessary for walking erect. Pressures exerted along the foot attest to a striding gait. Scuff marks appear in the toe area, and a fossilized burrow seams the footprint.

Fossilized bones of 22 individuals have been found in the vicinity of Laetoli, so named after the Masai word for the area's red lily. Both bones and footprint tuffs lay sandwiched between strata dated by potassium-argon tests to about 3.6 and 3.8 million years ago. Teeth, jaws, and skull fragments from adults, as well as ribs and hand, arm, and leg bones from a 5-year-old (**below**, right), may help determine the trail makers' species. Similar in type to later specimens discovered by Dr. Donald C. Johanson in Ethiopia, the bones belong to what Dr. Leakey and others consider the earliest hominids yet found. Dr. Johanson classifies both finds as *Australopithecus afarensis*.

of the University of Rhode Island was attempting—delicately and successfully—to quarry out a block of rhinoceros tracks, he noticed a barely exposed, hominidlike heel print.

When we removed the surrounding overburden, we found a trail some 23 meters long; only the end of the excavation season in September prevented our following it still farther. Two individuals, one larger, one smaller, had passed this way 3,600,000 years ago (painting, pages 448-9).

The footsteps come from the south, progress northward in a fairly straight line, and end abruptly where seasonal streams have eroded a small, chaotic canyon through the beds. The nature of the terrain leads us to believe that the footprints, though now covered, remain largely intact to the south. And that is where we will continue our effort.

The closeness of the two sets of prints indicates that their owners were not walking abreast. Other clues suggest that the hominids may have passed at different times. For example, the imprints of the smaller individual stand out clearly. The crispness of definition and sharp outlines convince me that they were left on a damp surface that retained the form of the foot.

On the other hand, the prints of the larger are blurred, as if he had shuffled or dragged his feet. In fact, I think that the surface when he passed was loose and dusty, hence the collapsed appearance of his prints. Nonetheless, luck favored us again; the bigger hominid left one absolutely clear print, probably on a patch of once damp ash.

What do these footprints tell us? First, they demonstrate once and for all that at least 3,600,000 years ago, in Pliocene times, what I believe to be man's direct ancestor walked fully upright with a bipedal, free-striding gait. Second, that the form of his foot was exactly the same as ours.

One cannot overemphasize the role of bipedalism in hominid development. It stands as perhaps the salient point that differentiated the forebears of man from other primates. This unique ability freed the hands for myriad possibilities—carrying, toolmaking, intricate manipulation. From this single development, in fact, stems all modern technology.

Somewhat oversimplified, the formula holds that this new freedom of forelimbs posed a challenge. The brain expanded to meet it. And mankind was formed.

Even today, millions of years beyond that unchronicled Rubicon, *Homo sapiens* is the only primate to walk upright as a matter of course. And, for better or for worse, *Homo sapiens* dominates the world.

BUT WHAT of those two hominids who crossed the Laetolil Beds so long ago? We have measured their footprints and the length of their stride. Was the larger one a male, the smaller a female? Or was one mature, the other young? It is unlikely that we will ever know with certainty. For convenience, let us postulate a case of sexual dimorphism and consider the smaller one a female.

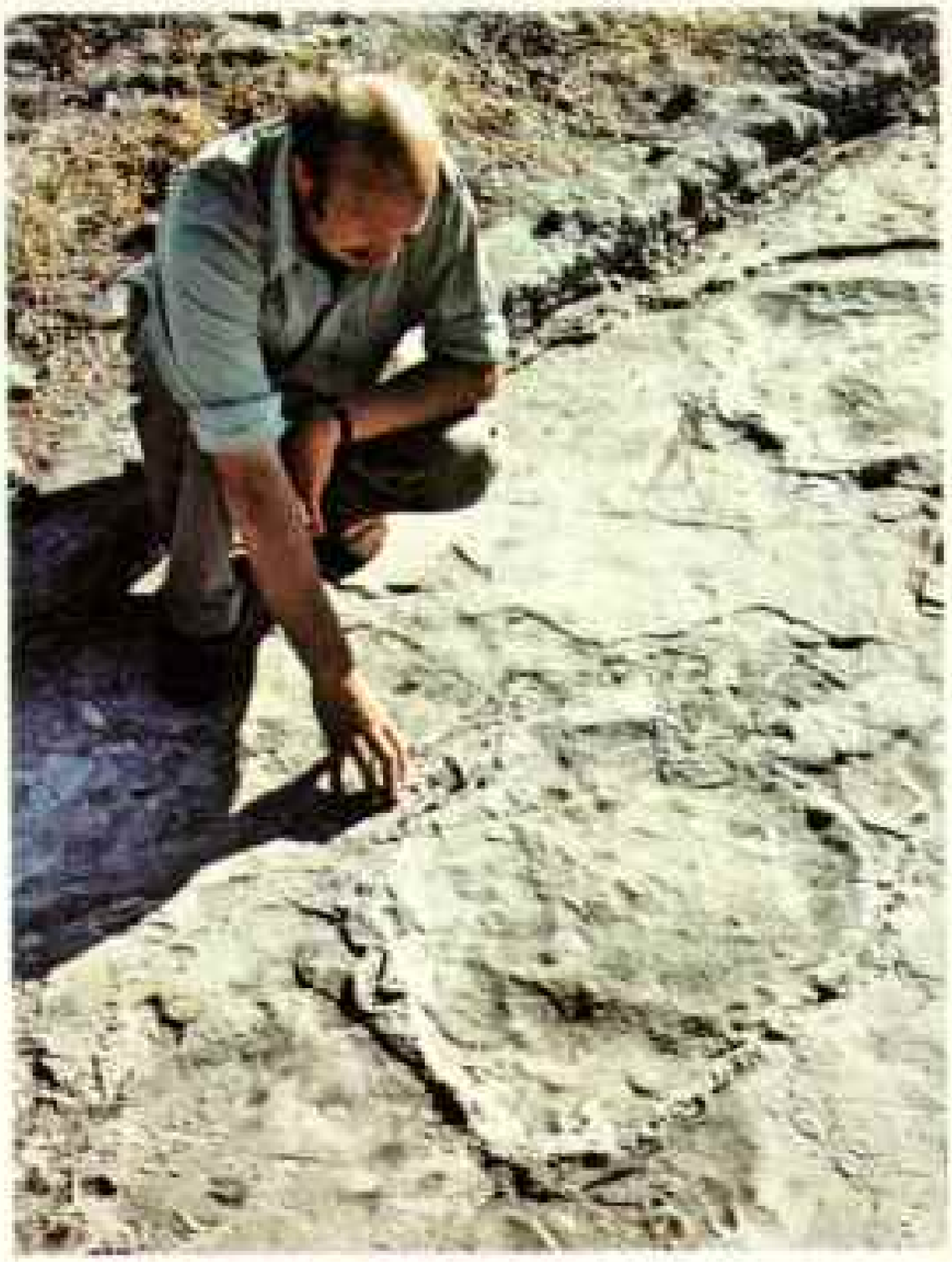
Incidentally, following her path produces, at least for me, a kind of poignant time wrench. At one point, and you need not be an expert tracker to discern this, she stops, pauses, turns to the left to glance at some possible threat or irregularity, and then continues to the north. This motion, so intensely human, transcends time. Three million six hundred thousand years ago, a remote ancestor—just as you or I—experienced a moment of doubt.

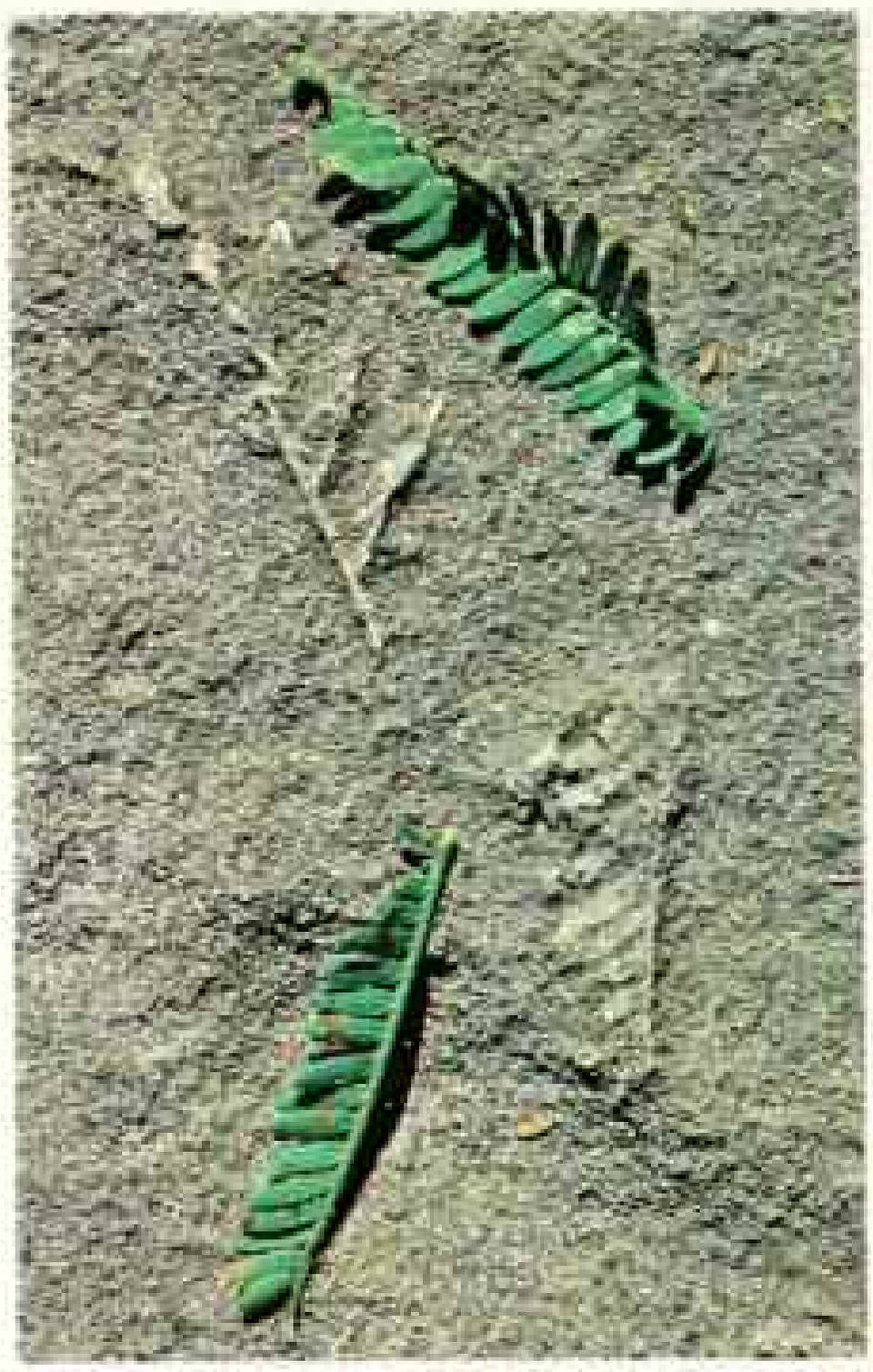
The French have a proverb: *Plus ça change, plus c'est la même chose*—"The more it changes, the more it is the same." In short, nothing really alters. Least of all, the human condition.

Measurements show the length of the smaller prints to be 18.5 centimeters (slightly more than 7 inches) and 21.5 centimeters for the larger. Stride length averages 38.7 centimeters for the smaller hominid, 47.2 centimeters for the larger. Clearly we are dealing with two small creatures.

An anthropological rule of thumb holds that the length of the foot represents about 15 percent of an individual's height. On this basis—and it is far from exact—we can estimate the height of the male as perhaps four feet eight inches (1.4 meters); the female would have stood about four feet.

Leg structure must have been very similar to our own. It seems clear to me that the Laetoli hominid, although much older, relates very closely to the remains found by Dr. Johanson in Ethiopia. Dr. Owen



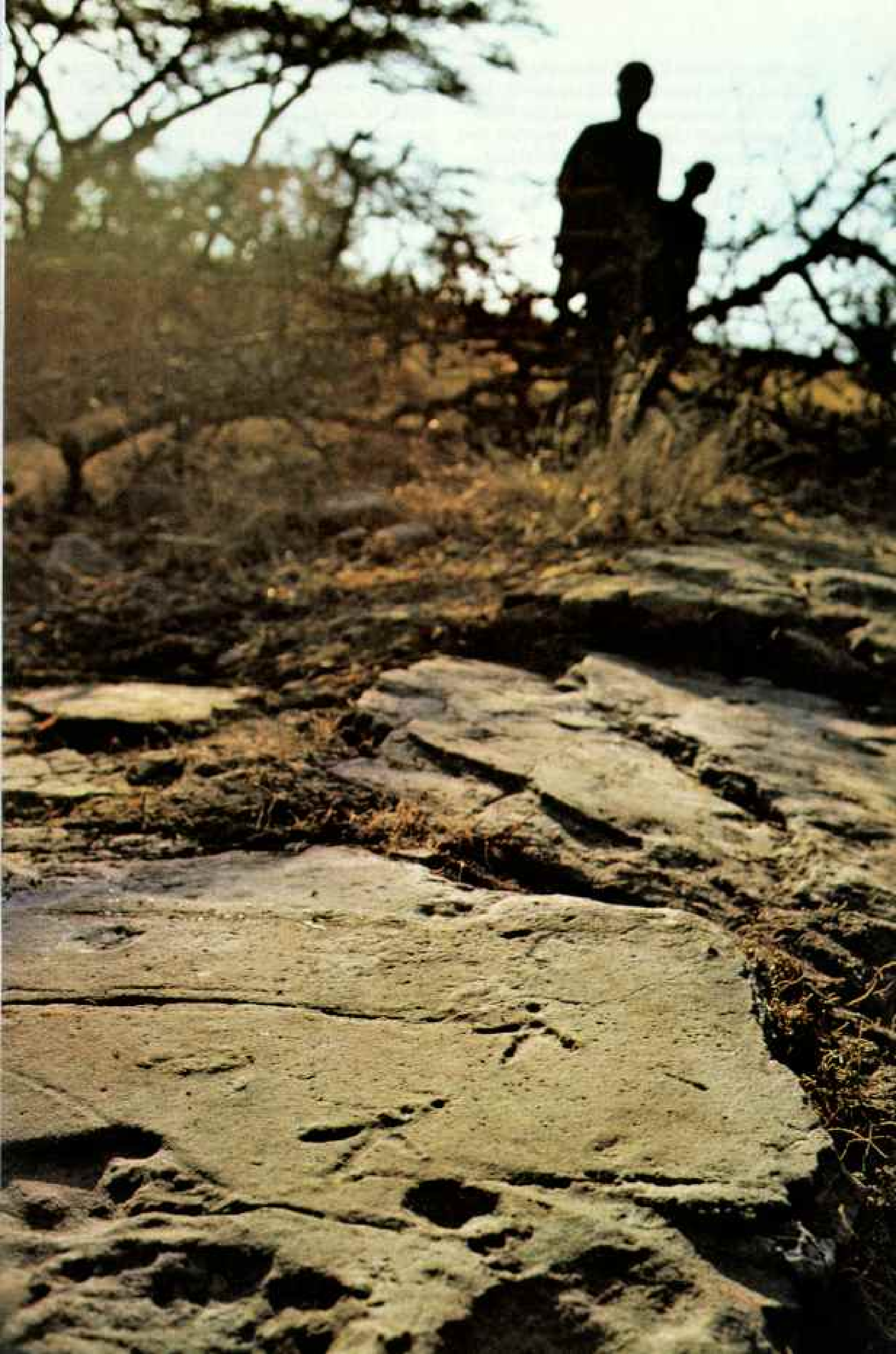


JOHN READER (ABOVE AND BELOW)

Nature's ashen ledger recorded all that touched earth for perhaps a month of intermittent light rain and ashfall. Hard rains might have washed out the prints; dry ash would have blown away. This chance register (**clockwise from top**) logged an elephant trail, here examined by Dr. Ron Clarke of the Transvaal Museum, Pretoria. Fossilized whistling-thorn leaves appear identical to today's. Guinea-fowl tracks abound, and a giraffe dragged its foot, a trait still common among its descendants. Even millipede furrows remain.

Trackers identified gazelles and other creatures almost indistinguishable from present-day inhabitants, but the saber-toothed cat and the clawed chalicothere, both now extinct, roamed with them.

TIM WHITE (TOP LEFT, ABOVE, AND FACING PAGE)



Lovejoy of Kent State University in Ohio studied a knee joint from Ethiopia—the bottom of the femur and the top of the tibia—and concluded that the Afar hominid had walked upright, with a free, bipedal gait.

Our footprints confirm this. Furthermore, Dr. Louise Robbins of the University of North Carolina, Greensboro, an anthropologist who specializes in the analysis of footprints, visited Laetoli and concluded: "The movement pattern of the individual is a bipedal walking gait, actually a stride—and quite long relative to the creature's small size. Weight-bearing pressure patterns in the prints resemble human ones. . . ."

I can only assume that the prints were left by the hominids whose fossils we also found in the beds. In addition to part of a child's skeleton, we uncovered adult remains—two lower jaws, a section of upper jaw, and a number of teeth (page 452).

WHERE can we place the Laetoli hominids and their Afar cousins in the incomplete mosaic of the rise of man? This question, quite honestly, is a subject of some contention among paleontologists. One school, including Dr. Johanson, classifies them as australopithecines.

But the two forms of *Australopithecus*, gracile and robust, represent, in my opinion, evolutionary dead ends. These man apes flourished for their season, and perished—unsuccessful twigs on the branch that produced mankind. Of course, the Laetoli hominid resembles the gracile *Australopithecus*, but I believe that, so far back in time, all the hominids shared certain characteristics. However, the simple evidence of the footprints, so very much like our own, indicates to me that the Laetoli hominid stands in the direct line of man's ancestry.

We have encountered one anomaly. Despite three years of painstaking search by Peter Jones, no stone tools have been found in the Laetolil Beds. With their hands free, one would have expected this species to have developed tools or weapons of some kind. But, except for the ejecta of erupting volcanoes, we haven't found a single stone introduced into the beds. So we can only conclude, at least for the moment, that the hominids we discovered had not yet attained the toolmaking stage.

While the hominid prints rank as the most exciting of our discoveries at Laetoli, there is also a petrified record of Pliocene animal life. Oddly—or perhaps not so oddly, given the geologic continuity of East Africa—we find the same type of wildlife in roughly the same proportions as exist today.

Before the first fall of ash, the prehistoric plain of Laetoli apparently possessed a normal array of vegetation. Beneath the bottom layer we find fossilized twigs, small branches, and grass. Thereafter, with the terrain buried in barren gray dust, animals continued to drift across in their habitual patterns. Why did they do so, with so little sustenance present? With the data available at this point, we just cannot explain it.

But the footprints are visible in their plenitude. Countless hares have pocked the ash with their distinctive hopping pattern. Baboon prints lie in profusion; all we have found possess a narrow heel similar to those of smaller present-day females. Baboons, incidentally, still arrogantly patrol the beds. *Deinotherium*, a prehistoric relative of today's elephant, lumbered through, its huge footprints obliterating the strata beneath.

We encountered a variety of antelope prints, large and small. In studying these, we enlisted the aid of two African trackers, members of the Hadza and Wasukuma tribes. Because the extinct species possess hooves of roughly the same shape as their living relatives, the trackers provided valuable identifications.

In addition to footprints we also have found skeletal traces of both white and black rhinos, two types of giraffe—one as tall as today's species, the other a pygmy—and two genera of pigs. Various carnivores prowled across the ash, including one very large saber-toothed cat; hyenas were numerous.

A unique discovery, though, is a pair of prints left by a chalicothere. This strange creature had claws on its feet; yet it was an ungulate rather than a carnivore and ate only vegetation. To my knowledge, our prints are the only ones ever discovered.

BUT IN THE END one cannot escape the supreme importance of the presence of hominids at Laetoli. Sometimes, during the excavating season, I go out and watch the dusk settle over the gray tuff with its

Marching toward an uncertain future, the Laetoli prints, here filled with black sand (**right**), confirm what clues like a knee-joint cast (**below**) from Ethiopia had already suggested—that, very early on, hominids strode upright, an adaptation that literally stands them apart in the planet's gallery of evolution.

TIM WHITE, JOHN READER (RIGHT)

eerie record of time long past. The slanting light of evening throws the hominid prints into sharp relief, so sharp that they could have been left this morning.

I cannot help but think about the distant creatures who made them. Where did they come from? Where were they going? We simply do not know. It has been suggested that they were merely crossing this scorched plain toward the greener ridges to the north. Perhaps so.

In any case, those footprints out of the deep past, left by the oldest known hominids, haunt the imagination. Across the gulf of time I can only wish them well on that prehistoric trek. It was, I believe, part of a greater and more perilous journey, one that—through millions of years of evolutionary trial and error, fortune and misfortune—culminated in the emergence of modern man. □

THE PROMISE AND PERIL OF NUCLEAR ENERGY

JEFF MCCABE (ABOVE)

Radiation's eerie glow suffuses the water-covered core (**above**) of a reactor in Oregon. Like honey in a comb, spent fuel in rectangular bundles of rods fills a storage pool (**left**) at a South Carolina reactor. A technician lowers a bundle into a cask for shipment to a less crowded facility. Permanent waste storage is a major stumbling block in nuclear energy's bid to become the powerhouse of the future.

"NUCLEAR ENERGY is dying"—Amory Lovins, Friends of the Earth. "The vigorous development of nuclear power is not a matter of choice, but of necessity"—Hans A. Bethe, Cornell University.

The utter divergence of these points of view has marked the controversy in recent years about energy from fissioning atoms. The man in the street may be forgiven if he is not sure who is right.

The debate has been frequently emotional, sometimes bitter, often confusing. Frightening stories about radiation hazards of nuclear materials vie with worrisome forecasts of energy famine, economic troubles, and even environmental disaster if nuclear energy is abandoned.

Not many years ago prospects for the nuclear industry were booming. Nuclear electricity was heralded as the cleanest, cheapest, and most convenient form of power. It seemed certain to fill much of the vacuum caused by the predicted shortages of oil and gas.

Orders for nuclear plants flooded into General Electric, Westinghouse, and other suppliers. In just three years, 1971 through 1973, the utilities ordered an even hundred reactors. Optimistic predictions foresaw as many as 1,500 reactors in the United States by the end of the century.

Then came the oil embargo of 1973-74, followed by strong national pressures to use less electricity and to conserve fuel. At the same time, the price of electricity was rising sharply. The ever growing demand for electricity slowed. Utilities found themselves over-extended.

By KENNETH F. WEAVER
SENIOR ASSISTANT EDITOR

Photographs by EMORY KRISTOF
NATIONAL GEOGRAPHIC PHOTOGRAPHER

Abruptly, new reactor orders dropped—only 13 in the four years 1975 through 1978. Dozens of previous orders were canceled or postponed.

Meanwhile, Government policy shifted from enthusiastic promotion to mixed support. Public attitudes, once generally pronuclear, wavered. Opponents mounted demonstrations at reactor sites like Seabrook in New Hampshire and Diablo Canyon in California. They raised safety questions at public hearings and filed court suits to prevent licensing of further reactors.

Against this background stands one significant fact: Nuclear energy is already providing roughly one-eighth of all the electric power generated in this country. More than 70 nuclear power plants in 27 states have received operating licenses. More than 90 others are under construction.

In 1978 nuclear energy produced nearly 300 billion kilowatt-hours, rivaling gas-fired and hydroelectric stations. Eighty percent of electricity produced in Vermont comes from nuclear power; in Maine, 65 percent; and in Connecticut and Nebraska, 50 percent or more. All this has come about in just over two decades since the United States' pioneer nuclear plant at Shippingport, Pennsylvania, went into service.

What, then, is the future of nuclear energy? Is it at a dead end? Or will it recover from its current troubles and fulfill at least some of the bright promise of a few years ago?

Answers are murky, shrouded in uncertainties. But here are some of the arguments, and essential facts needed to understand them, based on the views of many experts and on tours of nuclear installations in the United States and Europe.*

The basis for nuclear power is that certain heavy elements in the earth's crust, such as uranium, have varieties (called isotopes) that can be made to split, or fission. When the nucleus of such an atom splits, it results in fragments that together weigh slightly

*Science editor Kenneth F. Weaver initiated the GEOGRAPHIC's coverage of energy in the November 1972 issue with "The Search for Tomorrow's Power." Last November Bryan Hodgson analyzed the natural-gas potential. Consult the *National Geographic Index* for recent articles on oil, coal, wind power, solar power, and geothermal energy.

Symbols of plentiful power, giant bulbous chambers will house reactors at San Onofre, California. Such nuclear plants now generate about 12 percent of all the electric power in the U. S. When a 1977 drought reduced the flow of hydroelectric power in the Pacific Northwest, Oregon's Trojan nuclear plant kept the state's lights burning.

less than the original. The loss in mass turns into energy.

The fissioning atom also gives off neutrons, heavy subatomic particles. Under the right conditions these strike other fissionable atoms and cause them to split, thus creating a chain reaction.

A reactor is a remarkable device to stimulate this splitting of nuclei on a grand, but controlled, scale. Resulting energy, as heat, can be harnessed to make steam that drives turbine generators to produce electricity. The scientific principle is simple; putting it into use safely calls for complex, highly sophisticated engineering.

If you could look into the heart of a typical pressurized water reactor—the commonest kind in use—you would see the nuclear core, scores of thick bundles about 12 feet long, made up of slender, shiny tubes. Each tube, or fuel rod, is filled with some 200 pellets of enriched uranium (pages 468-9).

The pellets are small—about twice as thick as a pencil and slightly more than half an inch long. But they are mighty: The energy content of each pellet is about the same as a ton of coal or four barrels of crude oil. The cost? Five to ten dollars.

A large reactor operating today holds tens of thousands of fuel rods in which are sealed some eight million uranium pellets weighing about a hundred tons. The capacity of such a reactor is roughly 1,000 megawatts (one million kilowatts) of electricity, enough for a city of 600,000 people. But the life of the core is limited. A third of the fuel must be replaced annually during the expected 30-to-40-year life of the reactor.

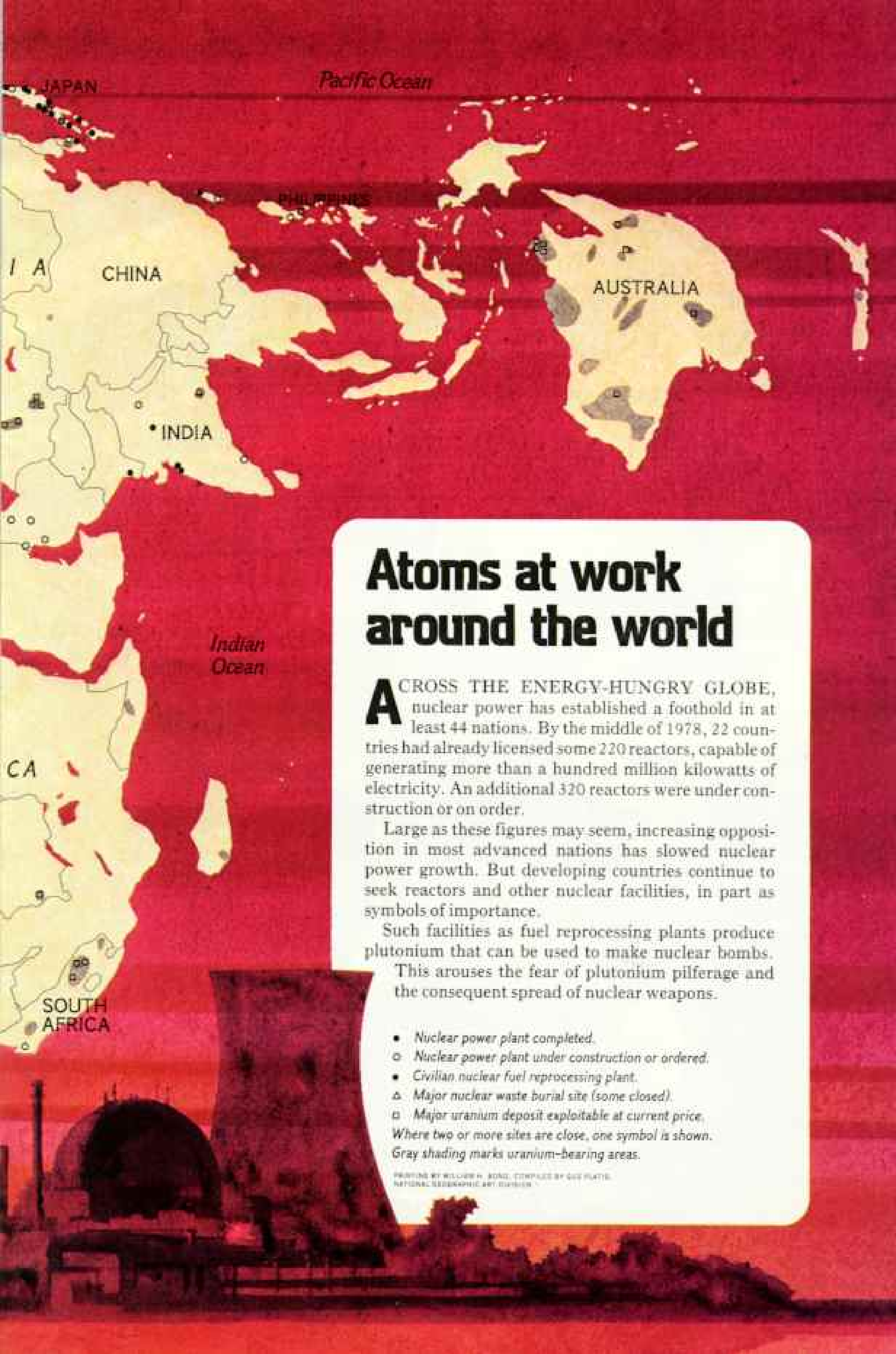
Once reactor operations begin, the core is surrounded and infiltrated with water—thousands of tons—which circulates under high pressure to carry away the intense heat and keep the reactor temperature within limits. The water also moderates, or slows, the flow of neutrons and thus helps control the chain reaction. Core and water are contained in a heavy steel pressure vessel. It, in turn, is shielded by a steel-and-concrete containment structure to prevent radioactivity from escaping into the outside world.

Suppose radioactivity does leak. Why is that a matter *(Continued on page 466)*

Troubled Seabrook: Blue-collar workers march in support of the Seabrook reactor in New Hampshire. Protesting against it and other plants, concerned groups have opened persistent debate regarding safety, radiation, and long-term storage of wastes. California and Maine have banned future plants until the storage question is resolved.

MARTIN ADLER LEVICK, BLACK STAR


The United States has three civilian nuclear fuel reprocessing plants, none now in use. Five European countries (aside from the U.S.S.R.) have built eight plants, and Japan and India one each.
Pacific Ocean
CANADA
GREENLAND (DENMARK)
U.S.S.R.
U.S.
WEST GERMANY
BELGIUM
UNITED KINGDOM
EUROPE
Atlantic Ocean
FRANCE
ITALY
SPAIN
Ocean dumping of low-level waste, once a policy of the U.S., is still practiced by the United Kingdom.
Most of the free world's easily recoverable uranium is in the U.S., Australia, Canada, South Africa, and Niger.
NIGER
AFR
SOUTH AMERICA
BRAZIL
ARGENTINA



Atoms at work around the world

ACROSS THE ENERGY-HUNGRY GLOBE, nuclear power has established a foothold in at least 44 nations. By the middle of 1978, 22 countries had already licensed some 220 reactors, capable of generating more than a hundred million kilowatts of electricity. An additional 320 reactors were under construction or on order.

Large as these figures may seem, increasing opposition in most advanced nations has slowed nuclear power growth. But developing countries continue to seek reactors and other nuclear facilities, in part as symbols of importance.

Such facilities as fuel reprocessing plants produce plutonium that can be used to make nuclear bombs. This arouses the fear of plutonium pilferage and the consequent spread of nuclear weapons.

- *Nuclear power plant completed.*
- *Nuclear power plant under construction or ordered.*
- *Civilian nuclear fuel reprocessing plant.*
- *Major nuclear waste burial site (some closed).*
- *Major uranium deposit exploitable at current price.*

Where two or more sites are close, one symbol is shown.

Gray shading marks uranium-bearing areas.

PRINTING BY WILLIAM H. BONG. COMPILED BY GUS PLATIS.
NATIONAL GEOGRAPHIC ART DIVISION

The making of nuclear fuel begins with a concentrate of milled uranium ore called yellowcake (**below**), here shown at the Kerr-McGee mill near Grants, New Mexico. The fuel is later enriched to increase its content of uranium 235, the isotope of uranium that feeds a reactor.

Converted to uranium dioxide, the fuel is compressed into thimble-size pellets (**bottom**), hardened by heating in a furnace like this one at Westinghouse's nuclear fuel plant near Columbia, South Carolina. Finished pellets on a tray (**left**) are only mildly radioactive and can be handled without special protection.

The pellets are later stacked end on end in long metal rods. A bundle of rods makes up a fuel assembly (**right**). Scores of assemblies constitute the core of a reactor.

(Continued from page 461)

of concern? Some kinds of radiation, such as ordinary light, are relatively harmless.

But ionizing radiation, the kind produced by radioactive materials or X-ray machines, is dangerous because—though invisible and unfelt—it can cause serious changes in the cells of the human body. Its intense energy can destroy or distort molecules in cells. It breaks DNA strands in the genes.

The long-range effects may be cancer if the damaged cells go out of control and duplicate themselves wildly. Or there may be birth defects and genetic mutations in future generations if reproductive cells repair themselves incorrectly and produce abnormal arrangements of the DNA strands that govern heredity.

Two kinds of ionizing radiation are actually electrically charged particles: alpha particles, or nuclei of helium atoms, and beta particles, or electrons. Alpha particles travel in air only inches before they are stopped. They cannot penetrate the skin and are not a health hazard as long as they remain outside the body. However, if an alpha emitter, such as plutonium dust, is inhaled, the heavy alpha particles can deposit all their high-energy content directly in very sensitive lung tissues and wreak damage that may eventually result in cancer.

Beta particles travel a few feet in air, and they can penetrate slightly into the body. They especially affect the bones and the thyroid if beta emitters are ingested. The particles can usually be blocked by thin sheets of metal or wood.

Gamma rays, a third type, are shortwave, high-energy electromagnetic radiation, akin to X rays. They penetrate easily into the body. Reactors have a biological shield of thick concrete to reduce their intensity.

Natural Radiation Unavoidable

Clearly, ionizing radiation is something to avoid if possible. And yet, although you may not be aware of it, you are bathed in low-level natural radiation all the time.

Cosmic rays from space, for example, subject you to about 40 millirems a year at sea level, even more at higher altitudes. (A millirem is a thousandth of a rem, the standard unit of radiation exposure.)

Also, uranium, radium, and thorium in stone, concrete, and soil, as well as radioactive carbon and potassium in your body and in water and food, combine to provide a radiation background that you cannot escape. From these natural sources the average person receives a whole-body dose of about a hundred millirems a year.

Besides absorbing natural radiation, many people are exposed to man-made ionizing emissions. Medical diagnostic X rays, for example, give the average person 70 millirems a year. TV sets and radium-dial wristwatches add perhaps a millirem over the course of a year.

From these natural and man-made sources, the average person gets close to 200 millirems of radiation annually.

A nuclear reactor, properly operated, adds little to this burden: no more than a few millirems a year for the exposed public. Actually, coal plants emit about the same amount of radioactivity because of radium and uranium in the coal.

How much radiation does it take to hurt you? Radiobiologists regard a single dose to

the whole body of 600 rems (600,000 millirems) as lethal to most people; 100 whole-body rems cause radiation sickness; 10 can damage the lymph nodes and spleen and decrease the bone marrow and blood cells, although you do not feel symptoms.

A few millirems or even a few rems seem small by comparison, especially when spread over a period of time. And some scientists believe there is a threshold below which radiation has no permanent effect. But many others insist no radiation level is harmless. Dr. Karl Z. Morgan of the Georgia Institute of Technology, former director of the Health Physics Division of the Oak Ridge National Laboratory, sums up this view:

"An overwhelming amount of data shows there is no safe level of exposure, and there is no dose of radiation so low that the risk of malignancy is zero. So the question is not: Is there a risk for low-level exposure? Or, what is a safe level of exposure? The question is: How great is this risk? Or, how great may a particular radiation risk be before it exceeds the expected benefits, such as those from medical radiography or nuclear power?"

When one visits a nuclear plant, he gets a mixed feeling of the awesome power and the extraordinary precautions to control that power. With Mike Malmros, an inspector for the United States Nuclear Regulatory Commission (NRC), I went to see the Rancho Seco plant in California's Sacramento Valley, near Lodi. A pressurized water reactor, operating since 1975, Rancho Seco is rated at 913 megawatts.

Our approach from the south brought us through barren hills into vineyard and ranch country, dominated by the Rancho Seco reactor building—a squat silo—and two colossal cooling towers 425 feet high.

"Air and farm products near the reactor are constantly monitored," Mike told me, "to make sure that any radioactivity reaching the outside world does not exceed our very low permissible levels. If the limits are exceeded, the plant is supposed to shut down until the problem has been corrected."

(In practice, critics say, fines are often

Radiation and you

IN NATURE are found some 60 varieties, or isotopes, of chemical elements that are radioactive. That is, they continuously transform, or decay, into new elements, giving off high-energy radiation in the process. Some two hundred other radioisotopes are created artificially in nuclear machines, such as reactors.

When emissions from radioactive substances enter the human body, they injure cells by ionizing (tearing electrons from) atoms. If the damage is slight, or takes place slowly, the body usually makes repairs. But if damage is great, adequate repairs are impossible and the biological consequences can be severe: illness, reduced life expectancy, eventual cancer. Or genetic defects may appear in future generations.

The time it takes a radioactive element to decay is measured by its half-life. After one such period, half the original radioactivity remains; after two half-lives, a fourth; after 20 half-lives, only a millionth.

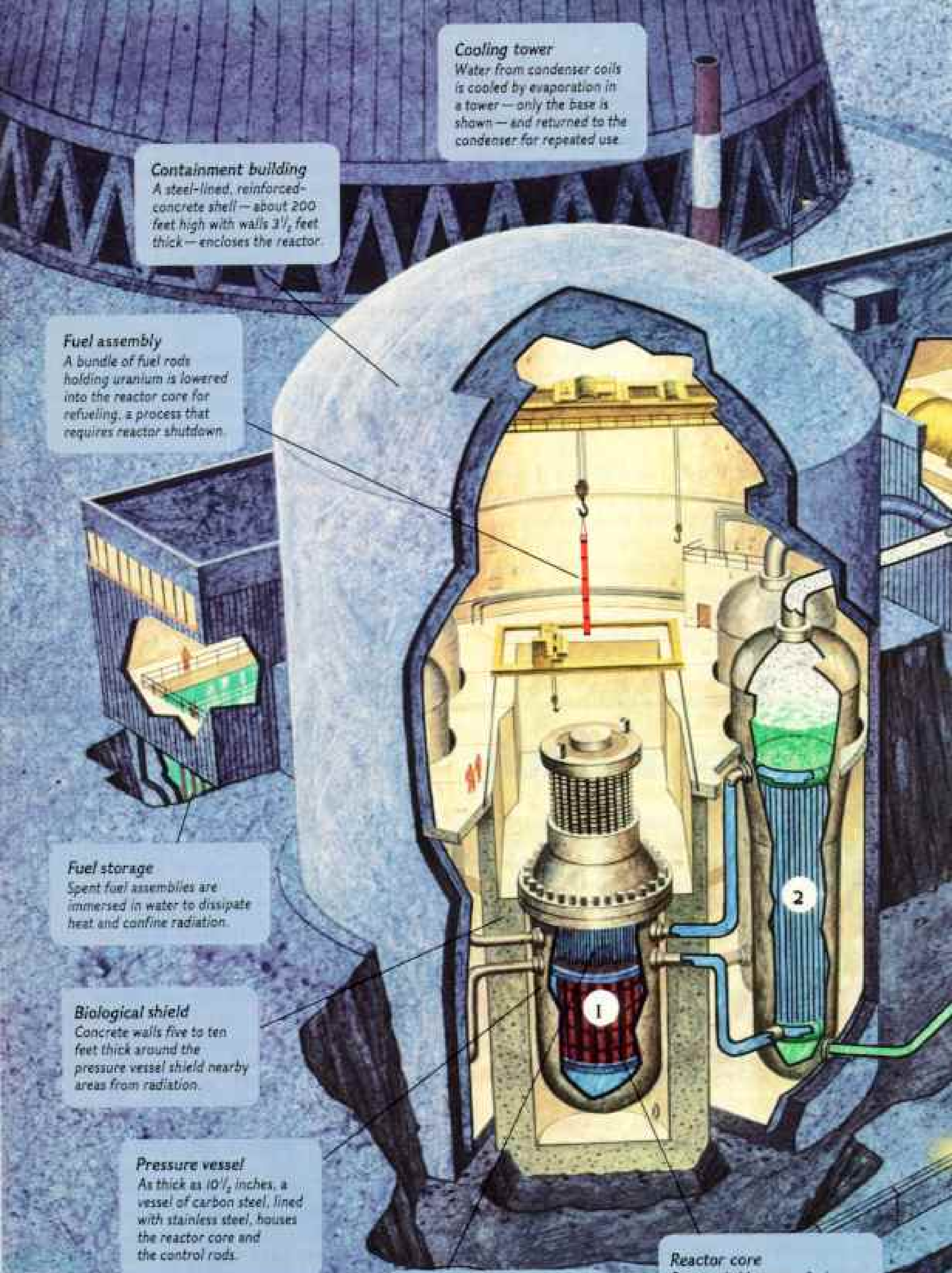
Some radioactive elements decay swiftly. Iodine 133 has a half-life of only 21 hours. But for iodine 131 the half-life is 8.1 days, and for iodine 129 it is 17,000,000 years.

Certain parts of the body, such as the gonads, thyroid, and bone marrow, are especially sensitive to radiation. Moreover, some radioisotopes have particular affinities. Strontium 90, for example, is a bone seeker. Iodine becomes concentrated in the thyroid instead of being eliminated.

Iodine 131, cesium 137, and strontium 90—all produced in nuclear reactors—are especially hazardous to man if they get into the food chain, because of biological concentration.

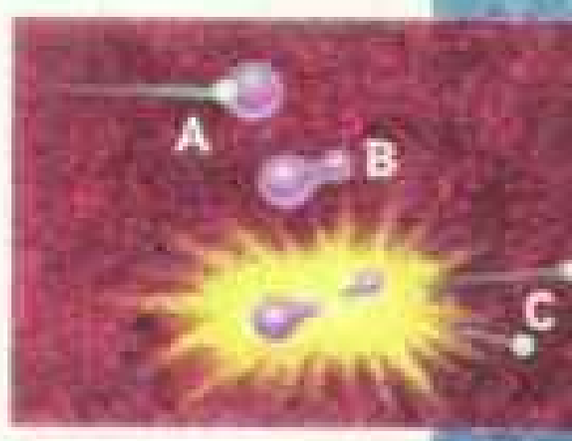
Most scientists believe it is prudent to assume there is no safe level of ionizing radiation, even though we constantly get some radiation from such natural sources as cosmic rays and granite in buildings.

RADIATION CHECK: A TECHNICIAN AT JAPAN'S FUKUSHIMA REACTOR USES A MACHINE AKIN TO A GEIGER COUNTER TO MEASURE ANY CONTAMINATION.


Cooling tower
Water from condenser coils is cooled by evaporation in a tower — only the base is shown — and returned to the condenser for repeated use
Containment building
A steel-lined, reinforced-concrete shell — about 200 feet high with walls 3½ feet thick — encloses the reactor
Fuel assembly
A bundle of fuel rods holding uranium is lowered into the reactor core for refueling, a process that requires reactor shutdown
Fuel storage
Spent fuel assemblies are immersed in water to dissipate heat and confine radiation
Biological shield
Concrete walls five to ten feet thick around the pressure vessel shield nearby areas from radiation
Pressure vessel
As thick as 10½ inches, a vessel of carbon steel, lined with stainless steel, houses the reactor core and the control rods
Control rods
Neutron-absorbing rods can be raised or lowered to regulate the rate of fission
Reactor core
Surrounded by water, fuel assemblies containing about a hundred tons of uranium dioxide comprise the core. Energy from fission heats the water.
1
2

Anatomy of a nuclear power plant

ONE OF MAN'S most sophisticated structures, a nuclear power plant for generating electricity operates on the same simple principles as plants powered by fossil fuels: Heated water produces steam; steam drives a turbine that spins a generator; a generator produces electricity.



The heat source for a nuclear plant is the energy released from the fission, or splitting, of the nuclei of fissionable materials, principally uranium 235.

A neutron collides with a U-235 nucleus (**A**), splitting the nucleus in two (**B**). Part of the energy that bound the nucleus is released as heat, and other neutrons are ejected (**C**). Bombarding other U-235 nuclei, the neutrons precipitate a self-sustaining chain reaction.

Energy from the chain reaction of fissioning uranium in the reactor core (**1, left**) heats the surrounding water, which is pumped under pressure into the tubes of a steam generator (**2**) to heat the water already in the generator. This type of reactor, the most common in the U. S. today, is known as a pressurized water reactor.

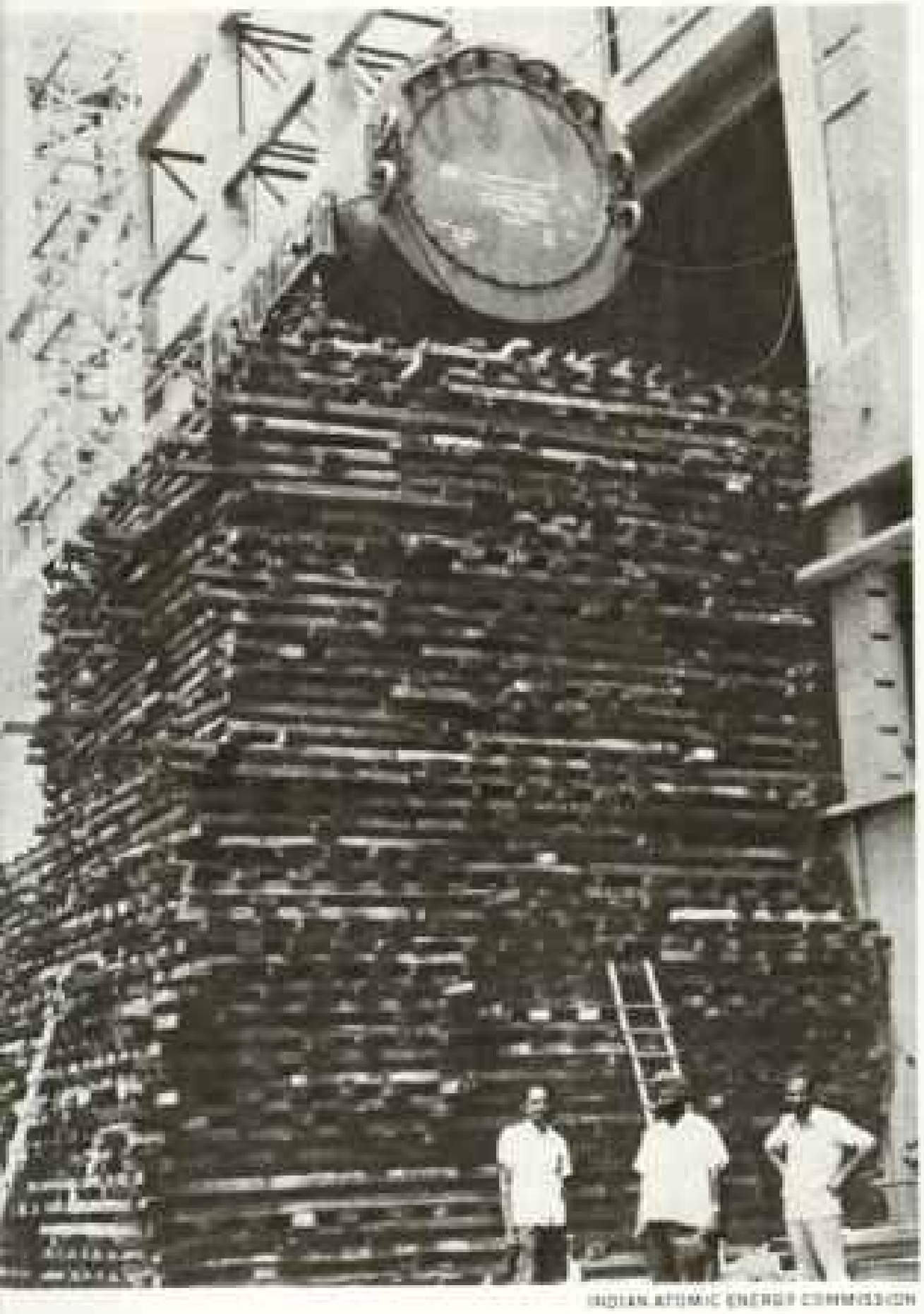
Heat from the tubes converts water in the generator to steam, whose energy turns the rotors of a high-pressure turbine (**3**). Lower-energy steam proceeds to low-pressure turbines (**4, 5**). An electric generator (**6**) converts the energy from the whirling turbine shaft into power for transmission to consumers through high-voltage lines (**7**).

Depleted steam from the turbines passes over the cooling coils of a condenser (**8**) and is converted to water, which returns to the steam generator to be heated again.

PAINTING BY PIERRE MION

Supplemental cooling
Small amounts of river water are piped to the condenser coils to replenish water lost by evaporation in the cooling tower.

Instead of a crane, Indian construction workers use wood planks to lift a multi-ton component into place at a nuclear plant near Madras. Starting from ground level, they raise the part with jacks—foot by laborious foot—then slide the planks under it to create a scaffold. Now at the right height, the cylinder is ready to be rolled into position.



INDIAN ATOMIC ENERGY COMMISSION

too small for effective enforcement of safety standards and regulations in some plants.)

A heavy barbed-wire fence surrounds the power station at Rancho Seco. Motion sensors to detect intruders are so sensitive that sometimes jackrabbits set them off.

At the gate, guards put us through detectors to assure we were not bringing in weapons or explosives. Inside we picked up dosimeters and film badges to record any radiation we might receive. We put on special clothing for protection against radioactive particles: coveralls, plastic bootees, cotton gloves under rubber gloves, and hoods that left nothing exposed except our faces.

To reach the containment chamber, we had to go through an airlock tunnel. Signs warned "Radiation Containment Area."

Inside the airlock our ears popped as the massive door locked into position; air pressure was being lowered to that inside the chamber. Because of this lower pressure, if there are leaks, air will always move from outside to inside.

Questions and answers

How do fission and fusion differ?

Fission involves the splitting of the nucleus of certain heavy atoms such as uranium. Fusion involves joining the nuclei of two very light atoms such as deuterium and tritium, forms of hydrogen. In both cases the nuclear reaction produces significant amounts of energy.

How do reactors differ?

Light water reactors include:

(1) Pressurized water reactors. The most common type, these use ordinary water under pressure to cool the reactor cores. Heat is transferred to a secondary water cycle to produce steam for the power-generating turbines.

(2) Boiling water reactors. These also use ordinary cooling water, but allow it to boil directly into steam for the turbines.

Reactors may use gases or heavy water (which contains heavy hydrogen, or deuterium) for cooling. Breeder reactors generally cool with liquid sodium.

Most U. S. reactors use uranium 235 for fuel. Uranium 233 and plutonium 239 are also fissionable and can fuel reactors.

Can a nuclear plant explode like a bomb?

No. The uranium 235 generally used in thermal reactors is not sufficiently enriched to create a nuclear explosion. A nuclear plant could, of course, suffer a steam explosion under certain circumstances.

Are we likely to run out of uranium?

At current prices of about forty dollars a pound for yellowcake (uranium oxide), United States mines can probably produce enough uranium 235 for all the reactors likely to be built in this country for the rest of the century. The breeder reactor, which converts uranium 238 to fissionable plutonium, theoretically could multiply the reactor fuel supply 60-fold.

What is reprocessing?

When spent fuel is taken from a reactor, it contains valuable materials such as unused uranium, as well as plutonium 239 that has been created by the intense bombardment of neutrons during the fission process. Mixed with these useful materials are highly radioactive and very dangerous fission products such as cesium 137 and strontium 90.

Reprocessing plants separate these materials by chemical techniques, concentrating the dangerous materials for storage and making the valuable materials available for use. This is how, for example, the defense establishment gets plutonium for nuclear weapons.

Reprocessing is essential if breeders are to come into use. Only by reprocessing can unused uranium be separated from spent fuel so that it can be irradiated in the breeder to produce additional fuel. Similarly, only by reprocessing can this newly created plutonium be claimed for use in reactors.

If a Third World country builds a nuclear plant, can it also make nuclear weapons?

All reactors produce plutonium as a by-product. With a reprocessing plant, this plutonium can be separated and purified for fuel; it is also highly suitable material for weapons. That is why many people believe the spread of nuclear technology will be followed by the spread of reprocessing, the proliferation of nuclear weapons, and the increased threat of nuclear war.

Indeed, proliferation is regarded by many thoughtful critics as the most serious hazard of nuclear energy. The "nuclear club"—nations possessing nuclear weapons—now numbers five. Two or three other nations are suspected of having them clandestinely. Still others covet nuclear weapons as a matter of national pride or to maintain the balance of power with a hostile neighbor.

What about the threat of terrorists hijacking shipments of nuclear materials?

Terrorists would probably want to steal plutonium for bombs. But they would not likely try to steal plutonium in spent fuel because of the intense radioactivity of fission products, such as cesium 137 and strontium 90, in the fuel rods. However, if the plutonium is separated out by reprocessing, the danger of radioactive contamination would be greatly reduced, and the plutonium would be relatively safe. This, again, is why President Carter and others oppose the reprocessing of fuel from nuclear power plants.

How much energy does the U. S. need?

Currently, United States consumption of all kinds of energy adds up to about 76 quads (quadrillion British thermal units). While population growth and industrial expansion will tend to increase demand, escalating costs for energy are tending to hold it back. Many estimates see U. S. energy use rising to 100 or 125 quads by the year 2000.

In the cavernous vault we could look directly down on the reactor vessel—a 422-ton steel bottle, 40 feet high, 14-foot inside diameter, with walls eight to ten inches thick. And deep within that cell, under nine feet of water, burns the fire of Prometheus.

But it does not burn unchecked. Cables on the reactor head connect with motors that drive control rods inside, poised above fuel assemblies. If the temperature rises unduly or other serious problems threaten, these rods are designed to drop into the core. By absorbing neutrons necessary for the nuclear chain reaction, they immediately cut it off.

Later, in the control room, we inspected batteries of lights and gauges that monitor the plant's operation. One row of green lights told us that all the control rods were inserted in the core; the reactor had shut down briefly for repairs.

As we toured the plant, Mike explained what he looks for in his inspections.

"I come *(Continued on page 475)*

Recycling uranium

CONTROVERSY over nuclear energy in the United States often centers on the fuel cycle—the series of steps from mining and processing of uranium through use as fuel to the eventual disposition of spent fuel from the reactor.

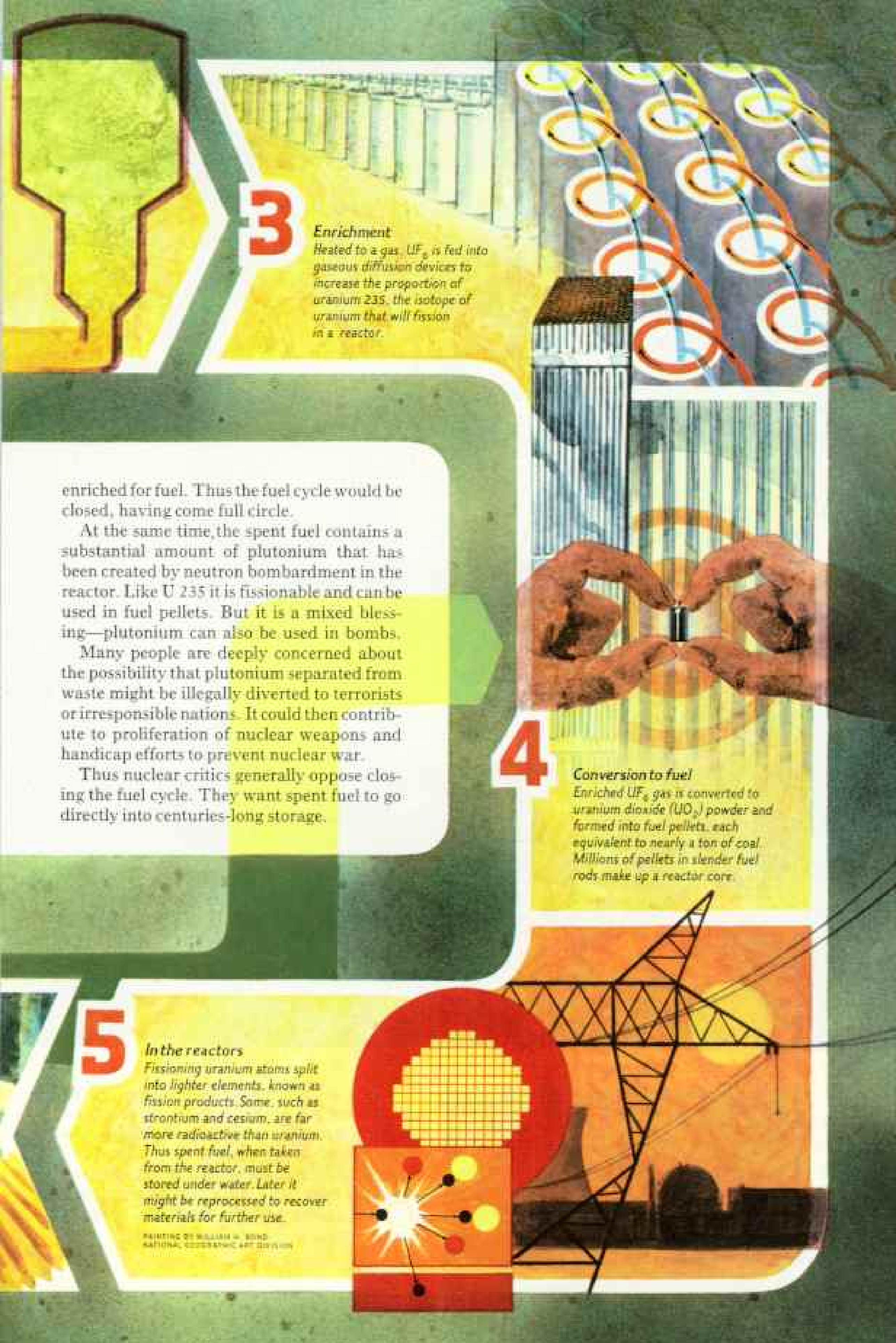
Much valuable material in spent fuel could be salvaged for further use by reprocessing. For example, nearly a third of the original uranium 235 has not been burned up. It could be added to new uranium and further

enriched for fuel. Thus the fuel cycle would be closed, having come full circle.

At the same time, the spent fuel contains a substantial amount of plutonium that has been created by neutron bombardment in the reactor. Like U 235 it is fissionable and can be used in fuel pellets. But it is a mixed blessing—plutonium can also be used in bombs.

Many people are deeply concerned about the possibility that plutonium separated from waste might be illegally diverted to terrorists or irresponsible nations. It could then contribute to proliferation of nuclear weapons and handicap efforts to prevent nuclear war.

Thus nuclear critics generally oppose closing the fuel cycle. They want spent fuel to go directly into centuries-long storage.



3 *Enrichment*
Heated to a gas, UF_6 is fed into gaseous diffusion devices to increase the proportion of uranium 235, the isotope of uranium that will fission in a reactor.

4 *Conversion to fuel*
Enriched UF_6 gas is converted to uranium dioxide (UO_2) powder and formed into fuel pellets, each equivalent to nearly a ton of coal. Millions of pellets in slender fuel rods make up a reactor core.

5 *In the reactors*
Fissioning uranium atoms split into lighter elements, known as fission products. Some, such as strontium and cesium, are far more radioactive than uranium. Thus spent fuel, when taken from the reactor, must be stored under water. Later it might be reprocessed to recover materials for further use.

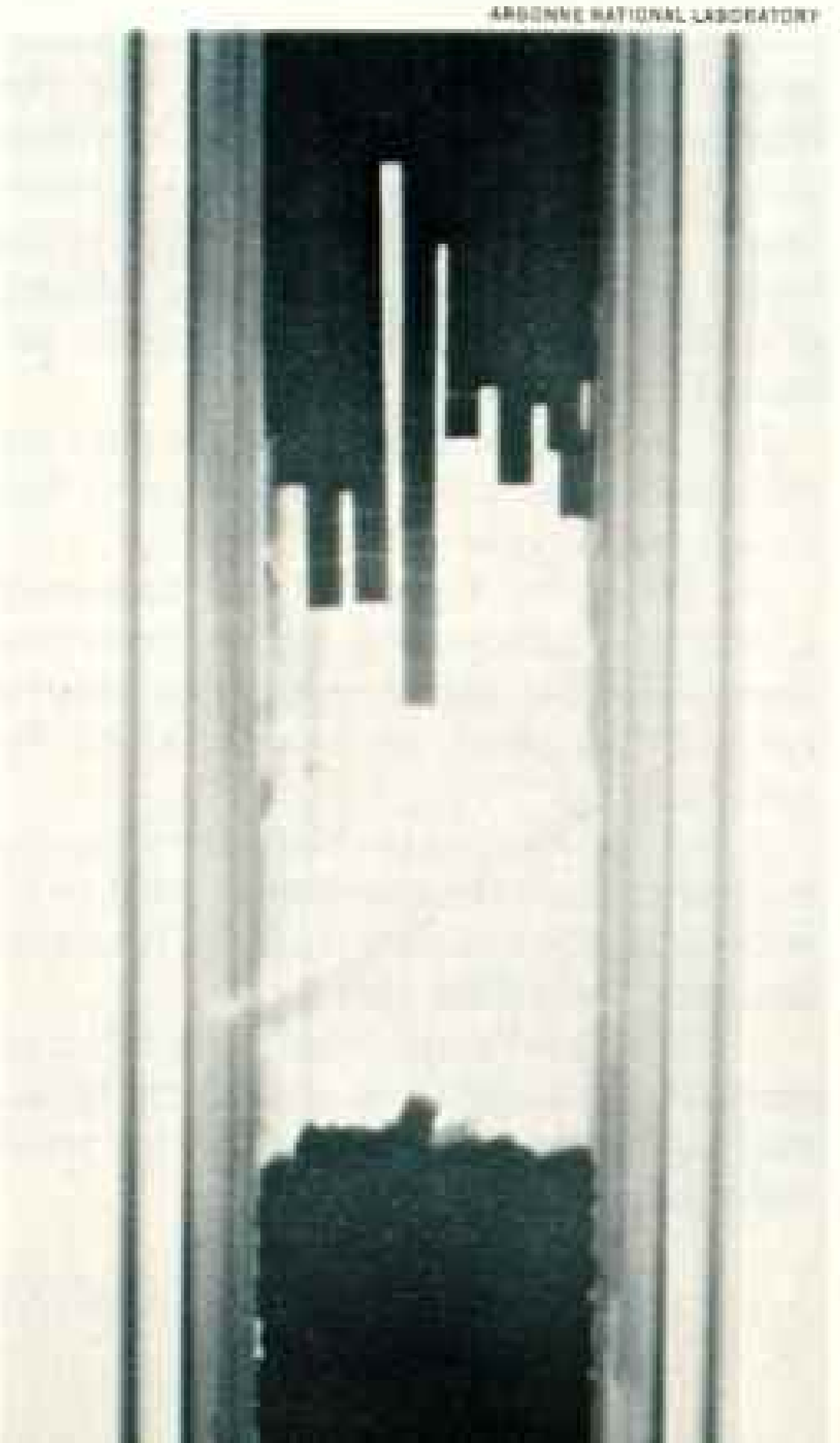
PAINTING BY WILLIAM H. BOND
NATIONAL GEOGRAPHIC ART DIVISION

Control rods plunge into a mock-up reactor core (**above**) in a project to test components for breeder reactors—so called because they promise to produce more fuel than they use. The U. S. program at the Hanford complex in Washington will utilize fuel of uranium and plutonium. Each pellet—dummies shown for size (**left**)—contains three times the energy of uranium alone.

Heavy rubber gloves provide access to an airtight enclosure where Hanford technicians inspect the uranium-plutonium pellets (**above**). Plutonium emits radioactive particles and can cause tissue damage if swallowed or especially if inhaled.

To gather data on breeder-reactor safety, scientists limited the coolant flow to a single fuel assembly in a test reactor. A neutron radiograph (**below**), similar to an X ray, shows that the assembly began to melt and fall to the bottom of the vessel.

ARGONNE NATIONAL LABORATORY



unannounced four to six times a year to see that the reactor is working properly and that our safety requirements are enforced."

He pointed his flashlight down a row of cable trays, looking for dust or debris. "They have to do a lot of housekeeping," he said. "One secret for control of radioactive contamination is to keep things very clean."

He checked pipes for leaks and vibration. He checked valve positions and the readings on radiation monitors in the exhaust stack and at various other positions in the plant.

He also examined records to determine that ultrasonic tests and other methods had been used to assure that pipe welds were holding and that no cracks were forming. This precaution took on added significance in light of recent problems with cracks at other plants.

Mike showed me bins where low-level radioactive wastes, such as contaminated gloves and plastic bootees, are stored before being compacted and shipped to burial.

The most important waste, of course, is in the spent fuel rods. As fissionable uranium 235 in the core splits, it creates a variety of fission products such as cesium 137 and strontium 90. Most are strongly radioactive and produce heat even when the reactor is shut down. Thus when the spent fuel rods in the core are replaced, they must be transferred by remote control to nearby storage pools, where they will sit quietly in underwater racks for months or years as their radioactivity decays.

Our inspection completed to Mike's satisfaction, we underwent radiation checks. We put our hands and shoes in slots in a detector; its slow clicking revealed only background radiation. Finally, we surrendered our dosimeters and film badges, which had recorded no radiation dose.

For those working daily in radiation areas, some exposure is inevitable. Five whole-body rems (5,000 millirems) over an entire year is the normal cumulative dose permitted under Nuclear Regulatory Commission rules. Anyone who reaches this limit is not supposed to work where there is radiation for the rest of the year. In fact, NRC records show, average worker exposure per year runs only 700 to 800 millirems.

For the public, the NRC annual limit on radiation from the nuclear fuel cycle is 25

millirems. In practice, the actual exposure is a tiny fraction of this permissible limit.

These "acceptable" limits are controversial even though they are seldom reached. Some critics insist they be cut further.

Industry spokesmen note that the public has suffered no known radiation death or injury from the operation of any commercial nuclear power plant in 450 reactor-years of experience. The overall safety record, they say, is good compared to other industries.

Critics Wonder, What If . . .

Some people are neither comforted nor satisfied with this record. They point to numerous safety infractions at individual nuclear plants. They note a General Accounting Office study released last fall that criticizes the Nuclear Regulatory Commission for not adequately monitoring the quality of construction in new plants.

And they express considerable concern about certain kinds of accidents. What if there were a "loss-of-coolant accident" in which a major pipe ruptured so that it could not carry cooling water to the core?

Shutting down, or scramming, the reactor does not solve the problem. Although a scram stops the nuclear chain reaction, radioactive fission products in the fuel rods continue to disintegrate and give off heat long after shutdown. Without cooling water, the core would melt within an hour or two, fall to the bottom of the reactor vessel, and burn through the steel and concrete within a day. Buildup of pressure within the containment chamber might rupture the walls and release radioactive gases into the biosphere—the outer world with its living things. Consequences of such a "worst-case accident" could be catastrophic, with heavy loss of life, multitudes of cancer cases and damaged thyroids, and contamination of surface and groundwater and of perhaps a hundred square miles of land for many years. The extent of the disaster would depend on many variables.

Nuclear plant designers have, of course, anticipated such possibilities. They have provided many layers of engineering barriers and emergency systems. Since keeping the reactor core cooled down is of paramount importance, a reactor has four to six backup cooling systems. These can be thrown into use if the main system fails.

So the real question is: How likely is it that the pipe would break, that all the backup systems would then fail, and that the core would melt through all the barriers?

A major effort to calculate such probabilities was carried out by the Reactor Safety Study, published in 1975 by the NRC. It is also known as WASH-1400 and as the Rasmussen Report, for the chairman of the study group, Professor Norman C. Rasmussen, now head of MIT's Department of Nuclear Engineering (page 478).

The study calculated that if there were a hundred reactors operating, a person living within 25 miles of one of them would have one chance out of five billion each year of dying in a reactor accident. (The figure does not include long-term fatalities from cancer.) By contrast, the report contended, there are much greater chances of dying in any year in more ordinary accidents: for example, automobile—one chance in 4,000; fire—one in 25,000; air travel—one in 100,000; lightning—one in 2,000,000.

Serious criticism has been leveled at the Rasmussen Report because of some of its assumptions and methods. Also, it does not consider the possibility of sabotage.

The most damaging criticism has come from the recent blue-ribbon Lewis panel, commissioned by NRC. It says that the numbers in WASH-1400 are not confirmable, that the margins of error and uncertainty are much too narrow, and that the report cannot be used to prove the safeness of nuclear power. NRC has formally endorsed these criticisms.

But, say nuclear supporters, the risks are still smaller than more familiar hazards that society regularly accepts.

As Dr. Jerry Cohen of the Lawrence Livermore Laboratory says, "Somehow there is a feeling that a man killed by a streetcar isn't as dead as a man killed by radiation."

A more immediate problem alarms many nuclear critics—the question of what to do with radioactive nuclear wastes. These may be divided into three groups:

. . . Low-level waste: bulky, slightly contaminated materials such as clothing, industrial trash, and sweepings, with only weak radioactivity.

. . . Transuranic waste: higher levels of radiation and more hazardous because of its content of very long-lived alpha-particle emitters such as plutonium.

. . . And high-level wastes of two kinds: (1) spent fuel, of which the typical large reactor produces about 30 to 40 tons a year, and (2) by-products of the Government weapons program. High-level wastes generate high heat and high penetrating radiation for centuries.

The question of how to handle this extremely dangerous material and isolate it in such a way that it will not harm either present or future generations was neglected for years and only recently has been given serious consideration.

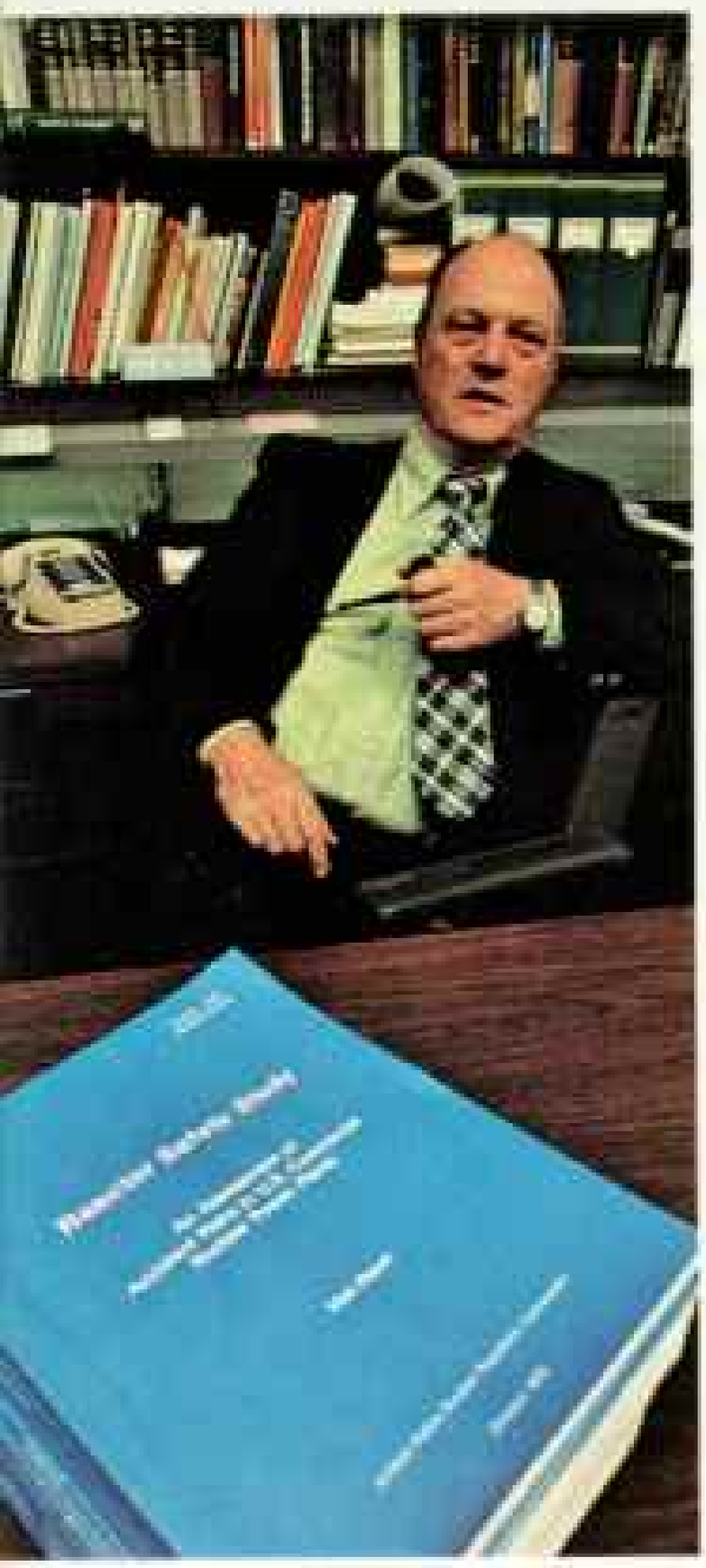
The waste problem cannot all be blamed on nuclear power. The problem began more than thirty years ago when the United States started making plutonium for nuclear bombs and putting nuclear reactors in submarines.

The defense waste is enormous: some 500,000 tons of highly radioactive material and 64 million cubic feet of less radioactive trash. It is stashed temporarily (and not too

How safe? In 1975 at the Browns Ferry plant (**above**) in Alabama a fire ravaged electrical cables (**below**), disabling the emergency core-cooling systems. Operators finally restored cooling water manually, with no release of radiation.

The blaze led to new fire-prevention standards in the industry, including the use of flame-resistant foam insulation.

TENNESSEE VALLEY AUTHORITY



Key voices pro and con

REASONABLE people disagree widely about the merits and dangers of nuclear energy.

Dr. Hans A. Bethe (**left**), Nobel laureate and professor emeritus of physics at Cornell University, speaks and writes frequently in favor of nuclear power as a necessary replacement for dwindling oil.

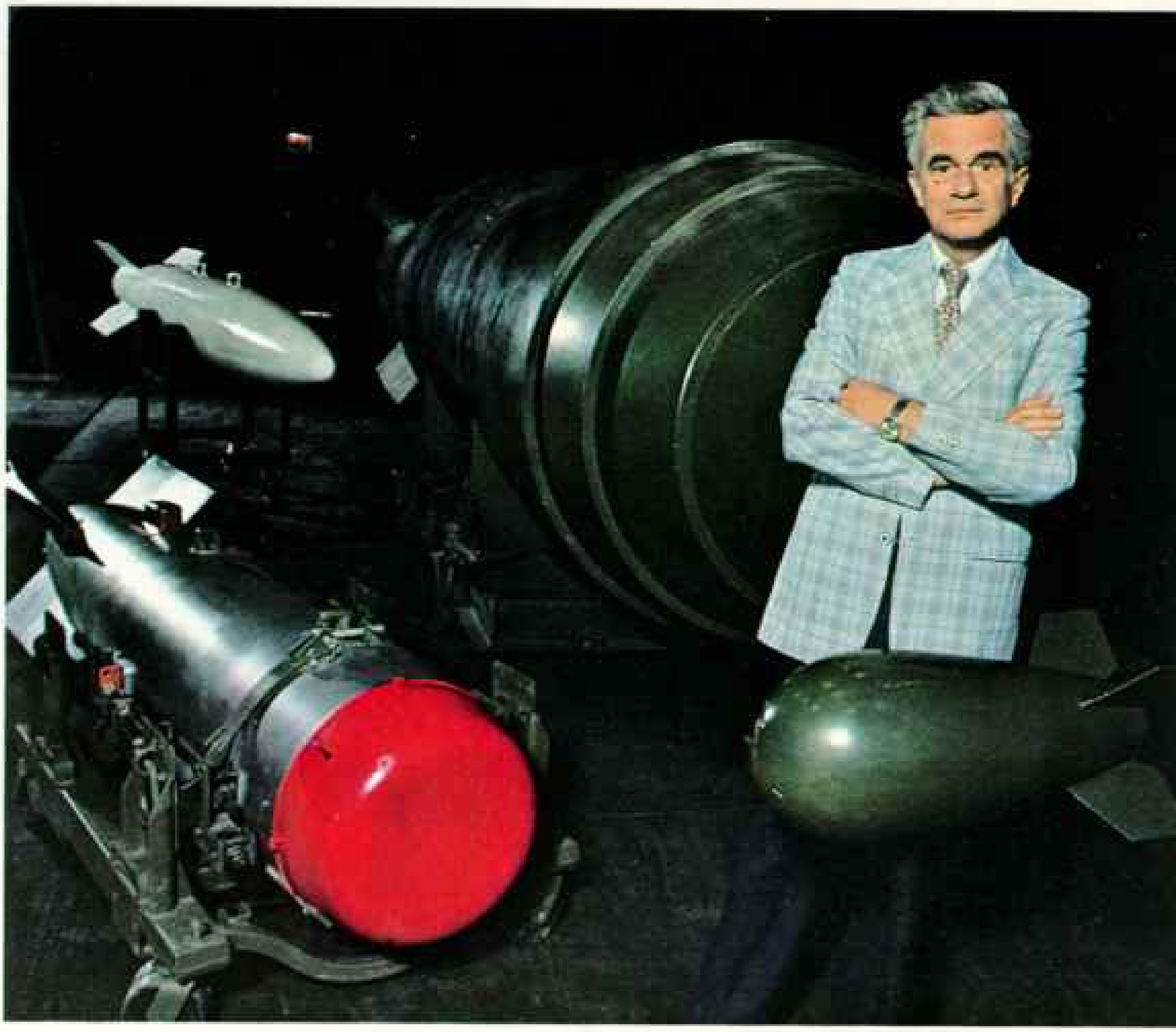
Professor Norman C. Rasmussen (**far left**), now head of nuclear engineering at MIT, directed the Government's Reactor Safety Study of 1975. It contended that risks from nuclear reactors are smaller than many commonly accepted risks of life.

Dr. Alvin Weinberg (**left, below**)—longtime head of the Oak Ridge National Laboratory, where he stands amid canisters of uranium 238—is a nuclear advocate. But he has written frequently about the need to improve safety.

Dr. Ted Taylor (**right, above**), nuclear physicist and former bomb designer, warns that nuclear weapons may proliferate without tighter security for fissionable materials.

David Pesonen (**right**), a San Francisco lawyer, stands at the site of the proposed Bodega Head nuclear reactor. He led the fight that stopped the plant because of its proximity to California's San Andreas Fault—a landmark defeat of a nuclear project by environmentalists.

Amory Lovins (**far right**), a consultant physicist with Friends of the Earth, opposes nuclear power as risky and unnecessary, and advocates renewable resources and more efficient use of all energy.



STORY LITCHFIELD

safely, insist the critics) in tanks and burial pits, mostly on three Government reservations in Washington, South Carolina, and Idaho, awaiting Government action on permanent disposal.

To this huge accumulation, nuclear plants have added something less than 5,000 tons of spent fuel, virtually all of it cooling in pools adjoining the reactors, and 16 million cubic feet of low-level material buried in Government-licensed repositories.

Yet the fear of radioactivity has focused largely on power plants. And it is true that power-plant waste contains more radioactivity and is increasing more rapidly than defense waste. Critics and proponents alike agree that waste is the political Achilles' heel of the industry, and that a satisfactory solution is necessary if there is to be any future for nuclear power in the United States.

Wanted: A Nuclear-garbage Disposal

The problem is not confined to the United States, of course. Forty-three countries abroad now have some kind of nuclear energy program. Of these, 21 countries have a total of 151 operable power reactors, with a capacity of more than 56,000 megawatts. A like number of reactors are under construction; more are on order.

In each case, waste must be disposed of in some fashion. Moreover, all nations that have nuclear weapons—the Soviet Union, Britain, France, and China, as well as the United States—must worry about waste from weapons production.

Nations have tried a variety of methods for disposing of nuclear waste. The British have been piping low-level effluent into the Irish Sea. The United States Atomic Energy Commission, from 1946 to 1970, dumped tens of thousands of canisters of low-level nuclear trash into the Atlantic Ocean 120 miles east of the Maryland-Delaware coast, and into the Pacific 35 miles west of San Francisco (pages 492-3).

One ominous sidelight: The manned submersible *Alvin* has located some of these canisters and found them crushed and leaking. Sponges were growing on the drums.

The Soviets, as I learned while touring nuclear facilities in the U.S.S.R., are pumping intermediate-level liquid wastes into sandstone that is as much as 2,000 meters deep beneath impermeable layers of clay.

In West Germany, near Hannover, I visited the world's first salt-mine waste repository. This prototype facility holds special interest because the United States has long considered the possibilities of storage in underground salt beds.

At a depth of about a kilometer, in glistening, low-ceilinged chambers abandoned when the Asse salt mine closed, I saw a stack loader piling yellow steel drums from floor to roof. The 200-liter drums held contaminated clothes and equipment, radioactive ashes, and air filters from nuclear plants. Since 1967 some 100,000 drums of such low-level waste have accumulated.

More dangerous wastes, which must be handled much more cautiously, have been stored at Asse since 1972. Drums of these intermediate-level materials, shielded in special casks, come through the tunnels by truck. Operators using remotely controlled cranes hoist the drums from their shielding casks and lower them through shafts into totally enclosed vaults. On a television monitor I could see the jumbled mass of barrels

SANDIA LABORATORIES

Slammed into concrete at more than 80 miles an hour, a 74-ton orange steel cask inside a protective railcar (**above**) is barely dented. The test at Sandia Laboratories, Albuquerque, New Mexico, demonstrated that even such violent crashes would leave a cask's radioactive cargo intact.

In a similar cask inside a white shipping container, spent fuel assemblies pass through a South Carolina town (**below**).

on the rough cavern floor 15 meters below.

Klaus Kühn, manager at Asse, told me that the two meters of rock salt between us and the hot wastes served as well as concrete for protection.

"That's fortunate," he added, "since the radiation in that room is 1,000 rems an hour. It would not be a good idea to go in."

German officials hope in the 1980's to establish a permanent waste storage facility in salt beds at Gorleben, near the East German border. That may prove difficult, however; as I left the salt mine, I saw signs demanding *"Kein Atommüll in Asse!*—No Atom Waste in Asse!" Anti-nuclear groups who oppose storage at Asse are also fighting against Gorleben. For that matter, they have been vigorously—and successfully—blocking a number of new nuclear plants.

Virtually every country in Western Europe shares to some degree this opposition to nuclear power. For example, in Sweden, which gets nearly a fourth of its electricity from the atom, two governments have fallen partly over nuclear issues. In Austria last fall a national plebiscite by a narrow margin prevented licensing of a completed 600-million-dollar nuclear plant at Zwentendorf—to the great embarrassment of Chancellor Bruno Kreisky and his government.

In France opposition climaxed in a bloody riot at the site of SuperPhénix, which will be the world's first commercial fast breeder reactor; 5,000 riot police battled some 20,000 demonstrators, leaving one person dead and a hundred wounded (pages 484-5).

In the United States nuclear opposition has not reached such violent proportions. But politically the impact has been strong. Thus two states—California and Maine—have prohibited any further nuclear plants until an acceptable solution has been found for waste disposal. Other states have imposed similar restrictions.

To complicate the problem, eight states have banned nuclear waste repositories within their borders, and others are considering such bans. In addition a number of states and communities have banned or severely restricted shipment of radioactive materials through their jurisdictions.

Thus it is not surprising that solution to the waste problem is now high on the priority list of the Department of Energy.

Where to put the waste? How about shooting it into space, into the sun? Fine if it worked, but incredibly costly and out of the question, say most experts, until we develop foolproof rocket launches.

How about the great ice cap of Antarctica or the deep-ocean sediments? Both have been considered, but both involve delicate international considerations. Moreover, both would likely in time expose the wastes to the marine environment, where they could spread to the entire biosphere.

How about copying the alchemists' fabled trick of transmuting lead into gold—that is, bombarding wastes with nuclear particles and converting them from unstable, radioactive elements into stable, innocuous substances? The idea is not ridiculous—after all, radioactive decay itself is a form of transmutation. But, alas, no one knows any practical, economical way of doing it, and the problem will not wait.

Deep Burial Most Likely Solution

Lacking one of these imaginative solutions, most experts both here and abroad believe that dangerous, long-lived forms of radioactive waste would best be concentrated in solid form. Then it should be encased in protective canisters and stored hundreds or thousands of feet deep in suitable geologic formations.

Scientists are currently studying such possibilities as salt beds, granites, basalts, and shales. They seek to learn which are most stable and which would best prevent radioactivity from leaking into the environment.

Much of the technology is now available to put the wastes deep into geologic formations and seal them off, according to several studies, most recently the draft report of the Interagency Review Group (IRG) on Nuclear Waste Management, a task force representing 14 federal organizations.

"A successful isolation of radioactive wastes from the biosphere appears feasible" for a few thousand years, says the report, which adds that assurance of success diminishes beyond that point.

The process of solidifying the waste in glass form is already being tested. At the nuclear center of Marcoule, in France, the government-owned Compagnie Générale des Matières Nucléaires (Cogéma) has since

last summer operated the world's first plant for vitrifying nuclear wastes.

In the French process liquid radioactive waste, left over after the reprocessing of spent fuel, is evaporated. The residue is incorporated at high temperature into 1,500-pound blocks of extremely hard glass. These, say the French authorities, may be encased in metal drums and buried safely for centuries.

Many U. S. experts are pessimistic about glass and believe that ceramics, for example, would be less vulnerable to leaching.

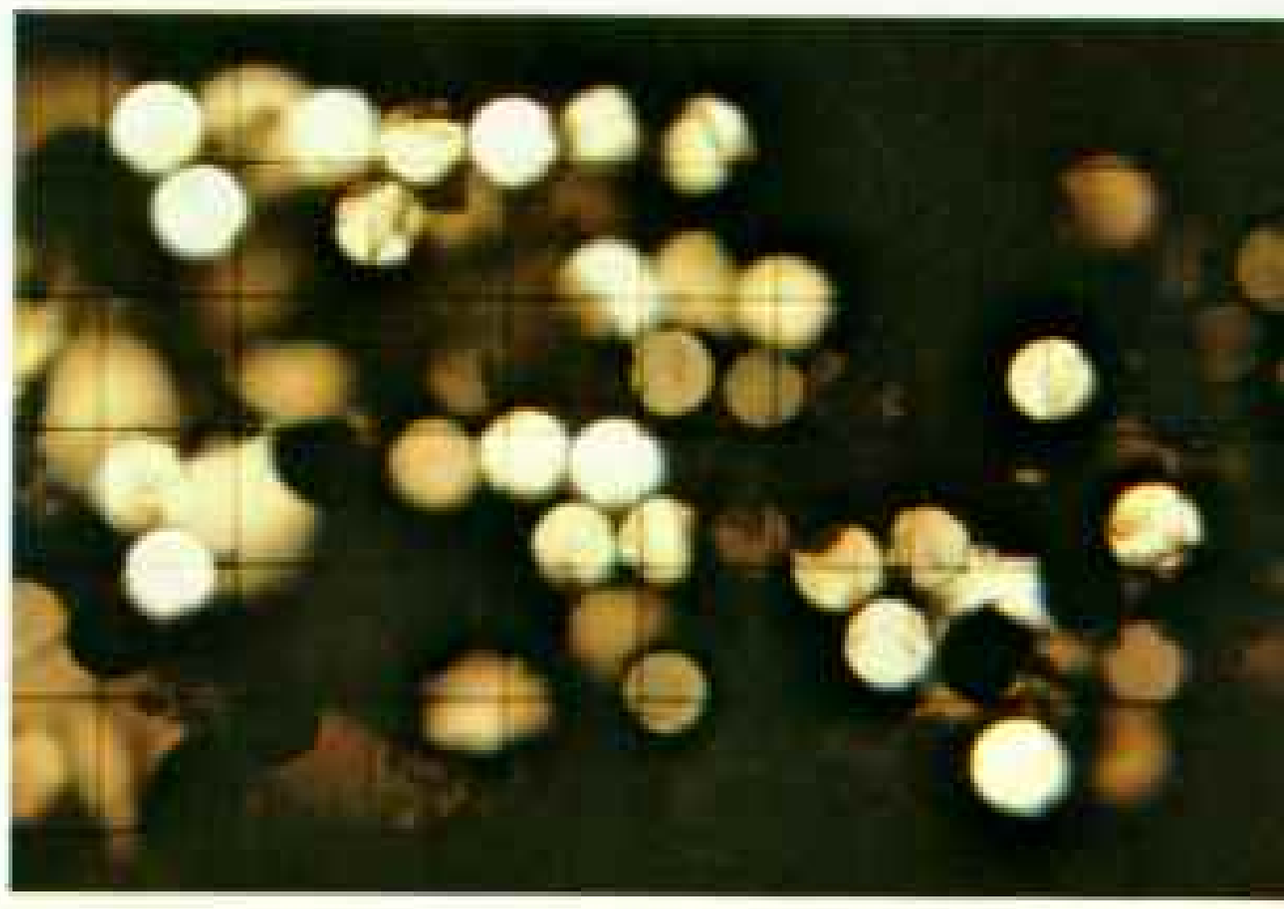
Whatever method is used, long storage will be required. The length of time involves the half-life of the most toxic isotopes: that is, the time it takes for half of the radioactivity to disappear. If the half-life is 30 years, for example, half of the atoms disintegrate in 30 years; half of what is left disappears in the next 30 years, and so on. Within 10 half-lives, only one-thousandth of the radioactivity is left; within 20 half-lives, only a millionth.

As it happens, most of the strong gamma emitters in nuclear waste have half-lives of about 30 years or less. Thus in 300 years they will be reasonably safe; within 600 years, nearly harmless. Plutonium 239, however, has a half-life of 24,400 years. A quarter of a million years will pass before most of its alpha radiation is gone.

In all cases the wastes need to be stored in sites where groundwater cannot easily reach them and where quakes and other tectonic activity are highly unlikely. In addition they need to be secure from human mischief.

Some 370 million dollars has been spent researching the waste problem. Yet it is uncertain how soon burial facilities will be available in the United States. The IRG report, which the Carter Administration is expected to use as the basis for a comprehensive waste-disposal policy, warns against undue optimism. It says that 1988 is the earliest that a permanent repository in salt for high-level wastes could be in operation for testing. If the decision goes instead to other kinds of geologic formations, about which we know less, a site would not be ready before 1992 at the earliest.

As a transitional measure meanwhile, the IRG report recommends that the Government set up at least one smaller facility, in



To detect theft of nuclear materials, a seal of light-transmitting glass fibers (**top**, left) can stand watch on the door of a vault containing, for example, plutonium. A microscope (**top**, middle) reveals the seal's unique "fingerprint" of light transmitted by the tiny fibers (**above**). A thief's tampering would scramble the dots, permitting detection during regular inspections.

Another seal, shaped like a disk (**top**, right), has at its center a random number or letter, programmed to change at specific intervals. Tampering disrupts such a sequence, thus revealing the time of a theft. The International Atomic Energy Agency is field-testing the seals.

Riot police fire tear gas to disperse protesters of SuperPhénix, the world's first

which as many as 1,000 spent fuel assemblies could be stored.

One such facility might be excavated deep in salt beds 25 miles east of Carlsbad, New Mexico. For some time the Department of Energy has considered locating the Waste Isolation Pilot Plant there. It would be primarily for transuranic defense waste, with space possibly for storage of spent reactor fuel. But questions have been raised, and the whole idea is unsettled.

Not all nuclear waste comes from power plants and defense uses. In New Mexico, Colorado, and wherever else uranium has been mined and milled, mountains of tailings—pulverized ore from which most of the uranium has been extracted—have been left to be spread by the wind and rain. One such mountain covers a city block four miles from downtown Salt Lake City.

For many years tailings were thought to pose little or no danger. At one time they were even used as foundation material for houses and public buildings in Grand Junction, Colorado, as well as other places.

However, tailings give off a radioactive gas, radon 222, which can seep through wood and concrete. Radon emits damaging alpha particles. In addition its decay products, called daughters of radon, are gamma-emitting solids that adhere to dust and can lodge in the lungs. Over many years they pose a cancer threat. Since radon is itself the decay product of radium 226, which has a half-life of 1,622 years, the problem is long lasting.

MICHEL ARTAULT, SAMMA/LIAISON

large-scale fast breeder reactor, now under construction near Lyon, France.

In properly operated uranium mines, ventilation carries away much of the radon gas and reduces the dose to the miners. But little has been done to cover or stabilize dumps of tailings. The IRG report calls for the Government to take more vigorous steps to prevent human exposure, and the NRC has begun to draw up regulations for underground disposal.

Waste problems are entwined with two other highly controversial matters: the fast breeder reactor and the reprocessing of nuclear fuel.

The fast breeder is a special kind of reactor that eventually may produce more fuel than it consumes. To understand it, you need to know something about uranium.

As it comes from the ore, uranium consists chiefly of two isotopes. Uranium 235, which is fissionable and thus can be used for fuel, makes up 0.7 percent. Uranium 238, which does not lend itself to fissioning, makes up most of what remains. For fuel pellets in U. S. reactors, the proportion of uranium 235 is enriched to about 3 percent.

After the uranium 235 is largely burned up in the reactor, the huge amount of uranium 238 remains as waste. But if the waste is placed in and around the core of a breeder and irradiated by fast neutrons, some of the uranium atoms absorb neutrons and are converted to plutonium 239. Plutonium 239 is fissionable and can be used in reactors for fuel.

Thus, with breeders, it is theoretically possible to extract sixty times as much

energy from uranium as with conventional reactors since the uranium 238 in spent fuel can be used over and over again.

However, the breeder has disadvantages. It is very costly. It is more complicated and in some ways more hazardous than conventional reactors, although its temperature and pressure are lower. And it uses liquid sodium instead of water for cooling.

Sodium is a soft, silvery metal that melts just below the boiling point of water. It will burn on exposure to air and reacts violently with water. And it leaks easily through very tiny openings. Thus extraordinary care must be taken in handling.

Despite such problems the breeder offers apparent attractions for nations that have little fossil fuel and must depend on other countries for uranium for reactor fuel. The breeder can make a little uranium go a long way. For example, the United Kingdom, using breeder reactors and only 5,000 metric tons of uranium, could theoretically unlock energy equivalent to all its estimated recoverable oil and gas in the North Sea.

Four nations abroad already are operating such reactors. Japan has a small one. The Soviet Union produces electricity and desalinates water with a 350-megawatt plant at Shevchenko on the Caspian Sea. The United Kingdom feeds electricity into the Scottish grid with a 250-megawatt prototype breeder at Dounreay. France operates the 250-megawatt Phénix, named for the mythical bird reborn from its own ashes. It symbolizes the ability of the breeder to create new fuel as the old is destroyed.

France, together with Italian and West German interests, is also building the 1,200-megawatt SuperPhénix at Creys-Malville near Lyon. The reactor is scheduled to begin operation in 1983.

The United States has fallen behind Western Europe in breeder construction. There's irony in that fact. In 1951 a small United States breeder produced the first electricity ever generated from nuclear energy—enough to power four light bulbs. Today Experimental Breeder Reactor No. 1, at Idaho Falls, Idaho, is preserved as a national historic landmark.

Whether the United States will ever build large breeders remains uncertain. The Carter Administration opposes the breeder in the U. S. on the grounds that it is unnecessary either for economic reasons or because of uranium shortage. Also, because the breeder recycles plutonium, making it more readily available for nuclear bombs, there is a fear that the breeder will contribute to the proliferation of nuclear weapons among nations that do not already possess them.

For the same reason the administration opposes reprocessing spent reactor fuel—a necessary step if plutonium is to be extracted and recycled.

President Carter hopes that foreign nations follow the U. S. lead in forgoing reprocessing and breeder construction. By way of example, the President has blocked completion of a large reprocessing plant at Barnwell, South Carolina, that has already cost 250 million dollars. It could handle each year all the spent fuel from 50 reactors.

The administration has also attempted to cancel a largely federally financed, 350-megawatt pilot breeder on the Clinch River in Tennessee. Nearly 600 million dollars has been spent, chiefly on design and components for the plant, since the project started in 1973. But, the Department of Energy contends, Clinch River is a poor, obsolete design that has been delayed too long to be of any use.

Congress opposes the President's attempt to scuttle the project and has kept it alive for at least the current fiscal year. Proponents say that with a green light the Clinch River reactor could start producing electricity in late 1986.

Breeder Facility Nears Completion

Despite the fight over Clinch River, breeder research, as this is written, continues in the United States to the tune of almost 600 million dollars a year in federal funds—nearly equal to what all other countries are spending.

In the desolate southeast corner of Washington State, on the 570-square-mile Hanford Reservation, the Department of Energy is completing a huge Fast Flux Test Facility to test breeder fuels and materials, not to generate electricity. This 540-million-dollar reactor will use plutonium and uranium for fuel and will be cooled by a fifth of a million gallons of sodium. The Government expects it to be ready late this year.

A paradox marks the attitude of the rest of the world with regard to the threat of proliferation. President Carter's appeals about the breeder and reprocessing seem to have fallen on deaf ears. Energy officials with whom I have talked in Western Europe say almost with one voice:

"The United States can afford to give up the breeder because it has its own uranium and oil and plenty of coal. We lack those resources, and we must have the breeder and reprocessing to meet our energy needs."

At the same time, these nations—along with the Soviet Union and Japan—have become deeply concerned about proliferation of nuclear weapons. They support the International Atomic Energy Agency (IAEA), headquartered in Vienna, which seeks to promote safeguards against diversion of nuclear fuels.

IAEA inspectors visit nuclear facilities in many countries to determine if supplies of plutonium and other fissionable materials are adequately safeguarded.

But these nuclear watchdogs lack teeth. They do not inspect in the U.S.S.R., or yet in the United States, or in certain smaller countries that have not signed the nuclear Non-Proliferation Treaty. Moreover, the inspectors have no powers of enforcement; they merely try to detect diversion.

Those who fear proliferation and diversion (and they are many) note that the bomb that devastated Nagasaki during World War II contained only ten to fifteen pounds of plutonium.

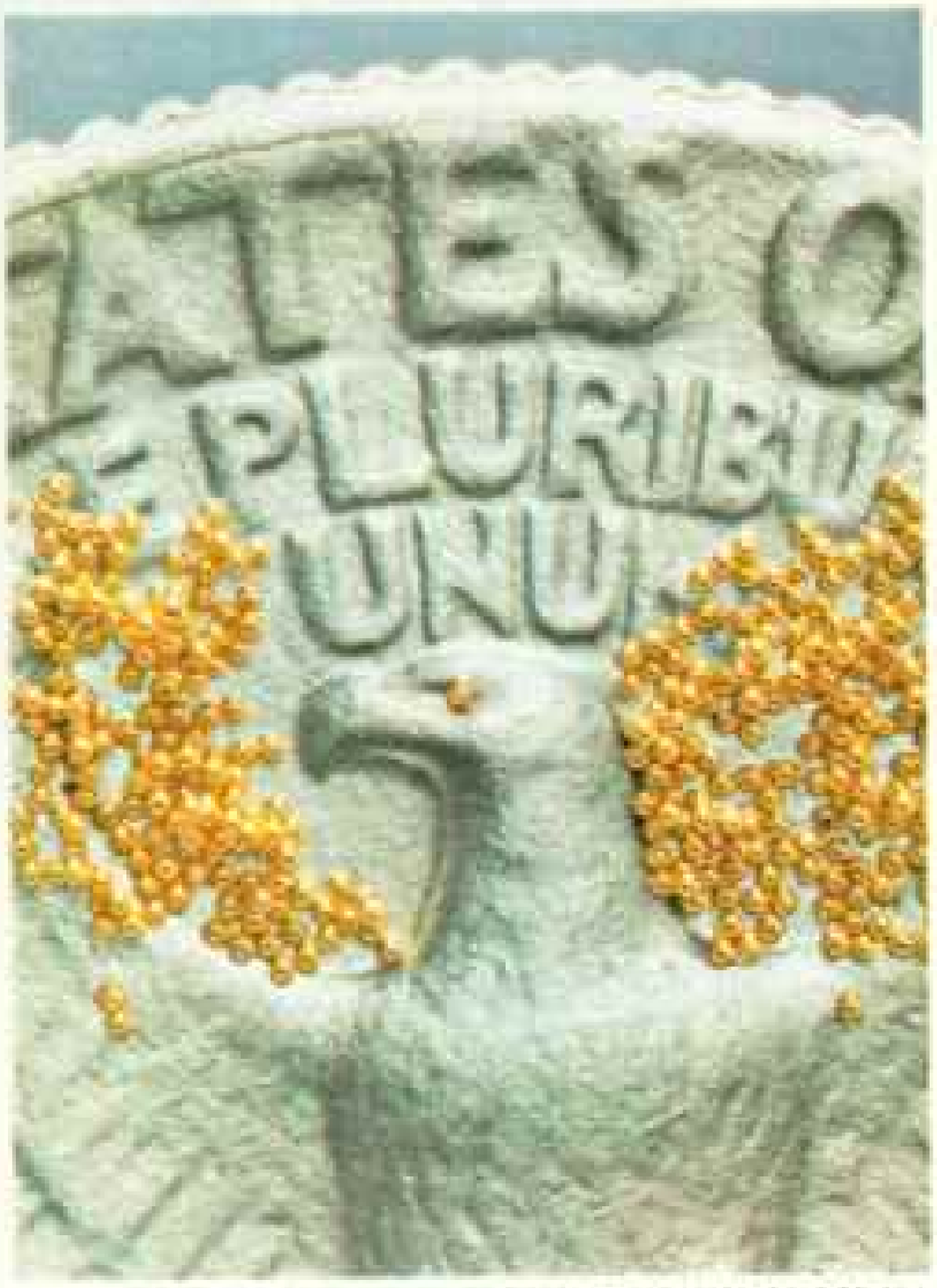
What if plutonium or uranium, from which bombs can be made, should be stolen by terrorists or by an irresponsible dictator?

A mysterious incident in the 1960's lends color to these fears. The story reads like the scenario for a paperback thriller.

On a wintry November day in 1968 the cargo vessel *Scheersberg A*, flying the flag of Liberia, cleared Antwerp harbor with a brand-new crew. Aboard were 200 tons of yellowcake, uranium oxide, made from ore mined in Zaire. It was bound for Genoa. All papers were in order.

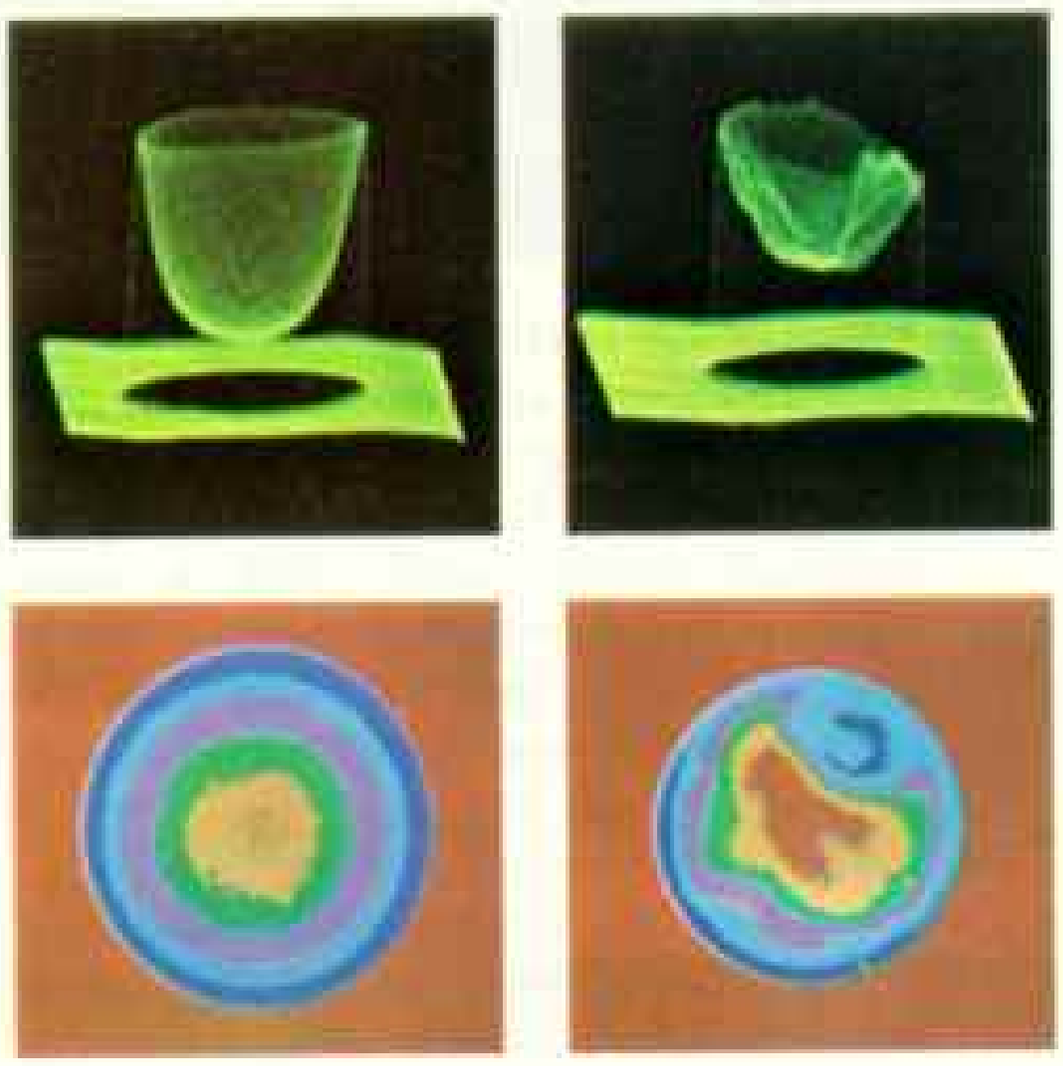
Once in international waters, beyond prying eyes, the drums of yellowcake vanished. The *Scheersberg A* never arrived in Genoa. When she put into a Turkish port 15 days later, the $3,700,000 cargo was missing.

Pioneer in fusion—where nuclei are joined rather than split—Boris Kadomtsev of Moscow's Kurchatov Institute stands atop a Tokamak. The Soviet-designed device, along with a sister machine at Princeton University, confines hydrogen nuclei in a magnetic field and seeks to fuse them at extreme temperature. Researchers also attempt fusion through electron beams and lasers (pages 490-91). If mastered, later-generation fusion processes could provide virtually unlimited energy from abundant hydrogen.



LOS ALAMOS SCIENTIFIC LABORATORY (ABOVE AND BELOW)

Bristling with tubes that house instruments, a spherical steel chamber (**facing page**) may help demonstrate the scientific feasibility of fusion by laser beams. Scientists at the Lawrence Livermore Laboratory near San Francisco focus Shiva, the world's most powerful laser, on a tiny fuel pellet inside the chamber. Such pellets, photographed on a quarter (**above**), contain deuterium and tritium, isotopes of hydrogen. Enhanced X-ray images (**below**) display the uniformity of an acceptable pellet (**left**) and the ragged contours of a reject (**right**).



Secret agents tried to trace the shipment. They found nothing but blank walls and blind alleys. The mystery remains unsolved.

Was it a hijacking, masterminded by some sinister private group? Or could it be, as some believe, that the valuable uranium ended up in a secret nuclear laboratory in an Israeli desert? Research reactors can readily produce plutonium.

Radiation, waste, plutonium, proliferation. These are problems plaguing nuclear energy. Two other questions figure in the debate. Does nuclear cost too much? And how will the nation meet its energy needs without increased nuclear power?

Many utilities executives say that current reactors produce cheaper electricity than coal-powered plants. Especially is this true, they say, if coal plants are equipped with all the expensive gear required to protect the environment—devices to filter out particulates, smog-creating nitrous oxides, and lung-destroying sulfur dioxide.

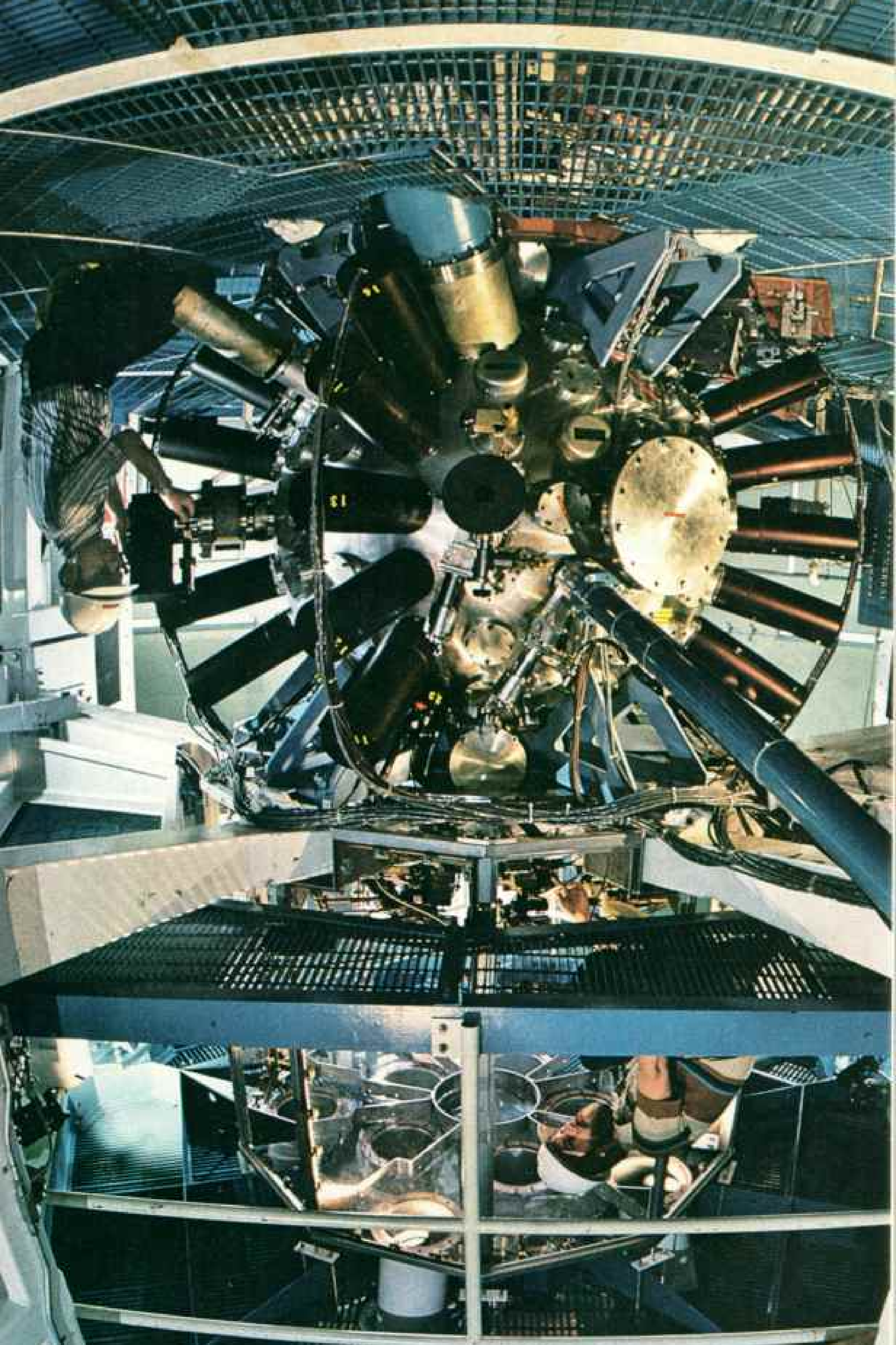
Some economists are not so sure. They note the ultimate costs of waste disposal. They estimate that the price for necessary dismantling or entombing of radioactive plants may be 5 to 30 percent of the original construction costs. Thus nuclear energy could prove to be very expensive.

Even initial costs are getting out of hand. A typical nuclear plant finished several years ago cost about $200 per kilowatt of capacity. Prices in the next couple of years will have tripled, and by the 1990's they could triple again. Of course, costs of coal plants are skyrocketing in similar fashion.

Utilities are shying away from such heavy investments at today's inflated interest rates, with hundreds of millions of dollars tied up unproductively during the dozen years it now takes to go through the prolonged licensing and construction process.

If not nuclear power, what then?

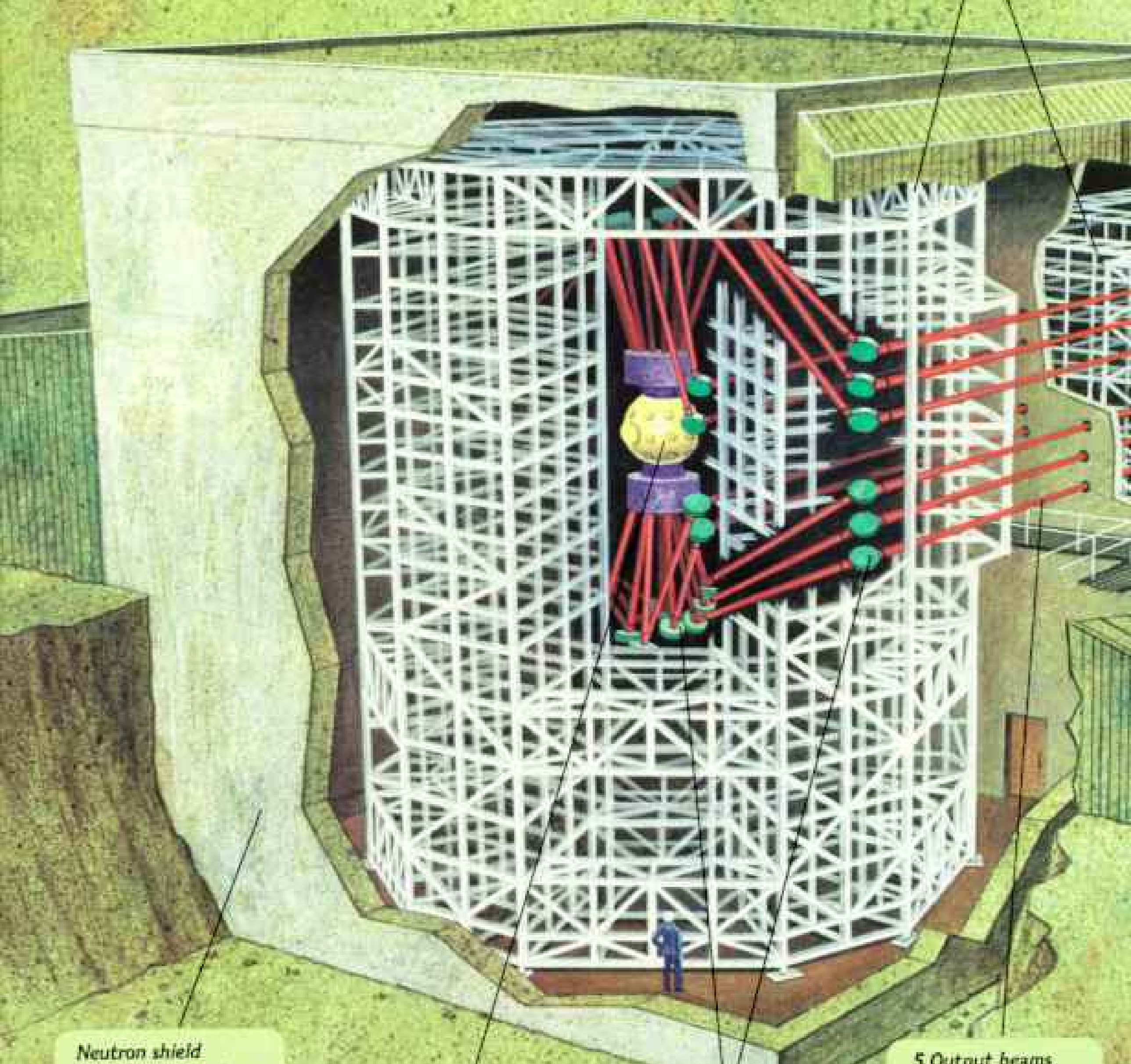
• *Oil?* As domestic energy demand mounts, we are importing more and more oil at high prices. Already we ship in some nine million barrels a day, at a cost of about 45 billion dollars a year. This heavy drain ruins our trade balance, contributes to the fall of the dollar, and spurs inflation. John O'Leary, Deputy Secretary of Energy, estimates that foreign oil could cost a hundred billion dollars a year by *(Continued on page 492)*



Called Shiva, after the Hindu god with many arms, the multibeam laser device at Livermore zaps the fuel pellets with more than 20 trillion watts of power for less than a billionth of a second. The goal: a step toward scientific break-even, where the energy produced from fusion equals that delivered by the laser.

A planned successor to Shiva —Nova—will employ a 200-trillion-watt laser that may yield energy in excess of break-even, thus demonstrating the practicability of lasers for fusion reactors.

Space frames
Five miles of square steel tubing (white) rigidly support the target chamber and the components of the laser system.



Neutron shield
Concrete walls four feet thick enclose the target room to absorb neutrons that escape from the fusion reaction.

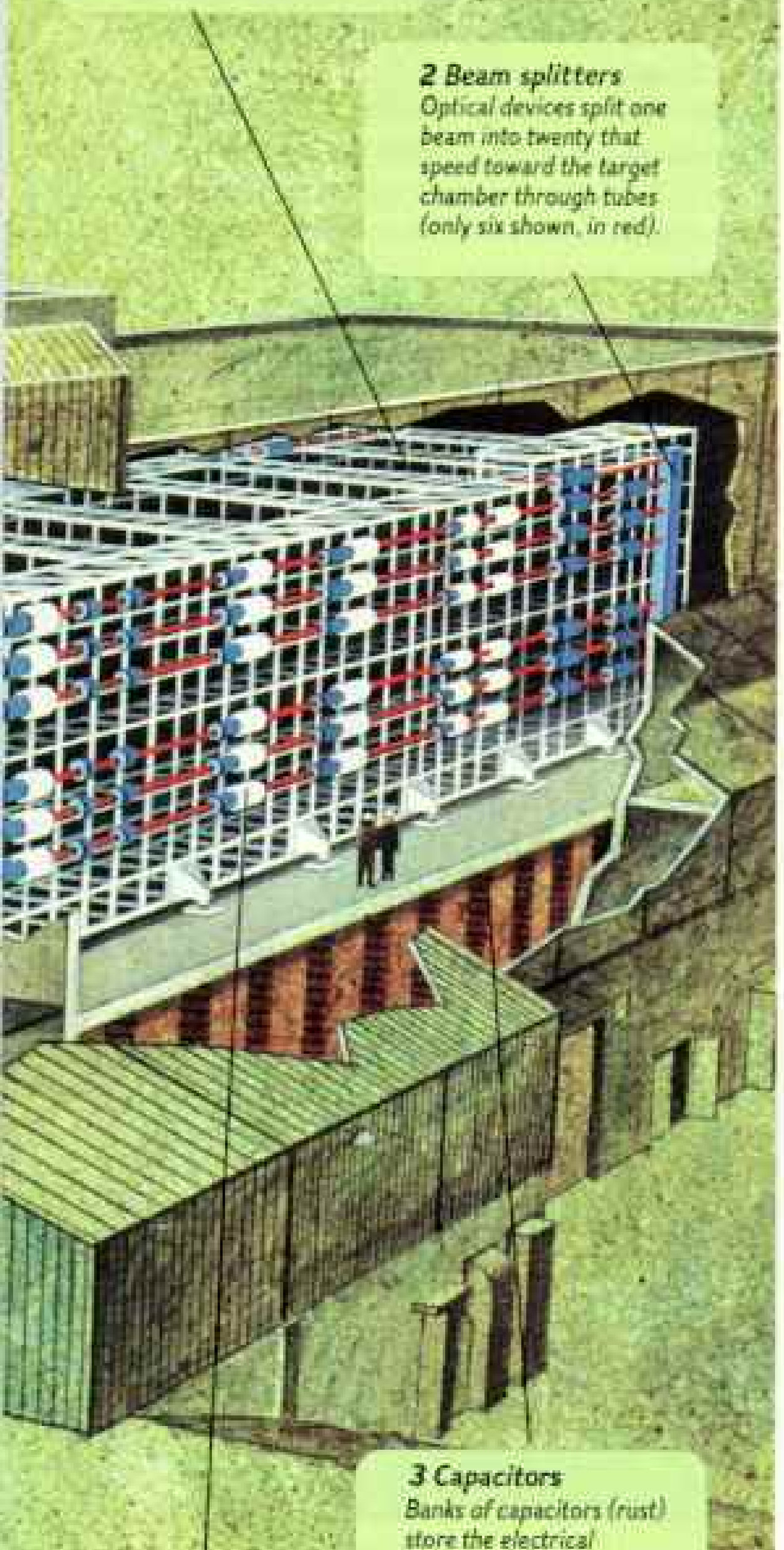
7 Target chamber
Clusters of lenses (in purple housing) focus the beams into the target chamber (yellow) to ignite the fuel pellet.

6 Turning mirrors
Like billiard balls, the laser bursts bounce off mirrors (aqua) and are directed to the target chamber.

5 Output beams
Each beam is now nearly a foot in diameter and one million times more powerful than the initial burst.

1 Beam generator
A master oscillator deep inside Shiva generates an intense burst of laser light about one inch long and a tenth wide.

2 Beam splitters
Optical devices split one beam into twenty that speed toward the target chamber through tubes (only six shown, in red).



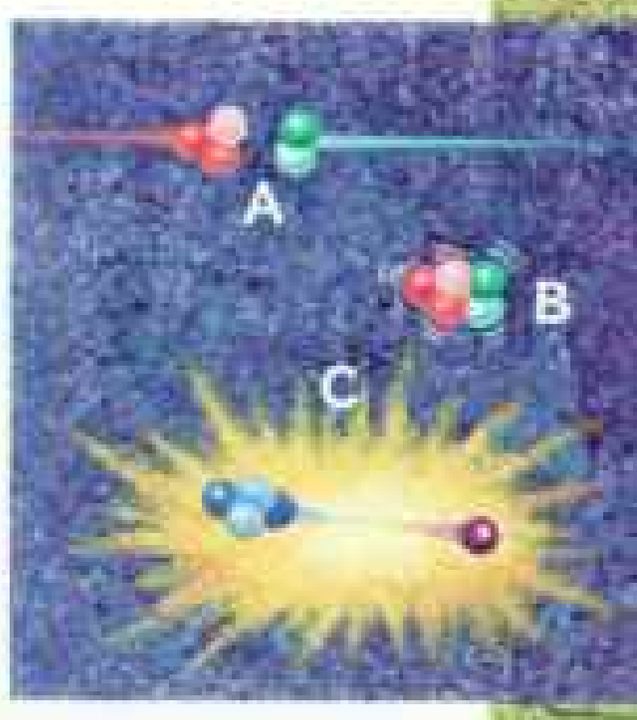
3 Capacitors
Banks of capacitors (rust) store the electrical energy needed to power the laser amplifiers.

4 Laser amplifiers
Amplifying system (blue and white) increases the power of the beams and expands them in size.

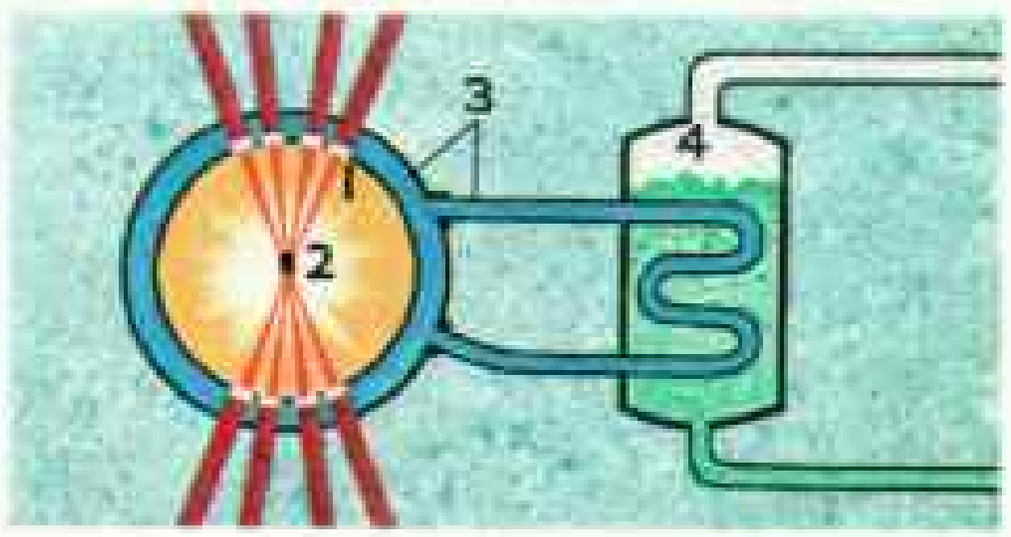
The promise of nuclear fusion

SAFE ENERGY? Clean energy? Energy from an abundant fuel, hydrogen, a component of water. Therein lies the promise of fusion, the same energy process that fuels the sun. But firing the furnace of fusion to stoke man's reactors requires a hellfire of a hundred million degrees Celsius.

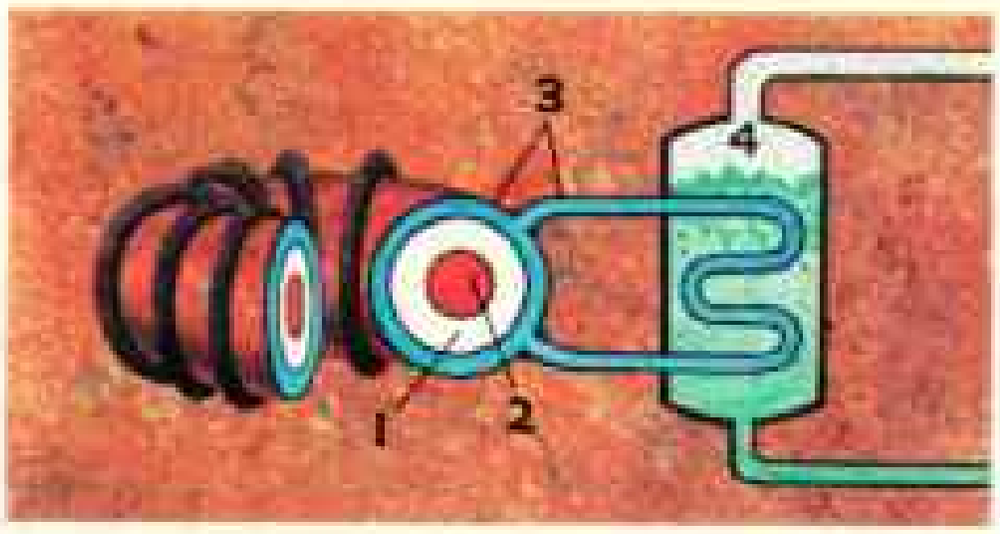
At that temperature nuclei of tritium and deuterium (**A**) fuse into an unstable nucleus (**B**) that spits out a high-energy neutron (**C**), leaving a nucleus of helium. In a reactor the neutron would give up its kinetic energy as heat.



Such is the theory, simply stated. Its implementation presents formidable difficulties that will not likely be surmounted until the next century. The two major types of fusion research involve lasers (**below**) and magnets (**bottom**), a technique being pursued at Princeton University and in the U.S.S.R.



LASER BEAMS (1) cause the deuterium and the tritium in the pellet to fuse (2). Molten lithium (3) absorbs the energy from fusion and transfers it as heat to a steam generator (4).



A MAGNETIC FIELD (1) confines a plasma (2) and allows it to be heated electrically to achieve fusion. Lithium (3) absorbs and transfers the fusion heat to a generator (4).

PAINTING BY PIERRE MION

1985 unless we curb imports. Clearly, oil is not the answer.

• *Gas?* Utilities have been ordered to switch to coal because of the threatened shortage. And even if unproved gas resources are far greater than once thought, exploitation on a significant scale will take years.

• *Coal?* Increasingly, coal is seen as a costly threat to the environment with its polluting sulfur oxides, nitrogen oxides, and acid rains. Perhaps worst of all, burning coal pours enormous amounts of carbon dioxide into the atmosphere, where it blocks heat radiation trying to escape from earth.

Many scientists believe that this greenhouse effect, along with other influences, will gradually increase the average global temperature. This increase may in the next century or so lead to a carbon dioxide catastrophe with disastrous changes in global climate.

• *Alternative energy sources?* Increasingly the nation is trying to exploit solar energy, wind power, geothermal energy. Solar energy, especially, offers tremendous possibilities when technology for using it is well developed. Major contribution to electric power production, however, is years away.

The garbage problem: How to store nuclear waste that may remain radioactive for thousands of years? Until 1970 the U. S. dumped low-level solid waste in drums—such as this one (**right**) off the Maryland coast—into the Atlantic and the Pacific. Now some drums are leaking radioactive materials. In West Germany citizen protests have suspended the dumping of wastes into an abandoned salt mine (**above**) near Asse.

For liquid wastes, solidification in glass or ceramics, with burial in metal containers, may be a solution. Demonstration glass pellets (**left**) from Battelle laboratories illustrate the amount of high-level reprocessed waste from nuclear electricity required to supply the annual needs of a family of five.

Even further in the future is the promise of nuclear fusion, power extracted from the fusion of hydrogen atoms—the ultimate power of the sun and the stars.

• *Conservation?* A most worthy objective. Americans waste far more energy per capita than do Europeans. Everyone gives lip service to conservation, and efforts to save (in addition to higher costs) have already slowed the rise in demand for electricity. But whether enough Americans will take the necessary steps to keep electricity use from doubling by early in the 21st century remains a question.

So, is nuclear energy bleeding to death? Some, with hope, say yes. Others, with sadness, agree. Still others see nuclear returning to health *if* uncertainties and licensing problems that now delay construction and increase costs are eased; *if* shortage of capital and high interest rates let up; and, most important, *if* public acceptance can be won for plans to dispose of waste and to safeguard dangerous materials.

It's a murky picture, filled with emotion and uncertainties. Only one sure fact shines through, and it is not comforting: Never again will energy be either cheap or easy. □

ROBERT S. DYER, ENVIRONMENTAL PROTECTION AGENCY

Swaddled in the old way, babies sleep through a cattle roundup on one

Warm Springs Indians

ARTICLE AND PHOTOGRAPHS BY DAVID S. BOYER

WHITE MEN did make a few little mistakes while taking America away from the Indians, and this reservation, stashed way out in the middle of nowhere, is one of them. While white men were still laughing their way to the bank, their cities got so big and complicated and polluted that the middle of nowhere became one of the nicest places to go.

That ironic thought, from my new Indian friends, ran through my mind as I looked out a picture window at nowhere. Sagebrush. Scruffy little gray juniper trees. Barely enough thin grass to nourish a scattering of white-faced cattle and wild Indian ponies.

Ironically too, I was dining in splendor on French wine and chateaubriand, for the good life is blossoming in this mountain-desert patch of north-central Oregon. The sun shines nearly every day of the year, and the Indian-owned resort I was visiting offers gourmet dining in a luxury lodge, plus golf, tennis, sauna baths, trout fishing, horseback riding, and marvelous swimming in an Olympic-size pool fed by hot springs. And we white men are coming—and paying.

Elsewhere on the reservation, 355,000 acres of Douglas fir and ponderosa pine yield jobs, bonuses, and millions in profits for the 2,300 members of the Confederated Tribes of Warm Springs Indians—the Wascos, the Warm Springs, and the Paiutes.

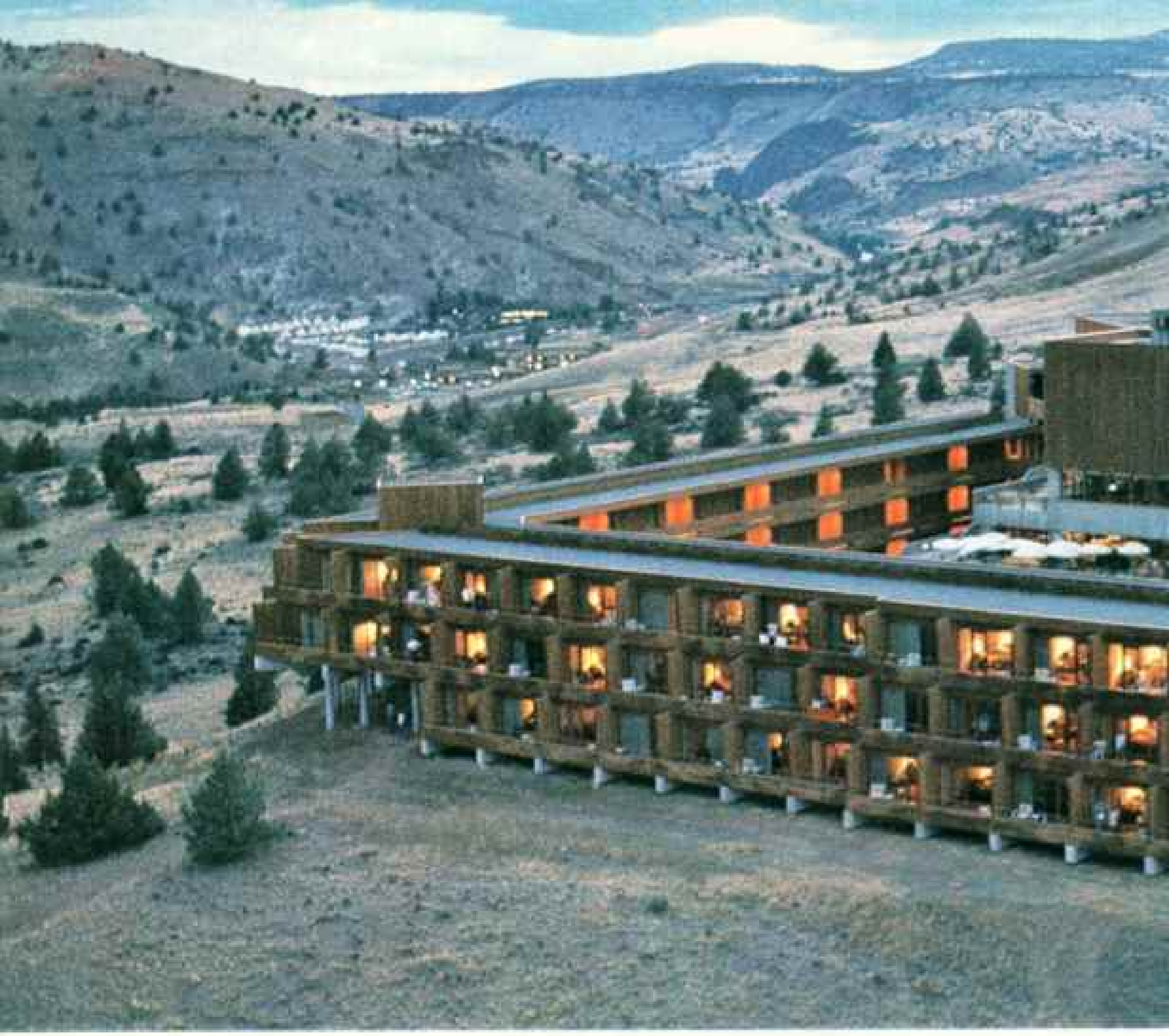
If you live among these Indians, sharing beer and sandwiches at lunchtime, in logging trucks and ranch-house kitchens, or buffalo steaks in mushroom sauce, served at night on gold-rimmed plates at their beautiful resort, Kah-nee-ta, you'll hear more words of hope than of sorrow.

Not that the bitter past is forgotten. Their ancestors were Columbia River Indians, whose lives were the river and its salmon, and the roots and berries and game animals of the forested Cascade Range. But then in

of America's most progressive reservations.

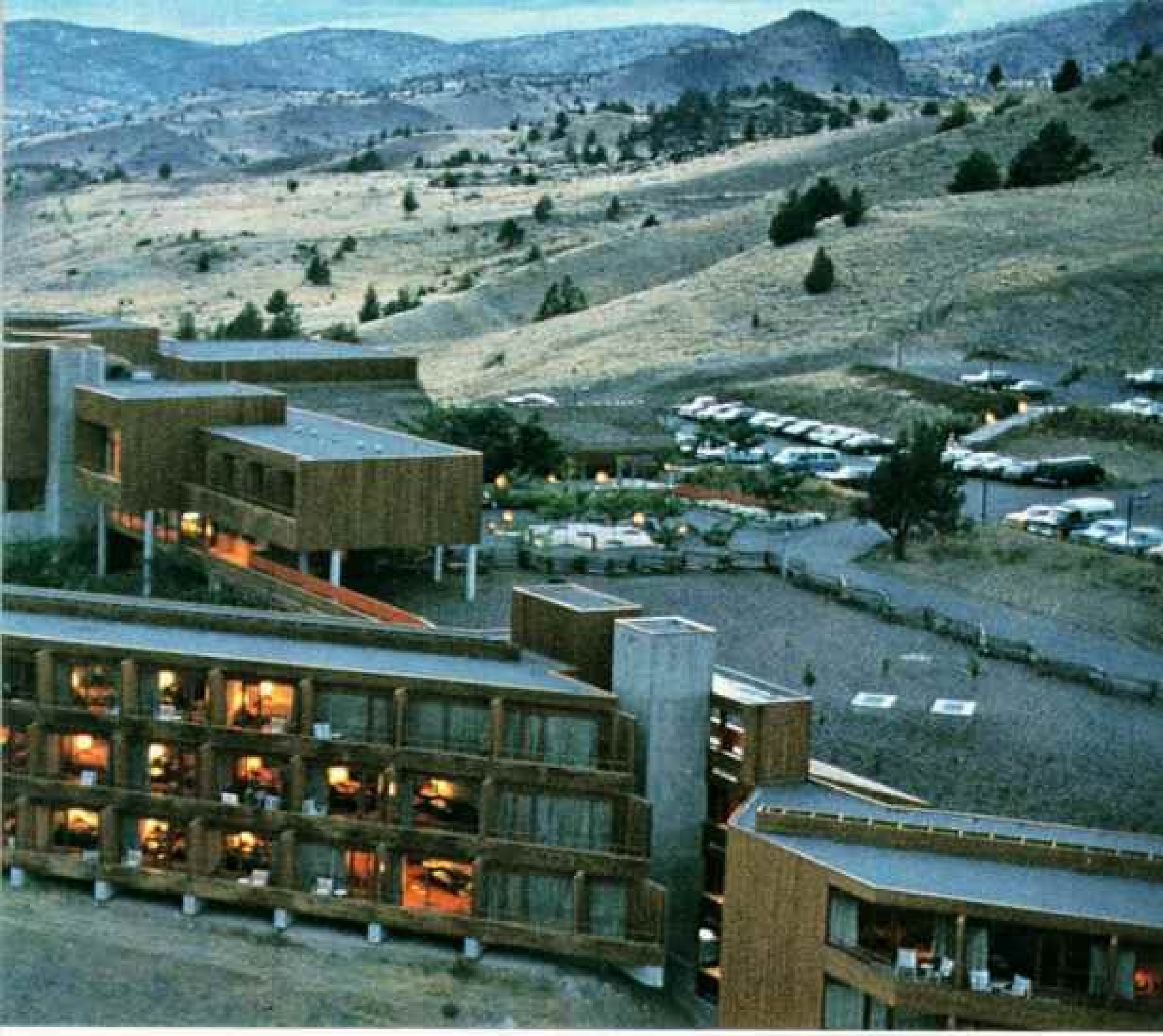
Carve Out a Future

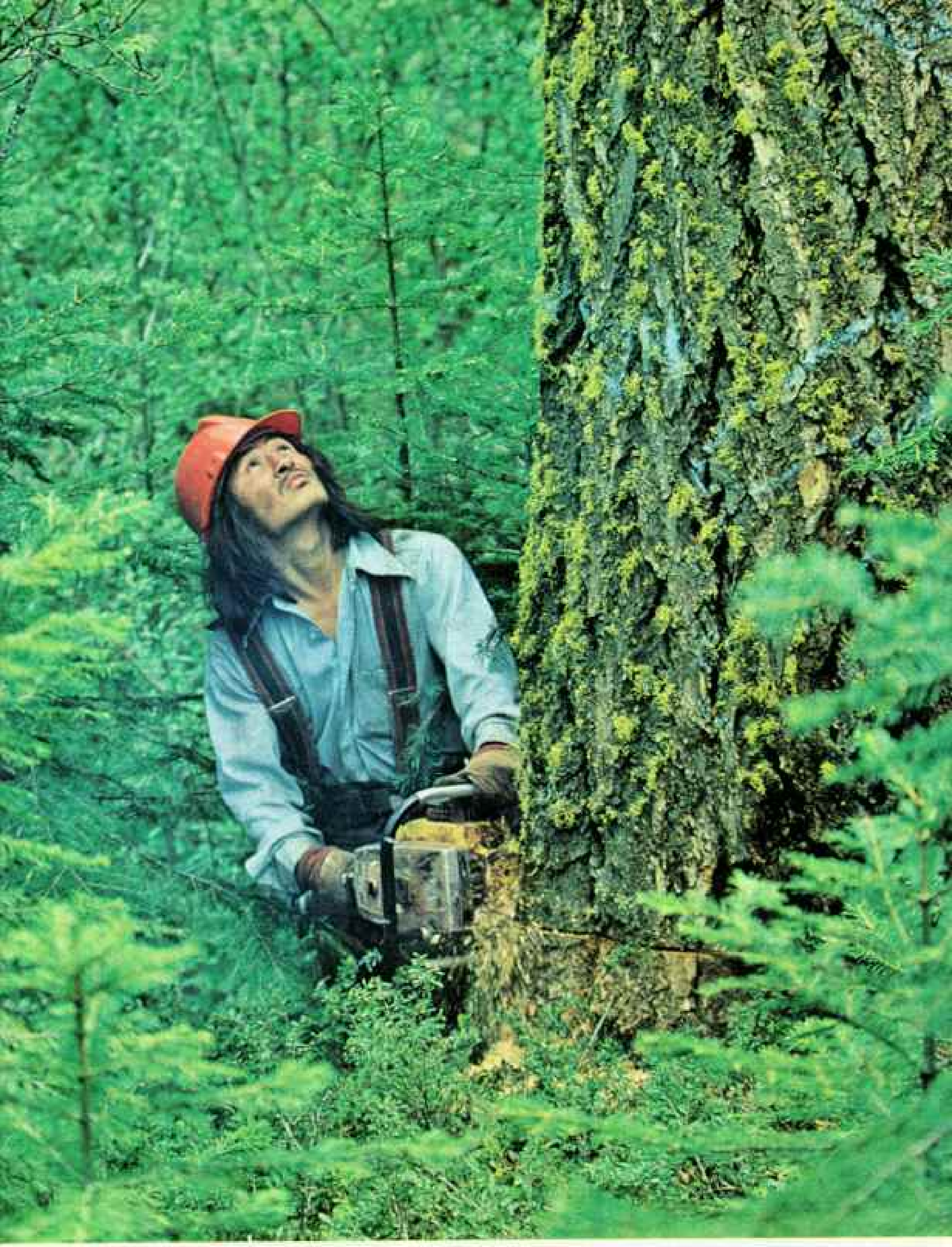
NATIONAL GEOGRAPHIC SENIOR WRITER



Pleasure palace for corporate powwows and sagebrush vacations, the multi-million-dollar lodge at Kah-nee-ta, the Indians' sprawling resort, represents but one of the Warm Springs reservation's bold ventures into a market economy. Aided by a four-million-dollar settlement for lost fishing grounds, reservation members—a confederation of Wasco, Warm Springs, and Paiute Indians—are making the move from poverty to prosperity in one generation.

At the year-round resort, guests can enjoy tennis, trail rides, trout fishing, and hot-spring baths. Fare in the sumptuous Juniper Room (**left**) includes chateaubriand, venison, and vintage French wines. By the 18-hole golf course, Chinook salmon is cooked in traditional Indian fashion (**right**) for outdoor repasts.





Playing David to a forest Goliath, Indian logger Jay Switzler undercuts a Douglas fir on the reservation's 355,000 acres of timber. Profits from a forest-products business and other enterprises generate monthly and year-end dividends for all confederation members.

1855 the U. S. Government kicked them out. Moved them over to the edge of the desert, left them with a few plows and horses, pots and pans, some bags of seed grain, and a schoolteacher and a doctor, and told them to become farmers.

They tried it. Had to. But today they're better as ranchers. And loggers and sawmill workers. And now, resort operators.

"We need the white man today," one patriarch told me. "But we're trying to keep from becoming too much like him, trying to stay Indian."

Forty-one years ago, when the Indians opted for self-government, their baseline was poverty. Today they're financially better off than many white Americans of the desert around them.

Feasibility Study Paved the Way

"This is the most viable Indian society in the country," says James Cornett of the U. S. Bureau of Indian Affairs; veteran superintendent of the reservation, he should know.

"When they settled with the U. S. in 1958 for the loss of their fishing grounds on the Columbia River, they didn't just divide up the four million dollars. They spent 100,000 dollars to have Oregon State University make an economic feasibility study of their reservation. They bought a sawmill and a plywood plant. Then they built the lodge, and now they're talking about building a 30-million-dollar hydroelectric plant on the Deschutes River."

The confederation's gross annual income from timber, lumber, plywood, tourism, and investments has soared to nearly 50 million dollars. Profits last year provided a monthly dividend of 75 dollars for every man, woman, and child, plus a Christmas bonus of 1,200 dollars each!

Tribal members receive pensions beginning at age 60. At all ages, they benefit from tribal funds—added to federal and state loans and grants—for medical and psychiatric care, alcohol and drug therapy, educational and vocational training. Low-interest loans are helping to replace the tar-paper shacks of the past with modern houses and mobile homes.

"They've learned to adapt to the ways of the outside," Jim Cornett adds. "They know they can't have it again the way it was before the white man came. But they're determined to hold on to their Indian heritage, and they're planning a beautiful new museum and cultural center as a focus for it."

No one qualifies to receive tribal welfare unless he's sick, or very old or very young. Although elders push the proposition that every able-bodied Indian should be employed, the work-ethic philosophy is admittedly no earthshaking success among Warm Springs men and women. The five-day workweek is still an exotic import from "white-man country." For thousands of years on the Columbia River, their ancestors worked only when there was game to be killed or salmon to be caught. That left lots of time for eating, singing, games, dancing, religion, and festivals.

I was perched on a corral fence with Allen Elston, a white Southern Baptist minister for 19 years at Warm Springs. Allen had been down in the dust with his Indian friends, roping and branding wild horses; the wildest were being separated out as broncos to be rented to rodeos across the Northwest. It had taken Allen nearly ten years, he told me, to realize why a formal type of Christian ministry had failed on the reservation.

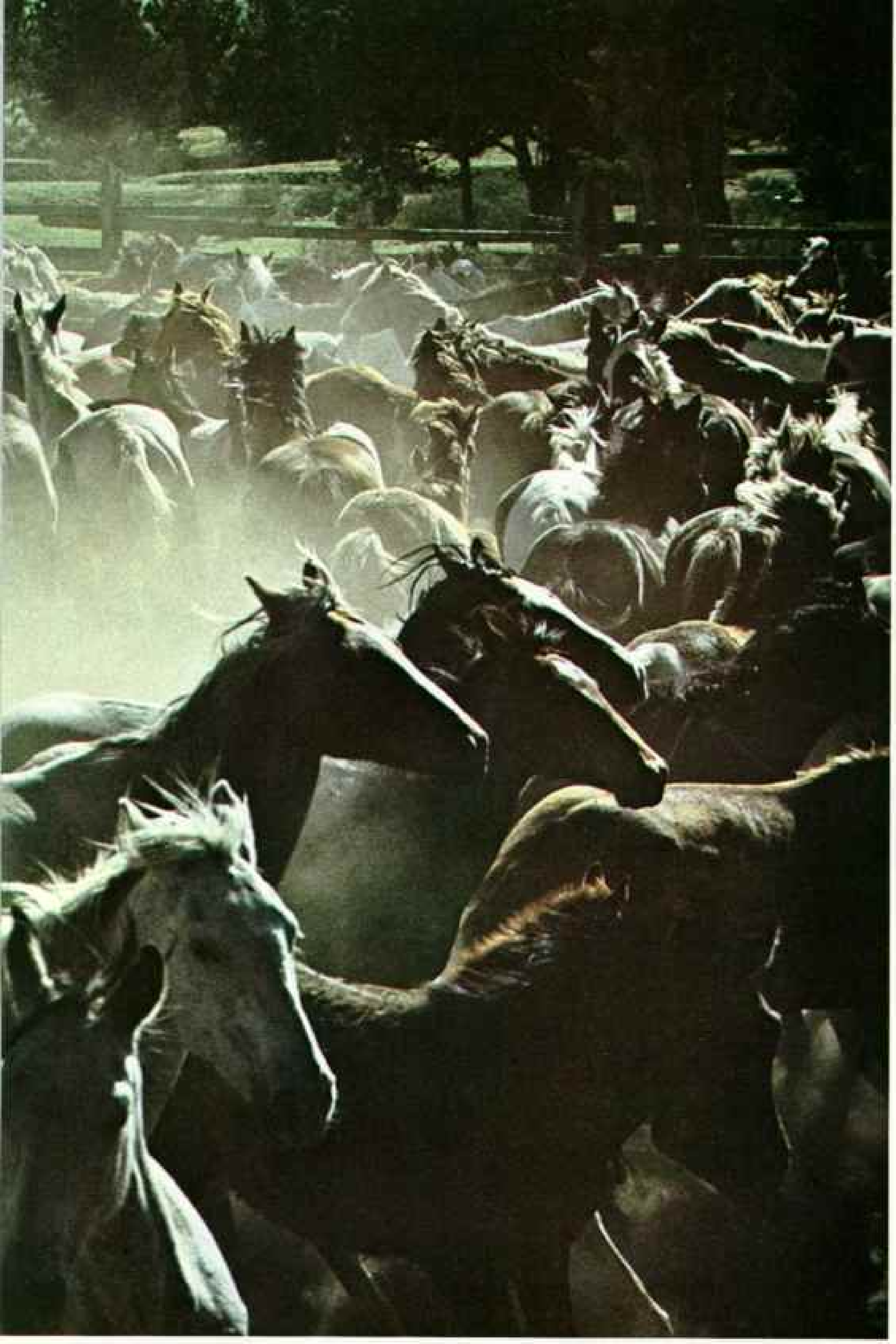
"I'd been trying to superimpose values from my own society on the Indians, my own ideas about how to worship God. It finally dawned on me that the Good Lord wasn't keeping a stopwatch on the Baptists any more than He was on the Indians. So we changed everything. Now we only conduct services the way it's natural for Indians."

Church starts when everybody gets there and is ready. Indian time. And stops when everybody is ready to go home. It's the same way with dozens of self-government committees, tribal council sessions, and general council meetings for all citizens too.

It's slow. But it's democracy, and it works. At Warm Springs they haven't made work a total virtue, nor time a taskmaster. That's not to say, of course, that contemporary problems have vanished.

The tribal council has decreed that no liquor or beer may be sold on the reservation, except at Kah-nee-ta, but that hasn't broken the alcoholism that pervades so much of Indian society, from grade school through old age.

Ornery natures become tribal assets when the reservation's wild horses are



rounded up for branding—with the unruliest separated out as rodeo broncos.

Catching up with their past, youngsters learn bow-and-arrow basics from Leah Conner at Warm Springs Elementary School (**above**). First woman on the tribal police force, Vickie Still (**below**) has since put her gun away to work as a court investigator, mostly with young people. Beset with the universal problems of youth apathy and delinquency, the reservation invests much money and hope in its counseling programs.

Nor have the tribal elders succeeded in conquering another plague, one that infiltrated from the white America all around them—a turned-off generation of youth, some turned on to drugs.

"We consider our kids the key to the future, and we're concerned."

Nelson Wallulatum, chief of the Wascos, told me that traditionally the next chief is supposed to come from his family. "But I have no children. My oldest nephew has the ability, but he's not interested in the world's problems. Particularly not the white man's world.

"For most of our kids, life is basically Indian. We've got some good young cowboys. They travel all over the West, riding in rodeos. But what we need is not so much rodeo champions as college graduates."

The reservation has its first graduate in fish biology: Eugene Greene, confederation chairman and director of natural resources, a key figure in the new trout and salmon hatchery on the Warm Springs River. Robert Macy, a graduate forester, will soon be qualified to take over as manager of the Warm Springs Forest Products Industries, a complex producing 35 million dollars gross annual income.

"We've got forty youngsters away at college right now," Nelson told me. "But they're mainly in social sciences or education. I don't know where we're going to get our first doctor or psychiatrist. We could use half a dozen. And how many college kids will come back? They're in school on tribal funds, but will they bring their expertise and leadership back to share with the tribes?"

Return Home Stirs Emotions

Irene Wells, though a little late, did come back. She had once studied law enforcement in college, and finally came back from Portland and San Francisco to see if she could be useful among her Indian family and friends. Today, as chief judge, she heads the reservation court system.

From the back of her courtroom, I watched Judge Wells sentencing a long-haired 18-year-old on a charge of contributing to the delinquency of minors. He had taken a case of beer to a high-school picnic.

"Tom," she said, "the sentence is six months, on probation, but since you like contributing to minors, it will be six months contributing to the *advancement* of minors. You're assigned to the new juvenile-alcoholism program, as a consultant to kids in trouble. I think you have the ability and talent to be a help to this reservation instead of a nuisance."

Coming back wasn't easy, Irene told me in her office that afternoon.

"My husband and I have to fight to be Indians again. People don't really trust you if you've been away. Our son and daughter want to be Indians too; they like it here. But they have to work twice as hard, learning the language, competing in Indian costume and dance and sports. It's difficult, too, because we bring white men's habits. The kids must wash the dishes, clean their rooms, do their homework.

"But we're trying to prove you can be an Indian, a proud Indian, and still have good study habits and ambition."

Too Many Whites, Not Enough Indians

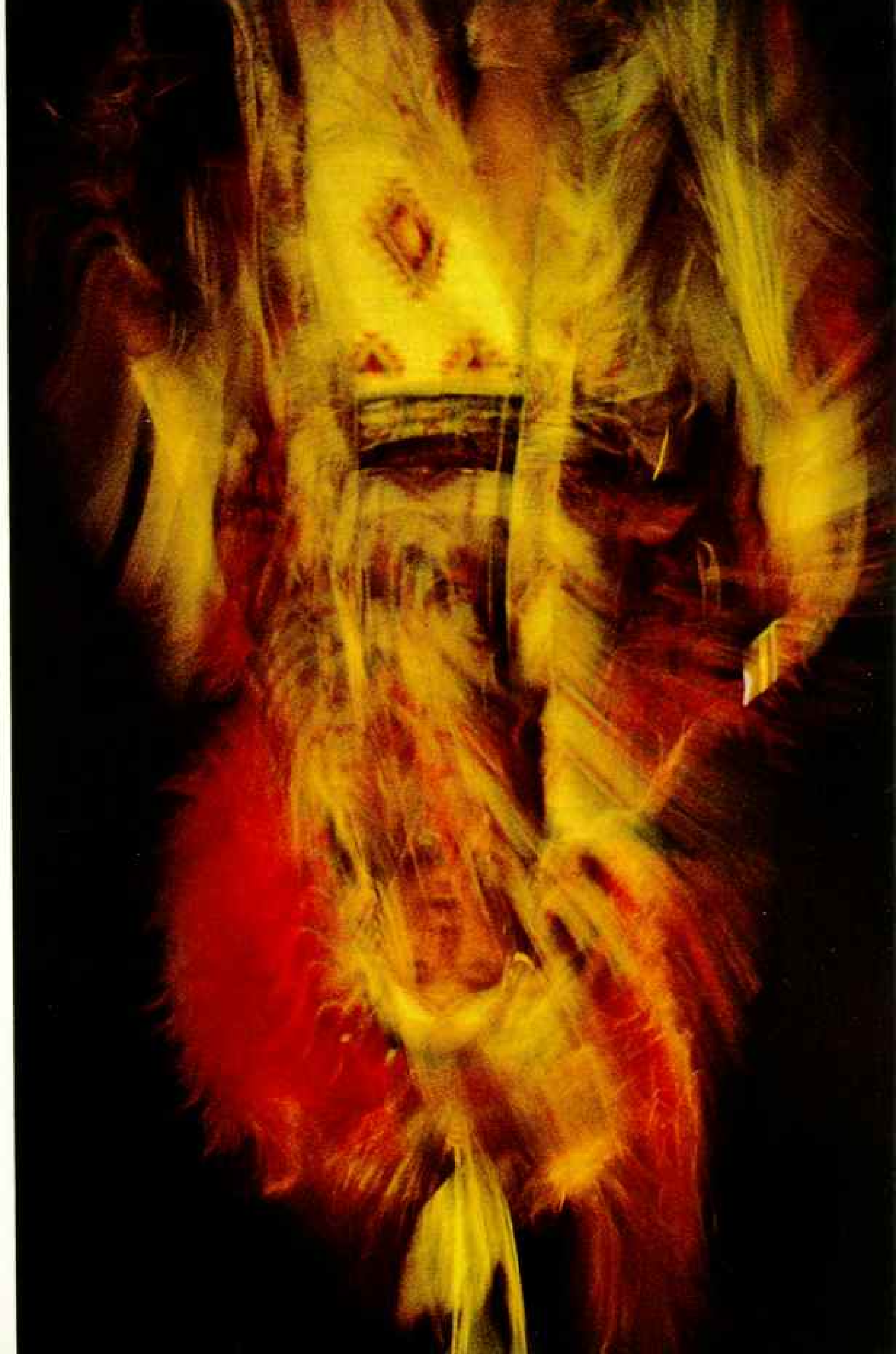
Leah Conner, an import from the Umatilla tribe, worked as a counselor in the reservation's public grade school, and now teaches high-school physical education to Indians and whites at the nearby town of Madras. For nearly a century, she says, the Bureau of Indian Affairs looked on Indians as red wards of Washington, D. C., becoming white—though the Indians persisted in seeing themselves as independent nations with their own values.

"The BIA," she told me, "is finally discovering that Indians should be allowed to be Indians, to stimulate revival of our own culture in school—through arts and crafts, costumes, song and dance, powwows and religious celebrations."

Today's children are far better off than their parents. That generation had been wrenched from their families, shorn of their braids, orphaned into boarding schools, regimented into uniform, and punished for speaking Indian languages.

"But we need Indian teachers badly," Leah emphasized. "We have only three, among 16 whites, at the grade school. But our new principal is Indian, and we're training Indian teachers' aides."

At Madras, she sees what happens when tribal youngsters are bused into largely



white junior and senior high schools. Racial catcalls and conflicts sometimes surface—on both sides. Indians hear white students sneering at them for spending their money on "Pontiacs and Pepsis." White teenagers encounter chip-on-the-shoulder Indian attitudes that occasionally make things tense.

The Indian dropout rate is high. Some Indian students do make the honor roll, though fewer than half of Warm Springs' students make it to graduation, and some tribal elders long for the day they can open their own Indian high school.

"Somebody has to help our kids before the police get them," one teacher's aide told me. "Delinquency begins when they can't keep up in school. If somebody would only care *before* they become delinquent!"

Warm Springs now operates its own foster-care program for children under 13 with severe family problems, and a center for teenagers in trouble. Both are manned by Indian parents and counselors.

Tribal police chief Jeff Sanders plays his part. His force works side by side with a juvenile director and two juvenile officers. They try to identify troubled youths before they're in too much trouble, and to plug them into the tribe's counseling program.

"It's all part of the nationwide struggle of Indians to become self-governing," one of his officers told me. "We've got a long way to go, even at Warm Springs. Still, when you look back, we've come a long way, fast."

Politics Part of the "Struggle"

The "struggle" at Warm Springs involves politics and complaints. I heard grousing about the tribal council, the BIA, the "domineering" Wasco tribe that "runs" the reservation. One Paiute ridiculed the idea of an eight-million-dollar resort. "We're inviting whites to overrun the reservation, to stare at us as creatures of curiosity."

I even heard that Warm Springs general manager Kenneth L. Smith, a Wasco, had too much white blood in his veins. Not quite true. Ken's five-sixteenths Indian blood qualifies him for tribal membership.

"But being Indian is more importantly a state of mind and heart," Ken (below) told me in the ultramodern office building where he oversees operations that employ more than a thousand people, with a payroll of 12 million dollars. A graduate in finance, he has worked for the Confederated Tribes for twenty years and is a member of the Oregon State Board of Education and a director of the Federal Reserve Bank in Portland.

KENNETH L. SMITH

Holder of many honors, Ken achieved his highest recently: consideration for the post of BIA commissioner. "My Indian grandparents adopted me when I was a year old," Ken told me. "They inspired me to get an education. 'We're in the white man's world,' they told me, 'and you're gonna have to learn to play the ball game.'

"Well, we're playing ball in both worlds at Warm Springs, developing our resources and investing in the future. We've been blessed with great leaders in the past, and we'll develop more in the years to come. We have our hang-ups, as you have seen—alcoholism and drugs, lack of initiative among the young. But we keep battling our problems, and solving some.

"I'm not sure other reservations can do what we've done in forty years. But I hope that they can, and that they will run us a good race.

"We're going to stay Indian. Reservation Indian. And as we prove ourselves worthy, and succeed financially, socially, and culturally, we will inevitably gain more responsibility, respect, and independence.

"We started American history. And we are going to stay in it till the end." □

"Like a waterfall," Warm Springs tribal policeman Jim Macy dances "to keep our traditions alive." A former U. S. champion of what Indians call fancy war dancing, he competes for prize money in longhouses all across the Northwest, wearing a self-crafted feather bustle and beaded breechclout. "Our children must never forget," he cautions, "that Indians are a very special people."

Diviner than the dolphin is nothing yet created; for indeed they were aforetime men . . . but by the devising of Dionysus they exchanged the land for the sea and put on the form of fishes.

—Oppian, *Halieutica*

The Trouble With Dolphins

By EDWARD J. LINEHAN
SENIOR ASSISTANT EDITOR

Photographs by
BILL CURTSINGER

Streaking in exhilaration, a pair of dolphins, or porpoises, swimming before a boat's bow show the verve that delights humankind. A tide of research probes the intelligence of these mammals, members of the suborder of toothed whales (foldout pages 508-10). Many people decry their deaths at the hands of fishermen, but the situation is improving.

NICHOLAS DEVORE III

FOR LONG MOMENTS in the turquoise world beneath Bahamian waters nothing moved save my spent air; with each breath a burst of pearly bubbles climbed languidly toward our other world, some thirty feet above. Absorbed in mutual contemplation, that marvelous animal and I hung face-to-face only a flipper's length apart: a man and a dolphin.

I reached out my hand, to bridge the vast gulf between us.

Gingerly (for here was a wild creature from somewhere in the surrounding sea, and that was the marvel of it)—gingerly, I touched the slim gray snout and ventured to stroke the smooth, rubbery melon, the dolphin's bulging brow. His eye narrowed, but the animal held steady; then the mouth opened, as if inviting me to match this fragile trust.

I clasped the lower jaw, across rows of sharp, hard teeth; the mouth closed to hold me lightly, yet fast. Had my hand been a mullet, now. . . .

For long moments, until he broke for the surface to breathe, we hung there in strange communion, a man and a dolphin, each of us grasping the other.

Or, perhaps more truly, trying to.

He was a sleek, gray, spotted dolphin, *Stenella plagiodon*, obviously young and male, slightly over six feet long. The divers whose companionship he sought, off the island of San Salvador, had named him Sandy. He appeared two years ago, alone, approaching dive boats warily, then more boldly. At last an engine's growl would bring him racing from a distance to fling himself in a great jubilant leap before the bow: a wild, free animal, eager to share the company of humans (pages 511-13).

No one knows why.

One hears of such dolphin behavior occasionally—at least half a dozen times in this century—and the ancients observed it too, but it remains unexplained. No one ever saw Sandy with another dolphin. Perhaps, ostracized from his herd, he sought the closest kin he could find—these other rubbery-skinned mammals, with our strange monocular faces, returning, as did primeval dolphins, to the sustenance and safety of our mother sea.

For a year Sandy swam and played with delighted divers off San Salvador and then, as abruptly as he had come, he went away. No one knows where. *(Continued on page 514)*

HOURGLASS DOLPHIN
Lagenorhynchus cruciger

FALSE KILLER WHALE
Pseudorca crassidens

COMMON DOLPHIN
Delphinus delphis

SPOTTED DOLPHIN
Stenella attenuata

SPINNER DOLPHIN
Stenella longirostris

RISSO'S DOLPHIN
Grampus griseus

COMMERSON'S DOLPHIN
Cephalorhynchus commersonii

KILLER WHALE
Orcinus orca

HECTOR'S DOLPHIN
Cephalorhynchus hectori

ROUGH-TOOTHED DOLPHIN
Steno bredanensis

INDO-PACIFIC HUMP-BACKED DOLPHIN
Sousa chinensis

FINLESS PORPOISE
Neophocaena phocaenoides

PACIFIC PILOT WHALE
Globicephala macrorhynchus

DALL'S PORPOISE
Phocoenoides dalli

BURMEISTER'S PORPOISE
Phocoena spinipinnis

SPECTACLED PORPOISE
Phocoena dioptrica

IRRAWADDY DOLPHIN
Orcaella brevirostris

HARBOR PORPOISE
Phocoena phocoena

BOUTU
Inia geoffrensis

BOTTLENOSE DOLPHIN
Tursiops truncatus

FRANCISCANA
Pontoporia blainvillei

NORTHERN RIGHT WHALE DOLPHIN
Lissodelphis borealis

WHITE FLAG DOLPHIN
Lipotes vexillifer

SOUTHERN RIGHT WHALE DOLPHIN
Lissodelphis peronii

GANGES SUSU
Platanista gangetica

TUCUXI
Sotalia fluviatilis

Dolphins, porposises, and whales shown are adult males

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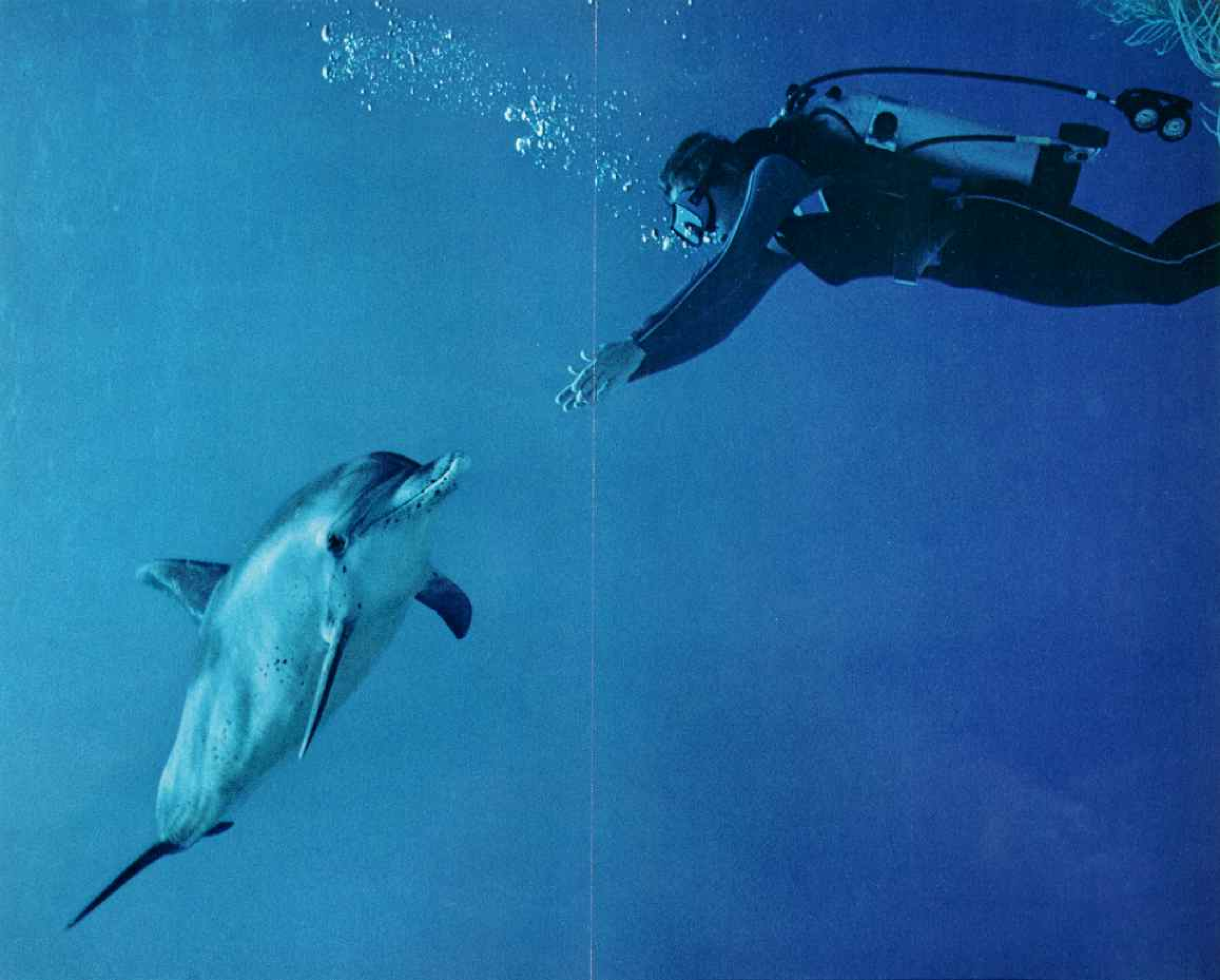
Larry Foster



AL GIDDINGS, SEA FILMS, INC.

Of his own free will, a spotted dolphin in Bahamian waters seeks out a human playmate—marine biologist Dr. Sylvia A. Earle. "He pulled my hair and gently mouthed my arm, like a puppy," she reported. For a year the dolphin, named Sandy, cavorted off San Salvador with scuba divers, including author Linehan. Such encounters enrich Plutarch's 1,900-year-old observation that the dolphin "is the only creature who loves man for his own sake."

Floating milk bar: A pilot whale nurses her calf in Hawaiian waters. Like all females in the Delphinidae family, she is equipped with muscles around her mammary glands

(Continued from page 506)

I wonder often what Sandy made of me that day. I know I have spent much time and travel since—to Atlantic and Pacific Coasts, to the Gulf of Mexico and Hawaii—attempting to understand his kind.

Along the way I met many others who shared that elusive goal. Some sought to capture dolphins, and others wanted to set them free. I talked with fishermen who rely on them for a livelihood, trainers who teach them clever tricks, veterinarians who treat their surprisingly human ills, psychologists probing their unfathomed minds. Some viewed dolphins with mystical awe, almost as little men in wet suits; others admired them as "extremely efficient predators." I found three scientists trying to communicate with them—and one who thinks they may be more intelligent than man.

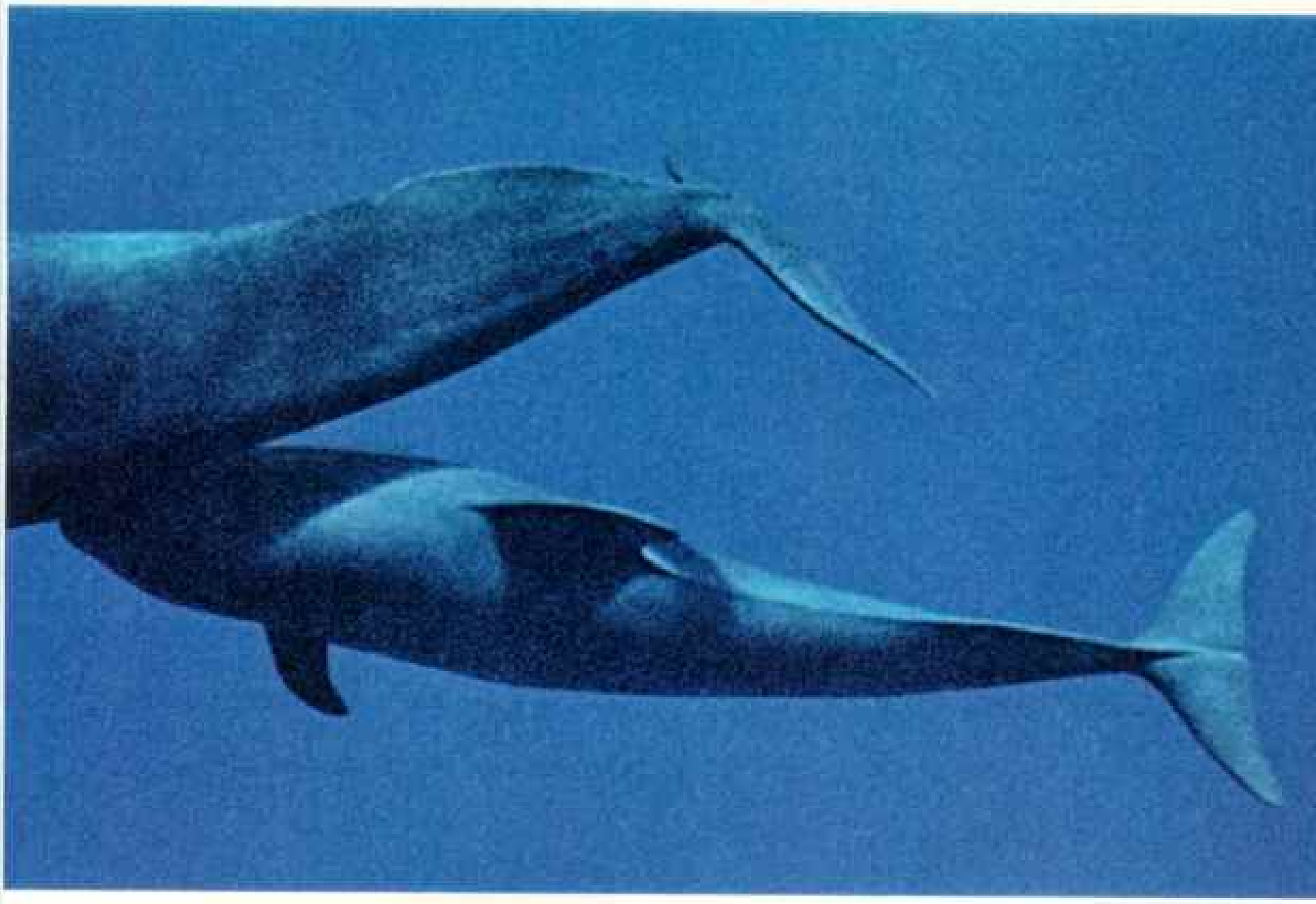
But no one, I discovered, can long remain indifferent to dolphins. These intelligent cetaceans—playful, curious, sensual, and intensely social, with an inexplicable affinity for humankind—inspire affection and, always, wonderment. The irony is that such amiable animals can generate such controversy, bitterness, and trouble.

Among the least of the problems posed by these smaller toothed whales (Odontoceti) is what to call them: dolphins or porpoises?

Purists refer to members of the distinctly snouted families Delphinidae and Platanistidae as "dolphins." They apply "porpoise" only to a few species of Phocoenidae that lack a pronounced rostrum, or beak, and have spade-shaped rather than conical teeth. Most fishermen and sailors (and some scientists too) call them all porpoises; this at least avoids confusion with the game fish also called the dolphin.

Use dolphin and porpoise interchangeably, I have finally concluded, and no one will bother to correct you.

Taxonomists calipering their bleached bones disagree about how many species of



that apparently squirt gulps of milk into her offspring's mouth. This youngster, about seven feet long and older than 6 months, probably also forages for solid food.

dolphins, or porpoises, there are—half a hundred or so. They inhabit every ocean, and even rivers in South America and Asia. In size they range from an almost dainty harbor porpoise, some five feet long, to the twenty-five-foot, seven-ton *Orcinus orca*—the killer whale (foldout pages 508-10).

Most widely seen, however, are the common dolphin (*Delphinus delphis*) that lopes like music on a ship's bow wave and the familiar "porpoises" of every oceanarium, bottlenose dolphins of the genus *Tursiops*, the ones with the irresistible built-in grins.

AS CHARMED as any 5-year-old by that accidental smile and the dolphin's sportive nature is Dr. Kenneth S. Norris, an eminent cetacean authority who is often consulted by other experts. He calls the animals porpoises, and himself simply a field biologist; I found him on the redwood-shaded campus of the University of California at Santa Cruz.

It was Ken Norris who put the stamp of scientific proof on the dolphin's astonishing ability to "see" underwater with bursts of sound.* (In 1959 he and a colleague, John Prescott, blindfolded a *Tursiops* with suction cups and found it could weave perfectly through an underwater metal maze.)

A dolphin, he told me, produces a rich variety of sounds by shifting air between nasal sacs inside the skull (pages 530-31), much as you can make a balloon squeak or hiss. Trains of high-frequency clicks focus like sonic searchlights through a "lens" of fat in the forehead; by swiftly analyzing the echoes, a dolphin can pinpoint a vitamin capsule dropped into the far end of a sizable pool.

"I think we'll find someday that they have an incredibly refined capability to form sonic images," Norris said. "It's already clear that they can 'hear' the composition and

*See "Porpoises: Our Friends in the Sea," by Robert Leslie Conly, GEOGRAPHIC, September 1966.

texture of objects around them. I suspect they can look *into* each other in eerie ways, inspecting the contours of internal air spaces." Such sensitive sonic readings, he thinks, might even inform one dolphin about another's emotional state.

Paradoxically, a dolphin has no outer ear—little more than a pinhole behind each eye. Sound travels through a thin "window" in the lower jawbone, Norris found. In those experiments he tried to fit a hood over the entire jaw of a young female bottlenose. The effort taught him something basic about porpoise personality:

"They'll try to play tricks on you, try to get away with something, act naive," he said, smiling at the recollection. "We'd put the cover on her jaw, and she'd simply back up in the tank, sit up, and shake until she got it off. Then—and this is the typically porpoise part of it—she'd pick up the cover and bring it back to us, as if to say, 'Well, that was an interesting trick. What's next?' "

Almost every porpoise trainer has tales of the dolphin's cleverness and ingenuity. Like Jim Mullen of Marine World/Africa, U.S.A., near San Francisco.

Mullen encourages his animals to tidy up their quarters by tossing them a fish for any trash they fetch from the water. He grew suspicious, though, when a big 12-year-old bottlenose named Mr. Spock began claiming one reward after another, steadily delivering soggy scraps of paper.

"It dawned on me finally that I was paying Spock an awful lot of fish for little bits of the same brown paper bag," Mullen told me. "I found he had hidden a big stash of debris down in a corner of the pool, and was tearing it off one piece at a time. Was he ever training *me!*"

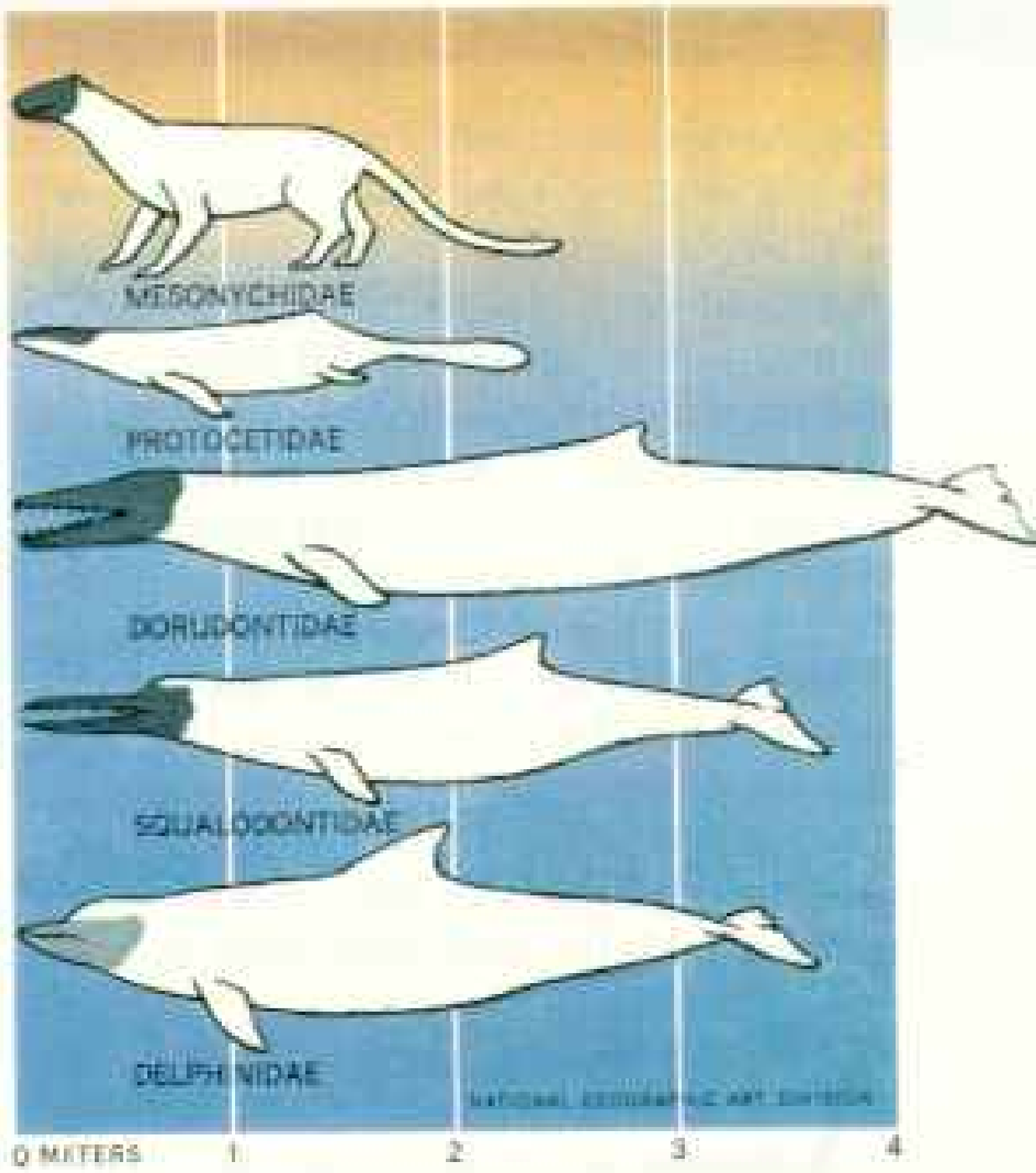
Last year Mr. Spock gained brief renown when he whimsically snatched an iron bolt from a diver working in his tank, and somehow swallowed it. After two days of unsuccessful retrieval attempts, Marine World officials finally turned to a specialist—Clifford Ray.

Ray, six feet nine inches tall, plays center for the Golden State Warriors professional basketball team. He oiled one of his endless arms and reached three feet nine inches down Mr. Spock's gullet to pluck the offending artifact from his stomach.

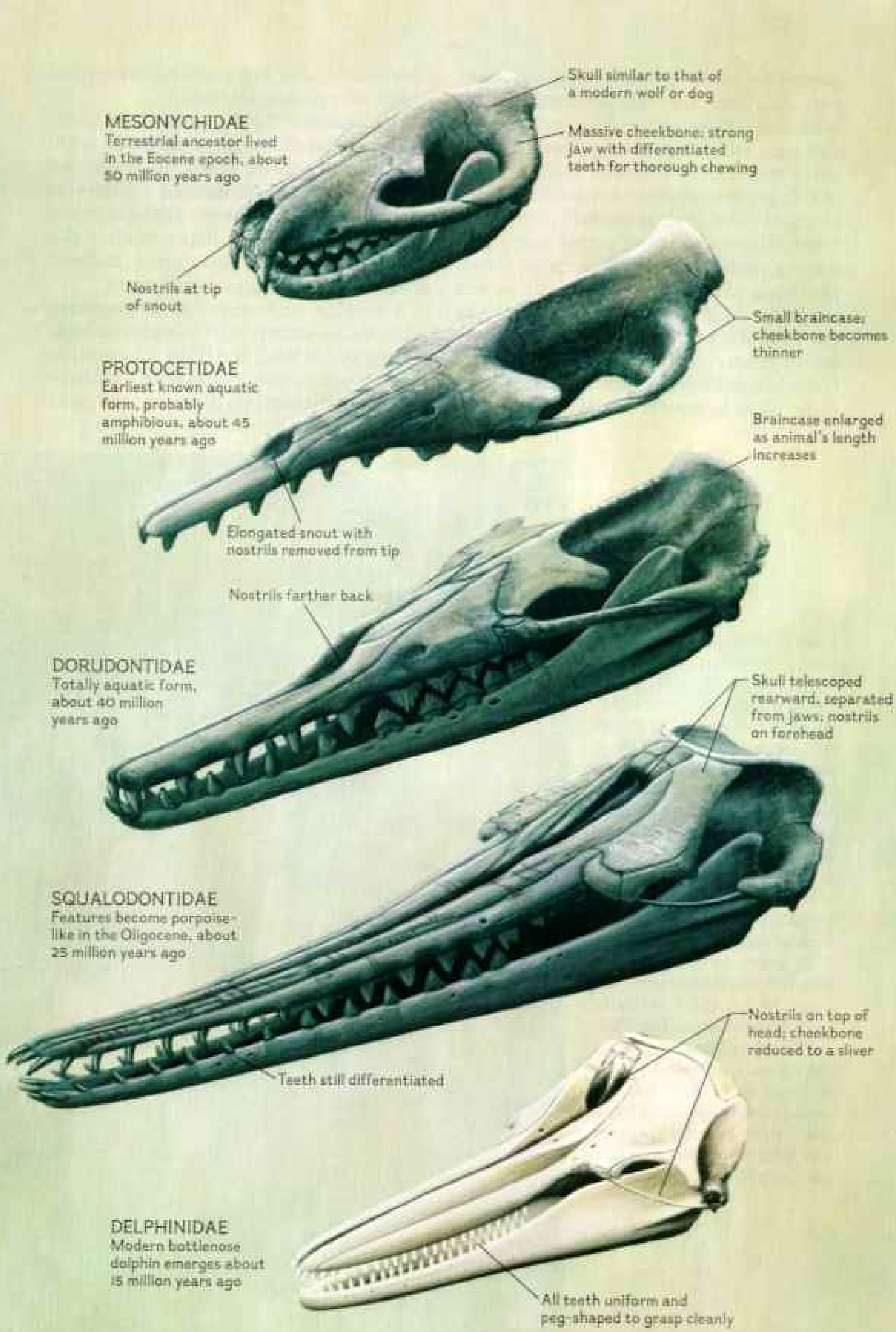
I SHOULD SAY *one* of his stomachs—a dolphin has several, like cows, goats, and sheep. Indeed, blood-serum analysis and certain behavior patterns suggest that, before sliding back into the sea some fifty million years ago, the ancestral cetacean shared dim evolutionary linkage with today's barnyard ruminants.

Dr. Sam Houston Ridgway, a distinguished research veterinarian at the U. S. Naval Ocean Systems Center (NOSC) in San Diego, offered me other parallels: "Dolphins concentrate salts in their kidneys as well as a camel," he said. "And they need only about as much sleep as a cow—maybe two or three hours a day. Curiously, they seem to be able to sleep with one eye open, and with half the brain still awake."

Dr. Ridgway, a formidable figure with a piratical black beard, has treated every sort of dolphin ailment, from pulling a tooth to mending a deep propeller gash—"like suturing an automobile tire"—to performing a hysterectomy. He showed me a respirator



Once land dwellers, porpoise ancestors gradually took to the sea. Fossil skulls show how nostrils moved rearward to aid surface breathing and teeth became uniform, adapted to grasping, not chewing.



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needed for major surgery; an anesthetized porpoise loses the reflexes required for breathing. They suffer from pneumonia, parasites, and skin problems, I learned, and stress may lead to ulcers of the stomachs. (Rx: One gallon of ground-fish-and-Maalox broth, by tube, three times daily.)

Dr. Ridgway has performed many pioneering studies, notably in porpoise diving physiology. When I spoke with him, he was tracing complex muscle-firing patterns in the animal's sound-making apparatus. A few days later, on the windy north shore of Oahu beside Kaneohe Bay, I watched other U. S. Navy scientists, at NOSC's Hawaii Laboratory, studying porpoises with more practical applications in mind.

Like sonar. "Our present electronic equipment can't match a dolphin's abilities—not by a factor of ten," said Richard Soule, a tall, easy-mannered Californian who heads the Biosystems Division of the laboratory. The Navy hopes to close this gap, he told me, with bionic sonar, modeled after the animal's natural equipment.

A dolphin emits many of its inquiring echolocation sounds at frequencies far higher than we can hear. But Navy scientists can now electronically reproduce porpoise pulses, beam them into the water, and, with

Finny windfall produces a frenzy of feeding as a dusky dolphin tears into a school of smelts off southern Argentina. A dolphin gorges itself at such banquets, aided by a large croplike compartment in its multichambered stomach. Larger species, such as false killer whales, go after heftier fish like tuna. Smaller ones may wait for nightfall to bring a blanket of crustaceans and squid floating up from the seafloor to shallower depths.

In some waters porpoises may fall prey to entrepreneurs eager to sell them to European oceanariums. For United States citizens, capturing the animals without a permit is illegal in U. S. or international waters—yet one Floridian was recently offered $50,000 to capture 40 dolphins off Costa Rica.

a computer, "stretch" the echoes down to human hearing range, allowing blindfolded divers to discriminate between two targets just as well as a porpoise.

The ultimate goal, of course, is a bionic sonar black box, and it is easy to imagine its value—to divers at night, or, say, in a torpedo-guidance system. The Navy won't discuss possible uses. But, said Dick Soule with proper restraint, "detection and classification will be very significantly advanced."

ALONGSIDE one of a dozen floating porpoise pens in Kaneohe Bay, biologist Earl Murchison, wearing a jaunty golf cap, plays an amazing game of Twenty Questions with a female bottlenose dolphin named Kae.

I listened through earphones as Earl, in a series of tests, lowered individual objects of various sizes and shapes into the water, 30 feet from Kae. Sounding an underwater tone, Earl asked the animal: "Is there anything out there?"

Kae swept the pen with her echolocating clicks. Over a background chorus of snapping shrimp, the characteristic staccato-click sound struck my ear like an audible dotted line. Satisfied, the animal turned and replied: Nudging a red ball meant "yes," and

the blue one, "no." She said yes and gulped a choice Columbia River smelt.

But Kae *really* impressed me when faced with question number two: "Is it cylindrical?"

Each time Earl lowered a cylinder of any size or proportion—short and squat or long and narrow; whether made of wood, steel, brass, plastic, or aluminum; hollow or solid—Kae sized it up with her sonar and replied correctly, "Yes." When he slipped a length of angle iron into the water, Kae disdainfully snorted a bubble from her blowhole and answered, "No." Clearly this animal now understood the *concept* of a cylinder.

"Next we may try the question, 'Is it metal or not?' " Earl explained. "Then maybe 'Is it moving?' With simple yes-and-no answers we can find out a lot about what a porpoise 'sees' with its sonar."

The Navy's interest in porpoises began in 1960, when someone wondered how they could swim so fast. Subsequent tests clocked a bottlenose at a disappointing 16 knots, and the swifter spotted dolphin at 21½ knots. To keep pace with faster vessels, they hitchhike on the bow or stern waves. "Of course dolphins may swim more *efficiently* than they should be able to in theory," said Dick Soule. "The Soviets are doing some work in this area; maybe we should be too." Conceivably, such studies could lead to improved ship-hull designs.

With him one blustery day I watched another test of a dolphin's physical limits: How deep can it dive?

Pitching uneasily a few miles outside Kaneohe Bay, our small boat unreeled a long cable, dangling an electronic pinger that sounded a steady tone 750 feet below. Some yards away a handsome dark Pacific bottlenose (*Tursiops gilli*) named Lii eyed his trainers aboard an outboard-powered rubber Zodiac. At the signal he surfed on a swell and dived, thrusting down with powerful flukes. By stopwatch, 62.5 seconds later the pinger's monotone suddenly ceased; Lii had reached those black, crushing depths and nudged the off button.

At 750 feet his flexible rib cage had collapsed, all air driven from his lungs, thus preventing nitrogen from being absorbed into the bloodstream—which helps explain why dolphins don't suffer from the bends.

Resting only briefly between dives, Lii repeated the feat half a dozen times. "We're lowering the pinger 50 feet a week to see how deep he'll go," explained Don McSheehy, who manages NOSC's deep-dive program. "We've got 2,500 feet of cable, and I think we'll use it all." (Three months later I learned that Lii had reached 1,700 feet before the experiment ended.)

All the way back to his pen Lii swam beside the rubber boat like an obedient Doberman at heel. This dependable "open-sea release" is quite crucial to any practical use of porpoises by the Navy.

On the way we passed another crew aboard a Zodiac, training a porpoise in the lime-green shallows of the bay.

I turned to Dick Soule: "What. . . ."

"Classified." He smiled serenely, gazing straight ahead.

CLASSIFIED. Ask how the U. S. Navy is *using* dolphins nowadays, and that is the inevitable reply. In two decades its scientists have published more than 175 papers on their marine-mammal research. But, predictably, the public is more captivated by what the Navy will *not* disclose.

Two stories, particularly, surface with the regularity of a dolphin coming up for air. The first, perhaps inspired by a popular novel and movie, suggests that Navy animals have been trained to carry explosive packs and blow up enemy vessels—kamikaze porpoises, so to speak.

The second is even more bizarre and chilling. Porpoises, it claims, were sent to Viet Nam trained to kill enemy frogmen with a hollow lance worn on the beak. When rammed, the story goes, the swimmers literally ballooned as a gas cartridge emptied into their vitals (thus providing even a convenient count of floating corpses).

"Nonsense!" In his Pentagon office Harris B. Stone, who is in charge of the Navy's porpoise work as director of research and development plans for the Chief of Naval Operations, flatly denied both tales.

A stocky, vigorous civilian, Mr. Stone spoke frankly. "We *have* deployed porpoises in open-ocean work," he admitted. "We are making use of their remarkable sensory capabilities. But we are not about to telegraph how and where and what they're used for

to a potential adversary by discussing it.

"The Navy," he declared, "has never used porpoises for anything that would harm either the animals or any human being. To me that 'killer dolphin' story is ludicrous. I think I can show you what started it."

He strode to a cabinet and took out what looked like a diver's knife in a black plastic sheath. In place of a blade a keen arrowlike point tipped a hollow metal shaft; the handgrip held a carbon dioxide cartridge.

"It's a dart the Navy developed to protect divers against sharks," he said. "You can now buy it in dive shops. But somebody had to make a James Bond thriller out of it!"

Yes, half a dozen Navy porpoises *were* sent to Viet Nam, he said, to test their transportability over long distances, and their adaptability—"tests you simply can't make in a laboratory." Cam Ranh Bay, a foreign, tropical environment, teemed with ships and debris; the Navy wanted to know, he continued, whether its animals could perform detection and surveillance functions under those difficult circumstances.

"We experimented with them there for about a year, then moved them to Guam—a different environment—for another year or so. Then we brought them home."

Even aside from developing porpoiselike bionic sonar, the Navy's interest in the animals continues. "What habits do they have that we can use?" said Mr. Stone speculatively. "Can we employ them to reduce the hazards to humans in diving tasks? Can we use them in search-and-rescue missions?"

However the Navy employs them, he said, it will be with the animals' interests firmly in mind. "We treat them as we do our humans. We do our absolute best to keep them healthy and well. That's common sense, when you consider what it costs to capture and train a porpoise nowadays."

It costs plenty, I learned from Mike Haslett, a lean, tanned Floridian, as we skimmed the wind-ruffled flats around Tampa Bay in his speedy workboat, just porpoise watching. (I've met no one who tires of this gentle sport.)

A tobacco-chewing former paratrooper and oceanarium manager, Mike has skillfully netted about a hundred porpoises for the Navy and various shows. "I love all animals," he said, spitting rather discreetly to leeward, "but porpoises are the top of the line!" With two brothers he has established the Marine Mammal Foundation in St. Petersburg, dedicated to dolphin research and the rescue of stranded animals. (Every year along the East and Gulf Coasts alone, hundreds of dolphins run themselves aground, and many die. Aristotle pondered the mystery centuries ago; scientists today speculate about disease, parasites, suicide, even an atavistic urge to find safety on land, but they still cannot adequately explain it.)

In 1972 Congress passed the Marine Mammals Protection Act (MMPA), making it illegal for U. S. citizens to "harass, hunt, capture, or kill" dolphins anywhere in U. S. or international waters without a permit.

"I think the day after the law was passed a black market opened up," Mike told me. "Just recently I was offered $50,000 to catch 40 animals in an illegal operation down in Costa Rica."

So widely has Flipper's engaging smile captured public *(Continued on page 528)*

Child's dream comes true as a bottlenose dolphin frolics with bathers in Shark Bay on Australia's west coast. A school of dolphins regularly visits this beach, delighting the crowd and begging treats from fishermen cleaning their catches.

BEN CROFF

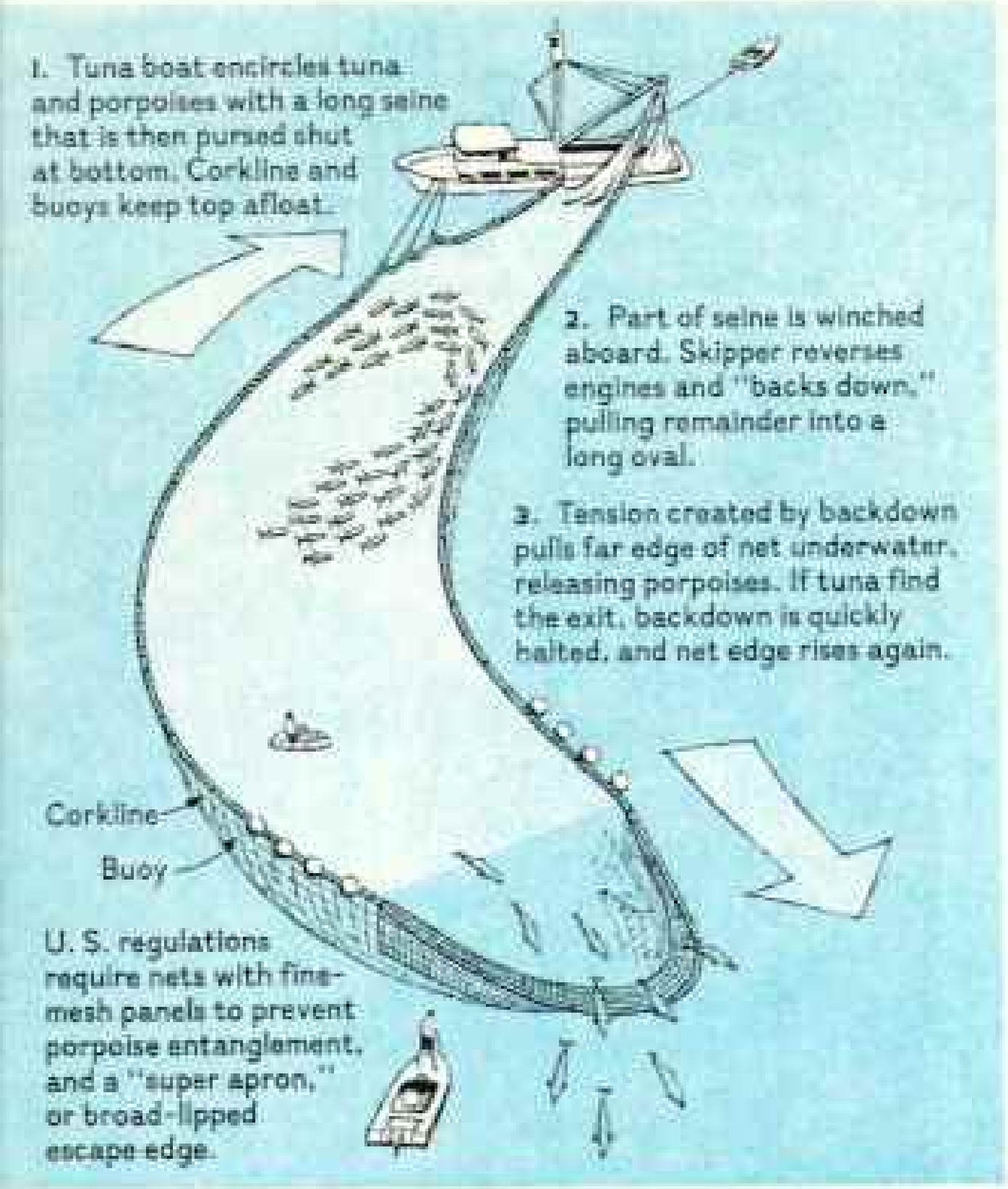
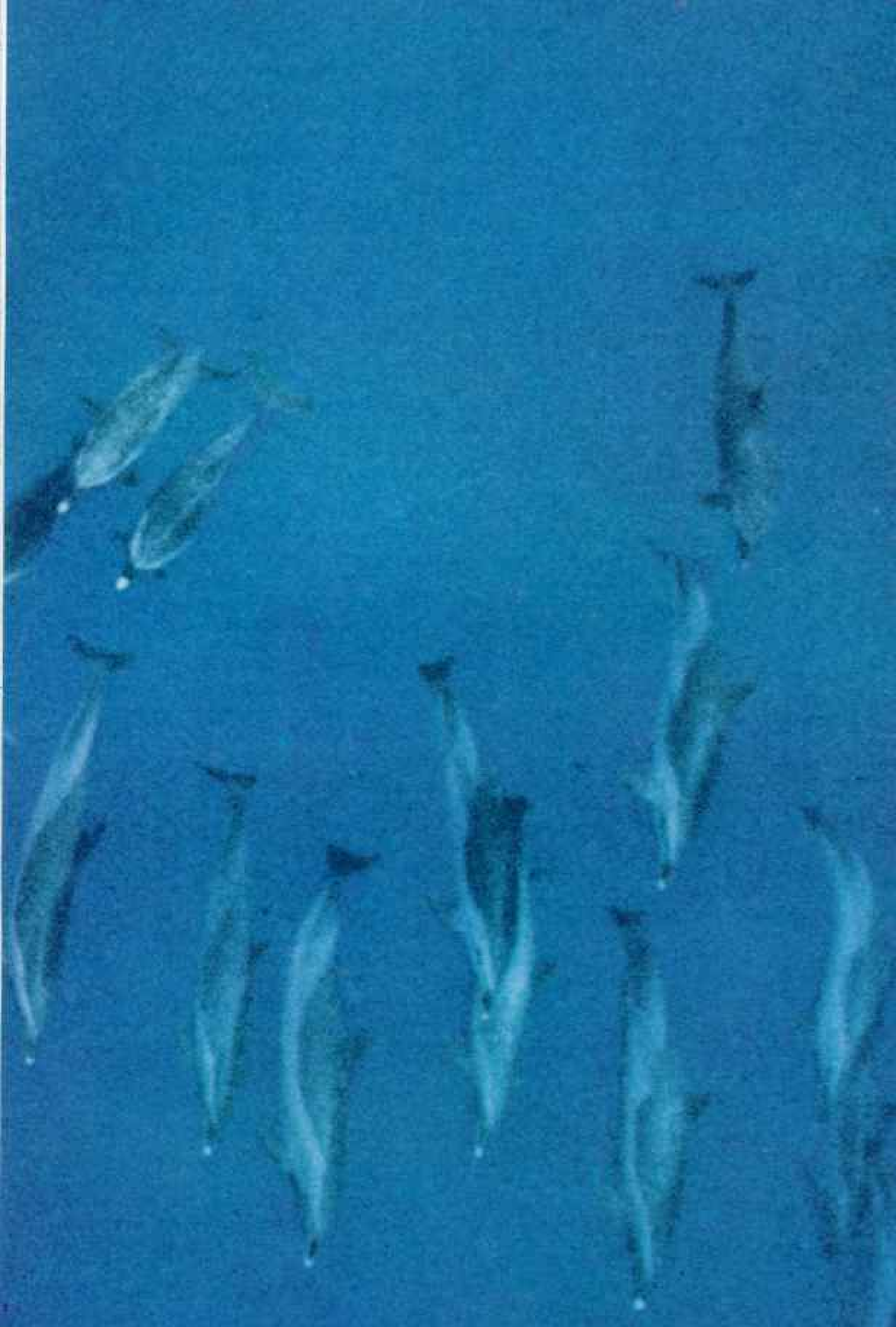


DIAGRAM BY NATIONAL GEOGRAPHIC ARTIST ROBERT C. MAGIS

Awaiting freedom, dolphins crowd a tuna net (**right**), as one escapes over the edge, at center. Because tuna often swim below dolphins, fishermen net both, then try to release the dolphins (**above**); a crewman checks for stragglers (**below**). Thousands drown annually but improved techniques have drastically reduced mortality.

BOTH BY JOSEPH A. THOMPSON, SEAVISION PRODUCTIONS

THE SEA COMES ALIVE *with sonar clicks and vocal cries from a school of Pacific spotted dolphins gliding toward azure depths off the island of Hawaii. A group at center eyes photographer Curtsinger. "They're always noisy. It's almost as if they have a well-established dictionary they use among themselves," he says.*



fancy that oceanariums around the globe can't get enough animals. There are few proficient porpoise catchers outside the U. S., and a healthy specimen fetches between $5,000 and $10,000, no questions asked, before it is even flown to Europe. A Swiss zoo recently purchased a trained *Tursiops* for $23,000, Mike said.

Considering such returns, he fears, "any mullet fisherman might be tempted to throw a net around a school of porpoises, and never mind how many he drowns."

I checked further with Charles M. Fuss, Jr., special agent in charge of the Law Enforcement Division, National Marine Fisheries Service (NMFS), in St. Petersburg. He confirmed that a lively foreign market exists. His agency, which enforces the Marine Mammals Protection Act, recently broke up a ring conspiring to capture porpoises in the Caribbean. "They were aiming to sell hundreds of animals to oceanariums in Europe, South America, and Japan, with an expected take of a couple of million dollars."

NMFS agents nipped that in the bud. Now, however, a new threat looms: One American who netted 21 bottlenose dolphins in Bahamian waters was found guilty in Key West, but an appeals court overturned the conviction on grounds the law was not specific enough.

Special agent Fuss shrugs. "We've shut down our foreign intelligence network," he told me. "We suspect a couple of people are engaged in this kind of thing right now, but we can't devote time to cases that won't stand up in court."

Unless Congress comes to the rescue again, the porpoise, it seems, will lose.

ON ANOTHER FRONT, though, the beleaguered porpoise appears at last to be winning.

A major mystery is why, in the vast reaches of the tropical eastern Pacific, big yellowfin tuna are so often found in the company of porpoises—usually spotted, spinner, or common dolphins, often found coursing the sea in herds of thousands. Experts suspect the common bond is food, but no one knows. Whatever the reason, the odd association has helped to build a billion-dollar fishing industry in the U. S.: purse seining for tuna (pages 522-4).

The idea was simple: Find a school of porpoises "carrying" tuna, herd them into a tight bunch with speedboats, drop a big seine around them and purse it shut at the bottom. Then you just winch in the net, release the porpoises, and keep the fish.

The trouble was, capricious winds, currents, or mechanical breakdowns sometimes collapsed the nets, some 400 feet deep and as long as three-quarters of a mile. Many porpoises, entangled in the mesh, suffocated and drowned.

Fishermen themselves probably didn't realize how many. But an NMFS biologist, William F. Perrin, returned from a tuna cruise, totted up mortality figures, and projected an appalling statistic: In 1966 an estimated 244,000 porpoises perished in U. S. nets alone. Over the years, quite clearly, millions of the animals have died.

Conservation groups, dismayed and angered at this apparently wanton killing, proclaimed a boycott on tuna and demanded an end to fishing "on porpoise." The MMPA permitted it to continue, but directed that steps be taken to reduce the toll to a rate "approaching zero mortality."

Stung by environmentalists' attacks, fearing for their livelihood, tuna men angrily spoke of "going foreign"—selling their vessels or changing registry to some less regulated nationality. On southern California streets bumper stickers proclaimed: "Endangered Species? San Diego Fishermen!"

That city is home port to most of the 130 U. S. tuna seiners; I found many tied along Harbor Drive. Black nets lay flaked high on their afterdecks; with glassed-in crow's nests staring empty-eyed from raked masts, the vessels resembled huge angular pelicans in repose. And like seabirds, they are formidable fishing machines.

The modern purse seiner can cost six million dollars. It's 200 feet long, carries a crew of 16, and, using advanced satellite navigation, can cruise at 15 knots for three months. On a single trip it can catch and freeze a thousand tons of tuna—worth $800 a ton—and it makes three or four trips a year.

Their headquarters—the American Tunaboat Association (ATA)—stands at 1 Tuna Lane, and is topped by a radio mast that links vessels with home port from as far away as Africa. ATA's general manager is

Seeking two-way communication, scientists attempt to teach dolphins an artificial language, using experiments patterned after those with chimpanzees and gorillas. At Marineland of Florida, graduate student William Langbauer (**right**) trains a dolphin to match a symbol on a steel square with an identical one on a magnetic blackboard. Other symbols represent actions and words for the animal to perform and identify; they will ultimately be used to communicate, he hopes.

At the Flipper Sea School on Florida's Grassy Key, trainer Carol Smith (**below**) holds two shells of different patterns. The symbol on the board tells the dolphin to pick the shell similar to the one adjacent to it. Answer: Left hand, correct.

August Felando, a highly articulate former fisherman whose skirmishes with conservationists and Congressmen may account for prematurely graying temples.

Felando spread his hands fatalistically. "We wear the black hats," he told me. "We're fighting a public-relations battle we can't possibly win. Listen—nobody *wants* to kill porpoises. The fisherman *needs* porpoises in order to make his living."

It was the tuna men themselves, he pointed out, who devised the so-called backdown maneuver and finer-mesh panels in the nets, two measures largely responsible for saving porpoise lives. The industry has also conducted "skippers' panels" to refine porpoise-rescue techniques, and has dedicated several of the best vessels to scientific-research cruises aimed at finding answers to the tuna-porpoise problem.

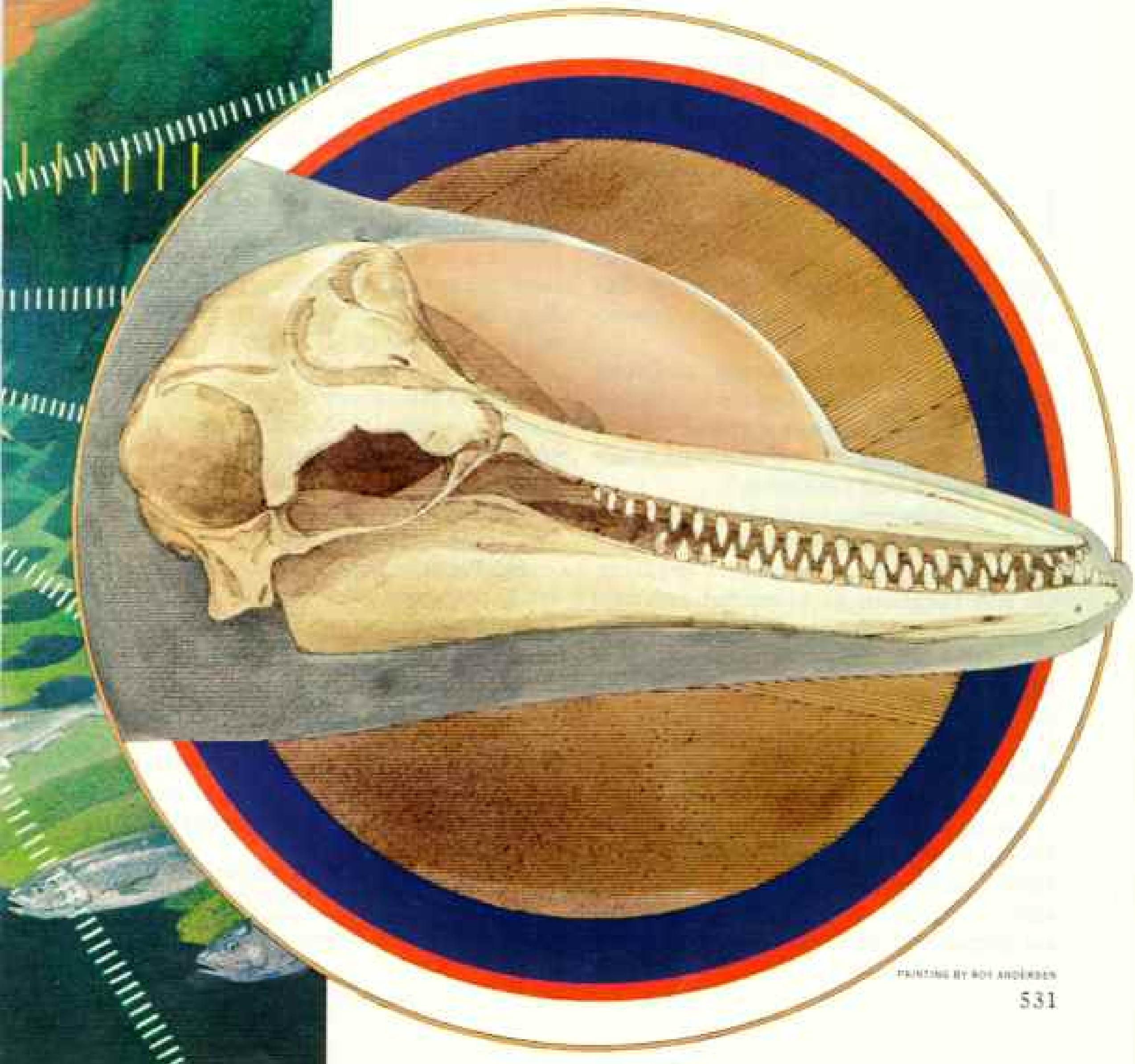
Those studies, with rapid modification of gear and techniques and regulations imposed by the National Marine Fisheries Service, demonstrated that we can have our tuna and porpoises too. The NMFS established a quota of 52,000 mortalities in 1978; it will decline to 31,000 next year. As it turned out, the 1978 toll was only 15,000.

Does this mean the tuna-porpoise troubles are over? Not yet. Some environmentalists believe a single dead animal is one too many. Fishermen, who now release 99.9 percent of the porpoises they net, doubt that

Porpoise sonar: the incredible sound machine

A MARAUDING SHARK cruises the depths. A school of mullet meanders far ahead. On the surface a boat's hull slides through the waves. Long before it can see such objects, the dolphin detects them. It has no sense of smell. It relies instead on a skull adapted to sending and receiving sound signals, and on a large and complex brain to interpret them.

A swimming dolphin emits bursts of split-second clicks that resemble, to eavesdropping scientists, a rusty hinge's creaking. Some believe the animal forces tough nasal plugs against bony edges in its skull to produce the clicks, which may be focused by passing through fatty tissue in the forehead. When the clicks strike a target, they return and may be transmitted to the dolphin's brain through its jaw and throat. Thus it computes the object's distance, direction, speed, size, and configuration.



PRINTING BY ROY ANDERSEN

they can ever meet a zero-mortality goal. And anytime they exceed the steadily declining quota, the issue will flare again.

Yet, in the long run, the canny porpoise itself may solve the problem.

In the skipper's stateroom aboard the gleaming thousand-tonner *Raffaello*, Capt. George Sousa—a third-generation fisherman—pointed out a significant trend.

"For years now we've been learning how to save porpoises," he said. "But the porpoises have been learning too. Nowadays when you put a school in a net, they just lie there calmly, saying, 'Hey, take it easy, fellas—it's just a routine we gotta go through.' They've been there before. But they're getting harder to wrap all the time.

"There's one bunch of 'spotters' off Costa Rica we call 'The Untouchables.' They're educated to speedboats now. When you try to lay your net around them, they dive right under it, taking the fish with them.

"Who knows? Unless we find some better way, maybe in five years it just won't be economical to fish on porpoise anymore."

FISHERMAN'S ALLY, a friend to man—through centuries the dolphin has inspired tales of assistance to humans by helping swimmers in distress, or driving off sharks, thought to be the dolphins' mortal enemy. The evidence, however, is far from clear.

True, the animals sometimes assist their young or injured to the surface to breathe. "It even happens between species," says biologist Ken Norris. "I've seen a pilot whale helping a sick Dall's porpoise."

But skeptics point out that similar "assistance" toward humans might be simply a form of play, or even aggressive behavior. On rare occasions an exhausted swimmer has reported being nudged toward shore; but as one expert points out, we're not likely to hear from any who might have been pushed out to sea. (During World War II downed U. S. airmen once had to drive away a dolphin that was enthusiastically shoving their raft toward a Japanese-held beach.)

Are sharks and porpoises deadly enemies? Forrest G. Wood, a senior scientist with the Navy and longtime observer of porpoises, sums it up this way: "Sometimes sharks eat porpoises. Sometimes porpoises attack sharks. Sometimes the two ignore each other completely. And that's all you can safely say about it."

It would be fascinating, of course, to hear what porpoises might have to say about it—if anything. They whistle and chirp and squeak and click and groan . . . but do they have a language of their own?

The dolphin's sonic repertoire appears to include emotional signals (one rising-falling birdlike cry almost certainly means "Help!") and even individual "signature" calls: "I am *Joe* Dolphin." But most scientists I spoke to believe, like behaviorist and veteran trainer Karen Pryor, that the whistle of the porpoise is "closer to a human frown, or sigh, or giggle, than to a human word."

Broadly speaking, language implies an ability to convey thoughts by using arbitrary symbols—words—in proper syntax. That ability, science once told us, resides only in the human species.

Man's self-definition, however, once so comfortably clear and sharp, has recently crumbled around the edges. Wild chimpanzees demonstrated that the talent for using tools does not, in itself, spell *Homo sapiens*.* And the age-old thought that only man can *have* a thought has lately fallen under scientific sniper fire. And now, electrifyingly, tame chimps and a charming gorilla named Koko have shown that other species besides our own can *learn* a language.†

So it may be with dolphins.

Beside a sun-splashed training pool at the country's original oceanarium, Marineland, near St. Augustine, Florida, I watched a graduate student, William Langbauer, and several associates give a pair of porpoises a language lesson (page 529).

The Porpoise Language Acquisition Project is patterned after experiments by Dr. David Premack, of the University of Pennsylvania, with a chimp named Sarah. Arbitrary black-and-white symbols are painted on metal rectangles designed to cling to a submerged magnetic board.

Langbauer was teaching a bottlenose named Snoopy to match identical symbols. Using his snout with a juggler's ease,

*See "My Life Among Wild Chimpanzees," by Jane Goodall, NATIONAL GEOGRAPHIC, August 1963.

†Francine Patterson recounted her "Conversations With a Gorilla" in the October 1978 GEOGRAPHIC.

DAVID DOUBILET

Kid stuff for a dolphin impresses U. S. Navy researchers in Hawaii, who found that their student, Heptuna, could detect this three-inch water-filled steel sphere at a distance of about 140 yards. Their goal: to develop a sonar system as effective as the dolphin's, which is about ten times better than their present equipment.

Snoopy maneuvered the metal symbol into place. But he and his sleek gray pool mate, Betty, were a long way from conversing with their teacher. These are trials that the porpoises must master before they can begin to form a vocabulary.

"We've spent six months getting this far," Bill told me. "But it's a two-way street. Eventually they'll be manipulating these same symbols to talk back to us."

How long might that take?

"If they understand the syntax of a two-word sentence in another six months, we'll be making good progress." He smiled. "Things should move much faster then."

THINGS HAD MOVED all too fast in a similar project some 5,000 miles away at a marine laboratory on the Honolulu waterfront. As we talked, Dr. Louis M. Herman, professor of psychology at the University of Hawaii, ruefully regarded a pair of empty concrete tanks (page 539). He is known as a cool and disciplined scientist, but I sensed at one point that he might be close to tears.

He summed up his work over the past decade with two *Tursiops* named Puka and Kea; studies dealing largely with vision, hearing, learning, intelligence, and memory. Puzzlingly, a dolphin can see both in and out of water equally well. And in tests of its auditory memory—remembering a specific tone—a dolphin easily outperformed another highly acoustical animal, man.

But most exciting to Dr. Herman and his students was Kea's relatively swift grasp of a 12-word sonic language. "We might have extended her vocabulary easily to fifty words or more," the bearded, sunburned scientist said. "She was showing comprehension of simple sentences—'Fetch the ball,' for example, or 'Touch the ring.' The next step was two-way communication."

DAVID DOUBILET (ABOVE AND UPPER LEFT) AND NAVAL OCEAN SYSTEMS CENTER, KANEOHE, HAWAII

Run silent, run deep? But how deep? Scientists at the Naval Ocean Systems Center in Hawaii seek an answer. Eager to work, Lii, a Pacific bottlenose dolphin, willingly accompanies a boat to a test site in the open sea (**above**). As a first step, trainers suspend a pinging pressure sensor from the boat and teach the dolphin to locate it and butt a switch on its end. That stops the pinging, signaling "mission accomplished" to those on board; it also triggers a camera and a strobe mounted on a bracket above the sensor. Lii learns the trick at a depth of 50 feet (**above, left**). Down, down, down goes the sensor, week after week, with Lii right behind. Like a phantom at 1,550 feet, Lii takes his own picture (**left**). Tremendous pressure has collapsed his flexible rib cage, an attribute that probably prevents the bends, a danger for human divers.

Are dolphins being turned into secret weapons? The Navy scoffs at allegations of "kamikaze porpoises" trained to carry explosives and blow up enemy submarines, but admits it tested their surveillance and detection abilities in Viet Nam's Cam Ranh Bay in the early 1970's.

And that in turn might yield some clues to an even deeper puzzle: How did human language itself evolve?

That next step never came. Showing me around, Dr. Herman paused before a blackboard. It still bore a message chalked there months earlier, preserved bitterly like a wartime ruin: WENT SURFIN'—KENNY, PUKA, STEVE AND KEA. ALOHA.

Late one night two former attendants, Kenneth LeVasseur and Steven Sipman, had loaded the dolphins into a van and released them into the open ocean.

Dr. Herman was convinced that his animals were dead. They were Atlantic dolphins, and had been hand-fed for more than eight years. It was unlikely, he felt, that their Hawaiian cousins would accept them, and without the security of a herd they might be easy prey for sharks.

He did see Kea again soon after her release in Oahu's Yokohama Bay. Efforts to recapture her failed, for ironically she had been taught to avoid a net, but for two days and nights someone remained in the water with her. "She came to me, whistling excitedly," Dr. Herman related. "I realized how strange this new place must be for her, how frightening. One of her eyes had been injured; it was completely closed. But I felt she was comforted by my presence."

Time and again the dolphin circled him, swam out to sea, and came back. But then, midway through the second night, she failed to return.

"I knew I'd never see her again," he said, in a voice that I could barely hear.

Not far away, in a small apartment near Punchbowl Crater, I found a man who was equally moved by Kea's release.

"It was very emotional—really beautiful," said Kenneth LeVasseur, his eyes gleaming. "We had the Milky Way directly overhead, and a full moon over the mountains. . . . A beautiful experience. We were giving them what every animal or person truly deserves in life, his own freedom!"

His beautiful experience cost the athletic, 26-year-old dolphin enthusiast a six-month jail sentence for grand theft. He was free pending an appeal.

Kea and Puka, he declared, had been frustrated by repetitious experiments. "They're like humans in dolphin suits; they're *akamai*—smart, really together."

Dr. Herman, he said, had sometimes removed the dolphins' toys and deprived them of human swimming company. "All these scientists are businessmen, slaveholders. We've formed an organization called

Bloody war for economic survival dooms about a thousand bottlenose dolphins and false killer whales, herded ashore and clubbed to death by fishermen of Iki Island in Japan. The fishermen say the act was one of desperation—they lose more than 30 million dollars a year because the animals compete with them in catching cuttlefish and yellowtail.

The incident last year triggered an international storm of protest by preservationists. Japanese researchers hope to drive the dolphins from fishing grounds by alarming them with their own distress calls broadcast underwater, as well as the voice of a dolphin predator, the killer whale.

ASAHI SHIMBUN

FREED—Foundation for the Release of Every Enslaved Dolphin."

And so a pair of dolphins innocently swam into another developing storm. During LeVasseur's trial, Greenpeace, the antiwhaling organization, issued a "Declaration of Dolphin Rights." A New Jersey law professor demanded to know "by what privilege did we put those dolphins in the tank in the first place?"

Some advocates of this growing cause—animal rights—turned for support to a pioneer dolphin researcher, Dr. John C. Lilly. After efforts to teach dolphins to speak English in the 1960's, he had released his animals because he "no longer wanted to run a concentration camp for my friends."

The animal rightists must have found his measured reply disappointing: "If the proponents of freeing captive dolphins have their way, by law or otherwise, proper scientific research will cease."

JOHN CUNNINGHAM LILLY, M.D., is a neurophysiologist and a psychoanalyst and a controversy all by himself.

No one in the world is more widely identified with dolphins. Indeed, one fancifully inclined might read his almost mystical empathy with them in his visage alone: A strong straight nose suggests a dolphin's rostrum; his hair (bottlenose gray) sweeps back from a prominent forehead. A faint, corners-of-the-mouth smile and deep intelligence pooled behind metal-rimmed glasses complete a striking parallel.

Dr. Lilly points out that a *Tursiops* brain weighs about 1,700 grams; that of a human, about 1,450. More significant, he says, are the dolphin's unusually large "silent associational areas"—those heavily fissured cortical regions where intellectual capacity such as language presumably resides. And, unlike many of his scientific colleagues, Dr. Lilly does not doubt that dolphins possess an elaborate language.

I first met him at the old Hawaiian whaling port of Lahaina, conducting a seminar for cetacean admirers from many walks of life. The setting was flawless, for here the gentle humpback whales come each winter to breed, and from time to time in the glinting channel a pale-flippered giant surfaced to emit a steamy sigh.*

At the workshop Dr. Lilly acknowledged his debt to oceanariums: "Without them we wouldn't know anything about dolphins." Still, he suggested, the animals should be held captive no more than a year at a time. Oceanariums should develop into interspecies schools, where humans and cetaceans can learn from one another.

How? Without a hint of levity he proposed equipping dolphin tanks with telephones, and interconnecting oceanariums and buoyed stations at sea via satellite. We could then listen in while captives conversed with their relatives in the wild.

"And when we get our communications equipment going," he summed up matter-of-factly, "people could talk to the dolphins themselves via telephone."

The equipment is being assembled in the laboratory of the Human/Dolphin Foundation, set behind his home in a canyon high above Malibu, California. The foundation is Lilly's brainchild, and its trustees range across a spectrum of talents: John himself, the scientist; his lovely artist-writer wife, Toni; a distinguished actor, Burgess Meredith; a businessman-poet, Victor DiSuvero; and a female surfer, Georgia Tanner.

Keystone of the foundation is Project JANUS: Lilly's renewed effort at interspecies communication after a lapse of several years. Janus (whence "January") was the Roman god of gates and doorways and new beginnings. And like the deity his JANUS (Joint Analog Numerical Understanding System) will have two faces: one human, in air; the other delphinic, underwater.

Onto a glowing green computer screen a young researcher named Dennis Kastner was keyboarding abstruse equations. "He's designing part of the equipment JANUS will use," Dr. Lilly explained.

When completed, the array will enable man and dolphin, each in his own element, to exchange precise sounds adjusted to their comfortable hearing range. Once both sides have learned to use a code of 64 sounds, communication will be rapid, he is confident.

One early objective will be to see if an animal can master simple arithmetic. They are so easily bored, he told me, that "you have to

*See the articles on humpback whales by Sylvia A. Earle and Roger Payne in the January 1979 NATIONAL GEOGRAPHIC.

think in terms of complex puzzles or you'll never get a dolphin to do anything."

After tests in an oceanarium, he hopes to take JANUS to sea—"say, the Bahamas or Florida, where dolphins live in shallow water. We might set up the apparatus on a float, or link the hydrophone and speaker by radio to a shore station. I know we can interest wild dolphins in communicating."

And suppose JANUS does pierce that tantalizing barrier and John Lilly finally meets that long-sought alien mind—what then? What do you say after you say "hello"?

He thought. He stared somewhere, seeing something I could not.

"They've been around for an estimated 25 million years with a brain size equal to and later greater than ours," he replied. "I want to find out if they have sagas, teaching stories, histories. It will take a lot of work, of course, before we get to the point where they can tell us stories we can understand.

"I'd like to know, too, if they have interspecies languages; can an *Orca* talk to a *Tursiops?* We might serve as a bridge between species, you know." The corners of his mouth turned up ever so slightly more.

A dolphin dilemma rages in Hawaii. Dr. Louis M. Herman, director of the Kewalo Basin Dolphin Laboratory, stands in an empty tank, where he once taught two Atlantic bottlenose dolphins a sonic language, using computer-generated electronic sounds. On May 29, 1977, two former lab attendants trucked the animals to the open sea and released them. One of the men, Kenneth LeVasseur, who was sentenced to a six-month jail term for his part in the action, criticized laboratory conditions and claimed humans have no right "to hold intelligent, feeling beings like dolphins in captivity." The trial of his companion, Steven Sipman, awaits the outcome of an appeal by LeVasseur. Dr. Herman, who believes the dolphins perished after release, has now replaced the two dolphins and resumed his research. "I feel we've always attempted to provide a healthy and stimulating physical and psychological environment," he says.

"That's a human, arrogant position, isn't it? They may laugh at us."

Then again they may not. It depends on whether you believe, like John Lilly, that dolphins are "quite as intelligent, quite as ethical, quite as sentient as humans."

The final trouble with dolphins is, nobody really knows. But, as Navy biophysicist C. Scott Johnson cogently puts it, "The guy on the street *wants* to believe these animals are as smart as he is. If you tell him it isn't so, he wants to punch you in the nose."

Since I gazed into Sandy's half-closed eye (was that apprehension, or a droll wink?) more than a year ago, I have been asking the experts what they think.

Most told me there is simply no way to measure a dolphin's brainpower. But from those brave enough to venture a guess, I offer the following:

- Trainer Jim Mullen: "I have to gauge their intelligence on a level with our own."
- Psychologist Louis M. Herman: "They are extremely flexible in what they can learn. I think we could probably teach a dolphin to do things at a level comparable to that of a chimpanzee. But one of the things we've learned is that certain questions, like the comparative intelligence of animals, may not be worth asking."
- Veterinarian Sam Ridgway: "I've been working with them every day for 15 years, and I still can't tell you where they fit—I guess somewhere in the neighborhood of the smarter animals like pigs, dogs, baboons, and chimpanzees."
- Trainer Karen Pryor: "I agree with the idea that they're between the dog and the chimpanzee, and closer to the chimpanzee. When you look at what chimps can do, that's quite a compliment."
- Porpoise catcher Mike Haslett: "I have to say I think a dog is as smart."

Take your choice; I'd rather not say what I think. I'm as fond of dolphins as anyone, but I'm not looking for a punch in the nose. □

Porpoise with a purpose: Springing high off Hawaii, a spotted dolphin tries to dislodge a remora, a scavenger fish, attached to its belly by a suction disk. It made dozens of such leaps, reflecting resourcefulness—and a free spirit.

KILLER WHALE

THE MORNING broke clear and calm as those aboard the research vessel *Sea World* began another day of tagging swordfish for a migration study. The gentle breeze and strong sunlight set the seas off the tip of Baja California sparkling with lazy undulations. There were no clues to the raw violence that would shortly be witnessed by those on board: Milton C. Shedd, owner of the boat and chairman of the board of Hubbs-Sea World Research Institute, San Diego; Capt. Robert Vile and two crew members; photographer Robert French; and two guests.

About 1 p.m. Shedd spied a patch of water whipped white by frenzied thrashing. Suspecting killer whales, Shedd alerted a spotter plane that was aiding the swordfish study. After the pilot confirmed Shedd's hunch, the boat headed for the area and found something rarely seen and apparently never before photographed—a group of supremely efficient predators attacking one of the most massive creatures that has ever

ATTACK!

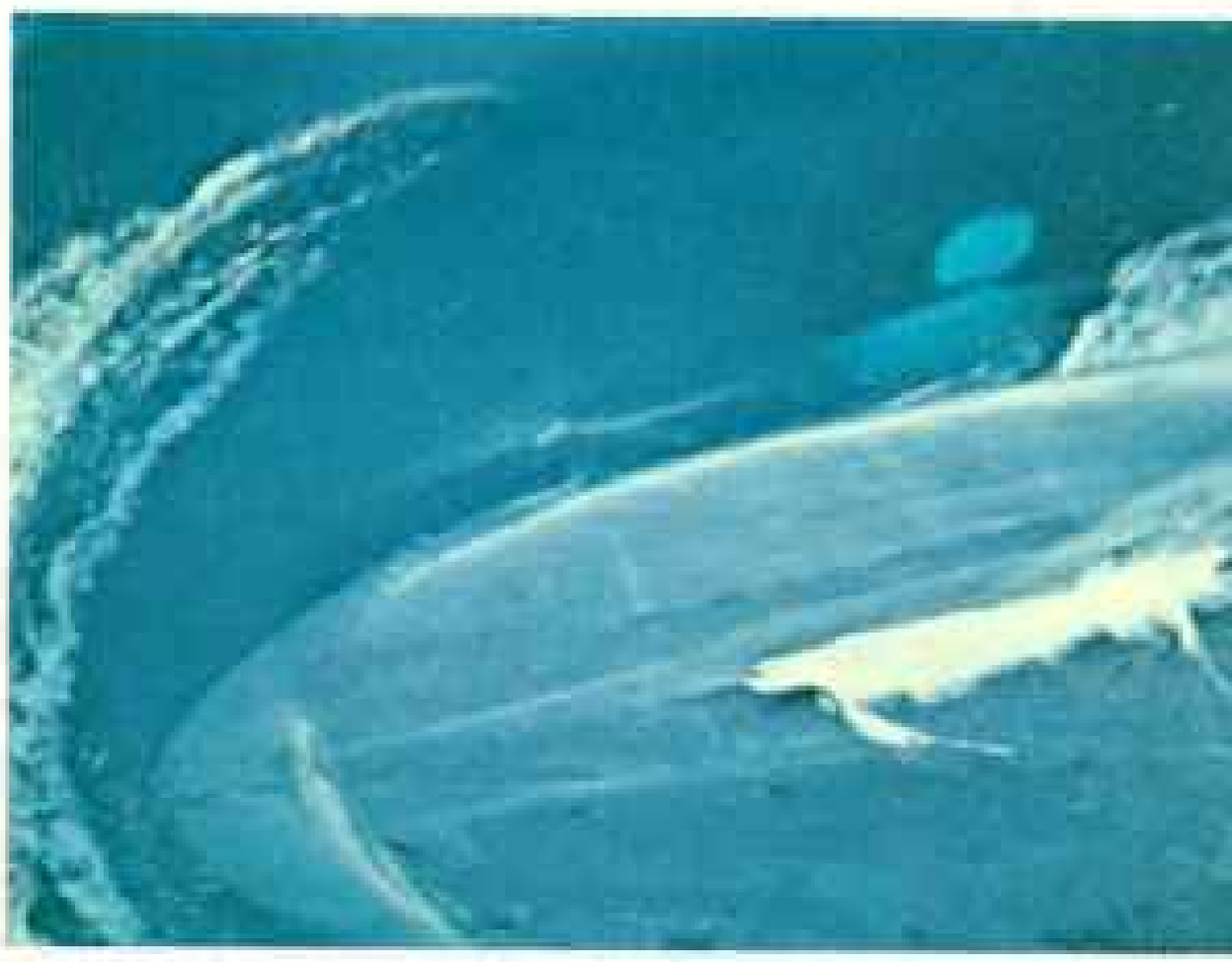
Text by CLIFF TARPY
NATIONAL GEOGRAPHIC STAFF

ROBERT VILE © SEA WORLD, INC., 1978

lived. About thirty killer whales were assaulting a young, sixty-foot blue whale. The relentless pack stripped away flesh and blubber, piece by piece, as the leviathan tried to flee, trailing a river of blood. Both movie and still cameras were close at hand to record the astonishing sight.

Some might think killer whales, tame and playful in captivity, unfairly named. But in their habitat, killer whales do kill. The predators exhibited distinct divisions of labor. Some flanked the blue on either side, as if herding it (**above**). Two others went ahead and two stayed behind to foil any escape attempts. One group seemed intent on keeping the blue underwater to hinder its breathing. Another phalanx swam beneath its belly to make sure it didn't dive out of reach. The big whale's dorsal fin had been chewed off and its tail flukes shredded, impairing its movement. The dominant bulls led forays to pull off huge chunks of flesh.

The attack continued until early evening. *Sea World*, covering nearly twenty miles,



ROBERT YALE (ABOVE, LEFT) AND ROBERT FRENCH © SEA WORLD, INC., 1976

followed the struggle for five hours. But its total duration is unknown since the spectacle was well under way when discovered. When the blue bared its back above the water, bloodied white blubber showed where its dorsal fin had been (**above left**). The movie camera, peering through the clear water, caught an attacker peeling off a strip of flesh as it glided toward the prey's nose (**top right**). That long, ragged wound became more distinct when the blue surfaced (**bottom right**). One gaping cavity dug in the big whale's side was estimated at more than six feet square (**left**).

Around 6 p.m. the attack came to a halt—suddenly and mysteriously. First the killers toward the rear slowed down. Then those toward the front turned back, and they all swam away. Why? Hubbs-Sea World director William E. Evans says the killers may have been taking a break to allow the blue to weaken further before renewing the attack. Or they could have been diverted by another, less demanding feeding opportunity. Or they might have eaten their fill. More may be learned when Sea World completes its editing and study of the film. Probably mortally wounded, the blue whale—the sea's mightiest creature, but not its deadliest force—swam slowly on. □

OLD PRAGUE IN WINTER

By PETER T. WHITE
NATIONAL GEOGRAPHIC SENIOR WRITER

Photographs by NATHAN BENN

I'LL NEVER FORGET the lady with the ten-foot pole. How at dusk she walked briskly with her dog on the cobblestones and periodically paused, lifted her pole which had a hook on it, and with a little pull turned on another gas lamp. Softly the glow would spread on her upraised face in the falling snow.

"I used to be a nurse, now I am a pensioner," she told me. "It is good to be useful. At six tomorrow morning we go out again to turn them off."

She was playing her part on the gigantic stage set that is old Prague—the capital of Czechoslovakia in the heart of central Europe, said to be unforgettable to all who come here. Slender Gothic spires and splendidly squat baroque facades right and left; at center stage, a many-arched sandstone bridge across the Vltava River, with medieval fortification towers at each end and between them a 1,700-foot-long gallery of sculptured saints, passionate and larger than life. On a hill above it all, the Castle. . . .

As a Czech writer put it, Prague will pop back into your mind "with pictures taken not by a camera but by your own surprised and enchanted eyes."

"But you should have come in spring." I heard this often—that this town is at its most sensuous when the chestnuts bloom white and pink amid exuberant greenery, when the gardens of many palaces are fragrant with lilacs.

Yet it is also true, so my Czech acquaintances would agree, that old Prague exerts its fascination most profoundly in winter. I could sense why. Muted reds of roof tiles, the soft yellows of great vistas, the crooked lanes seeming to beckon and whisper—all bore a wintry touch of gray that deepened the mood of mystery, compelling reflection beyond what meets the eyes.

"You feel something strong that won't let you go," said a painter. "You feel the great past, the history. . . ."

Tourist brochures spelled it out in Czech and Russian, in German, French, and English. Over the past thousand years—from the beginnings of the history of the Czech tribes and of their kingdom of Bohemia to today's Czechoslovak Socialist Republic—Prague has provided the setting for key episodes in some of the most fateful struggles in the Western world. Slavs versus Germans. Catholics versus Protestants. Communism versus capitalism. And relatively recently, within Communism itself. . . .

Bride of tradition—in a city wedded to preserving its past—enters Prague's Old Town Hall for her civil ceremony. Despite a tortured history of religious wars, political strife, and German occupation during World War II, a historic core of three square miles of Gothic and baroque buildings survives as a focus of national pride and home to 75,000.

Soft beacons of a slumbering city, gas lamps of Lesser Town are lit by Marie Chalupová. In another bow to the past, the Charles Bridge (**right**) has been closed to motor vehicles. Graced by thirty statues, the bridge was built in the 14th century by the monarch who as Charles IV made Prague seat of the Holy Roman Empire.

But that's not yet history, it's politics—to stay away from unless one is willing to take considerable risks, as did St. Jan Nepomuk, a priest of 14th-century Prague whose statue decorates the great sandstone bridge.

Bronze plaques relate that he was thrown off the bridge in a sack because he wouldn't tell the king what the queen had said in the confessional. "The real reason," a guide told me, "was a disagreement with the king. You might say he got a bit too interested in politics."

That would certainly not happen to me, I replied, not with so much else to intrigue me in the daily life of wintry Prague.

Hockey, for one thing. Czechs are world class, and I watched the heroes of Sparta, the Prague team, frustrate provincial opposition with many a crushing *bodyček*. What was the crowd screaming at the referee? *Vůl! Mrkev!* Meaning "Ox!" "Carrot!"

When not up to their ears in hockey, lots of people were having a ball. The hunters, the gardeners, and the municipal transit

workers, the symphony musicians and the army; every factory, school, and association (pages 558-59). On Thursday, Friday, and Saturday evenings you'd see couples at streetcar stops—she in boots and long dress, with a plastic bag for her dancing shoes.

And how they danced! Mazurkas and waltzes, the czardas and that bouncy Czech concoction first presented to the fashionable world in Prague in 1835, the polka. Also new things from America; a band promised *kauntri bit*. Ah, country beat!

My curiosity focused above all on what makes Prague stand out among the picturesque capitals of Europe. Few can claim such vast concentrations of old buildings, many still appearing as they did in the 17th and 18th centuries. And none can boast of so grandiose an effort to preserve them all and adapt them to modern needs. Government officials and scholars seemed glad to explain, particularly the distinguished art historian Emanuel Poche.

"What you see *(Continued on page 556)*

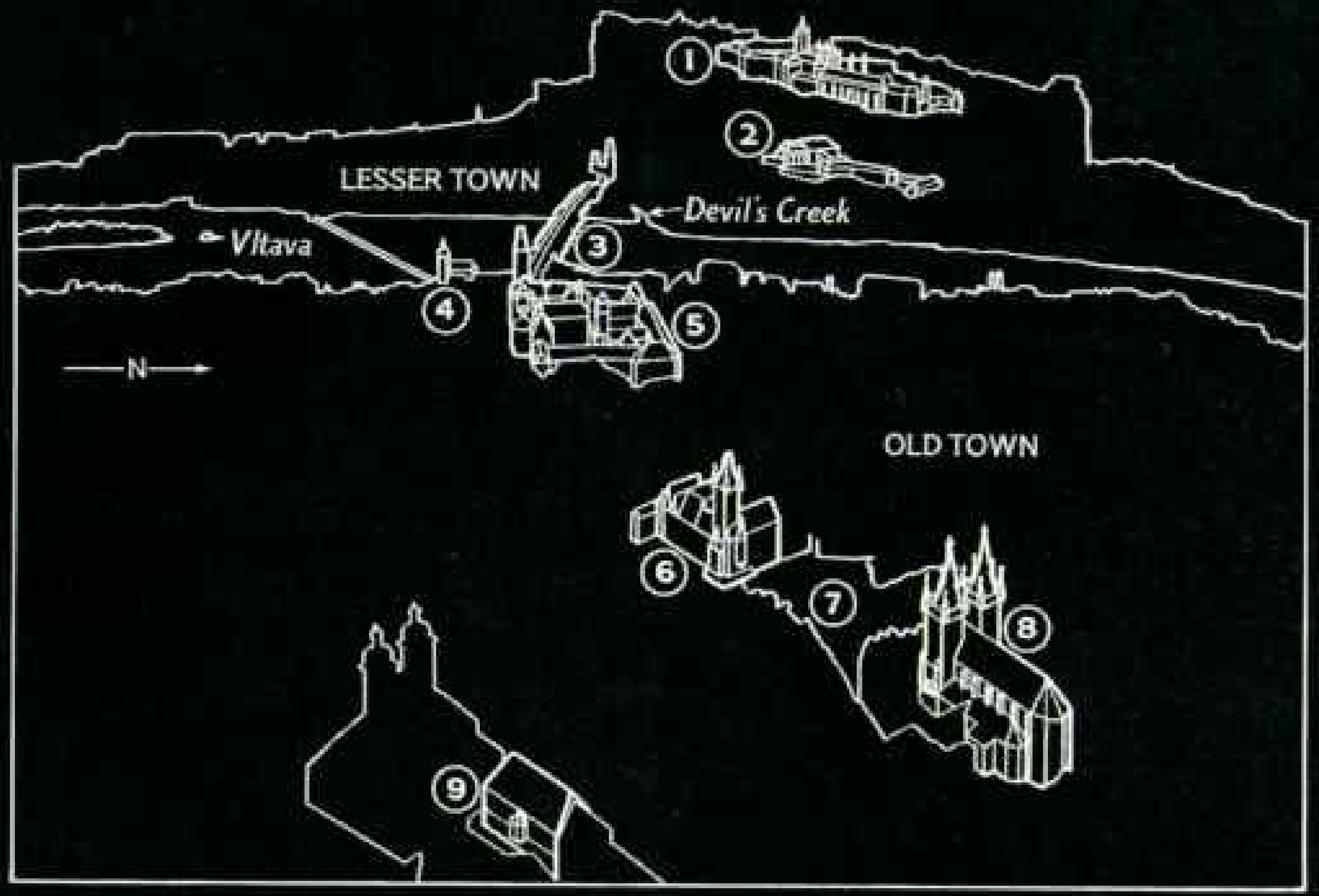
Old Prague in Winter

A golden catalog of thought, the library of the 12th-century Strahov Monastery cradles the treasures of Czech literature. The vaulted Hall of Philosophy (**right**), added in the 18th century, celebrates learning with a frescoed rococo canopy by Franz Anton Maulbertsch.

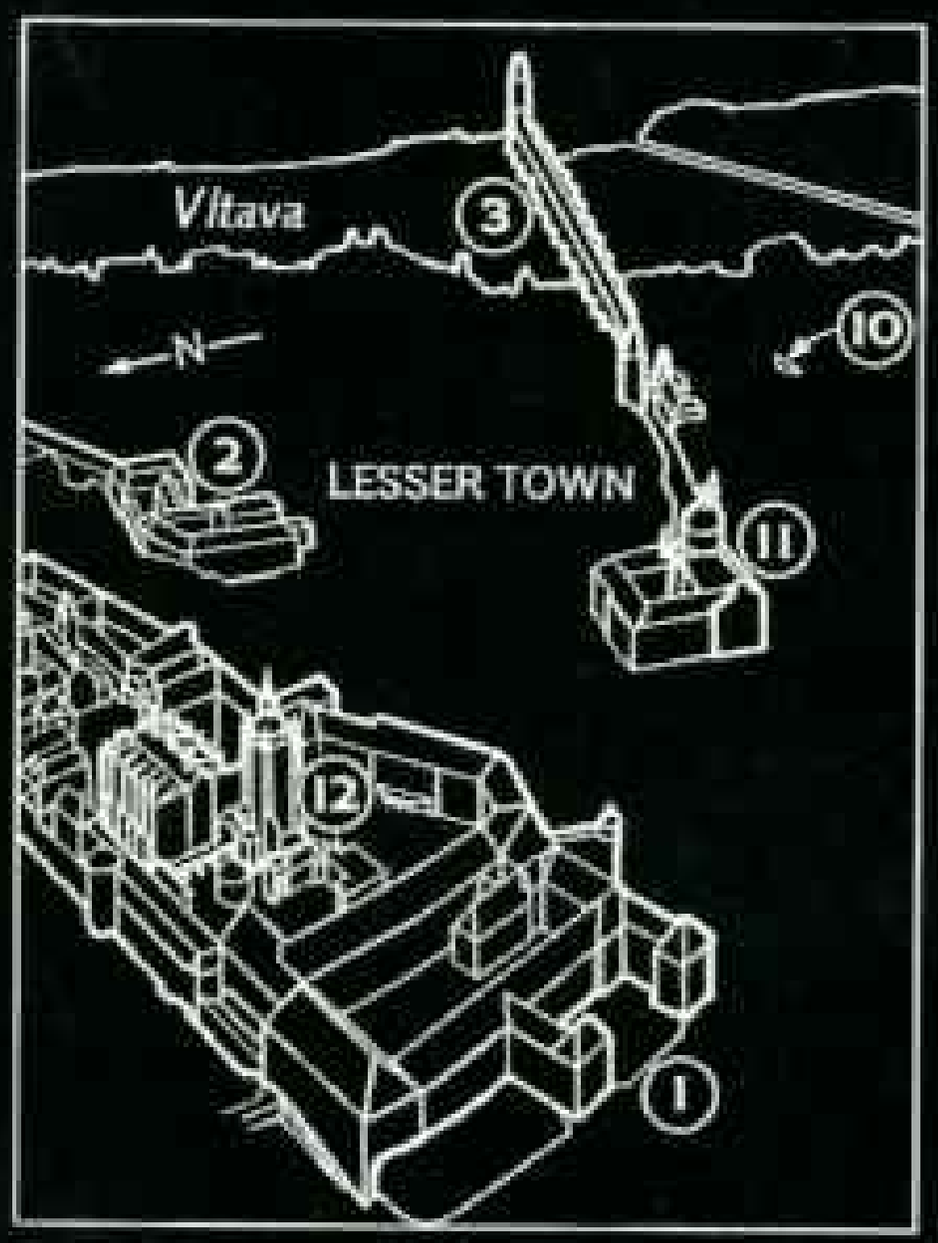
Prague has always cherished its cultural life and the love of the artists who found the city so hospitable. Said Mozart, whose opera *Don Giovanni* premiered here, "My Praguers understand me." Tchaikovsky found a "moment of absolute bliss" here. And Jan Neruda, 19th-century master of Czech prose, sighed: "The moon has told me no city is as beautiful as Prague." Yet the mystery of Prague muffles the city in shadows. Franz Kafka, Prague-born novelist whose dark tales mirror the secret inner life of the city, wrote: "Prague won't let go. . . . This dear mother has claws."

THE SPLENDOR OF OLD PRAGUE

"THE GOLDEN CITY" sprang from Slavic settlements on the Vltava River, at the crossroads of ancient trade routes. Medieval Old Town flowered on the right bank (foreground), and by the 13th century Lesser Town had formed across the river (far page, below). This model of the city, crafted of cardboard by Antonín Langweil, was finished in 1834.



1 Prague Castle
2 Valdštejn Palace
3 Charles Bridge
4 Old Town Water Tower
5 Clementinum
6 Old Town Hall
7 Old Town Square
8 Church of Our Lady of Týn
9 Carolinum
10 Grand Priory Square
11 Church of St. Nicholas
12 Cathedral of St. Vitus



(Continued from page 549) stems mainly from two cultural epochs," Professor Poche told me on one of our walks; he seemed blessed with indefatigable feet. "The first great period came in the 14th century under Charles I of Bohemia, who eventually also became Holy Roman Emperor as Charles IV. He made Prague the showplace of central Europe and founded its first university, in 1348."

Sacred Relics Lured Visitors

The style of the time was Gothic. That was once a derogatory term meaning rude, barbaric; what it describes is in fact elegant, delicate—pointed arches and intricately carved decoration, exemplified by the great tower guarding the bridge Charles built between Staré Město, or Old Town, and Malá Strana, the so-called Lesser Town (foldout, preceding pages). "In 1348," the kindly art historian continued, "Charles also founded New Town, where once a year on a huge square he displayed his crown jewels and the most miraculous relics in the Christian world, to attract tens of thousands of visitors bringing money.

"Great wealth accumulated here—among churchmen, the nobility, and powerful German merchants. The poor also proliferated, many of them Czech artisans in New Town. Antagonism arose, and from the modest Bethlehem Chapel a Czech preacher, Jan Hus, needled the clergy: 'Christ was poor, why are you so rich?' That preaching began in 1402—an early form of Protestantism, a century before Luther."

Hus was lured away to a church council and burned as a heretic, but Hussites rose in anger. "In 1419 they stormed the New Town city hall and threw the magistrates out a window. Rich Germans were expelled, and for two hundred years Prague was Czech ruled and Protestant."

Also economically stagnant: Hussite upheavals had stifled trade. And subsequent emperors—Roman Catholic, German-speaking Habsburgs, who had made themselves kings of Bohemia—usually held court in their Austrian capital, Vienna.

We had stopped in a 300-year-old building, once a convent for Ursuline nuns. It's now a restaurant serving excellent roast pork and sliced potato dumplings. That's no rarity in Prague, of course, where hearty eating is widespread—a good remedy, so I convinced myself, for my monumental Prague colds and sneezes. (*Pozdrav Pan Bůh!* "God greet you!" *Dejť to Pan Bůh.* "Let Him do that.")

My prescription for a typical wintry day would include goulash and beer in the morning; Hungarian salami and then carp with caraway seeds at midday; and in the evening, for dessert, a dozen dumplings filled with plums or apricots, smothered successively with mild grated cheese, sugar, and melted butter. I did note widespread side effects, however. My antidote was lots of walking—and for that, the history-laden backdrop of old Prague seemed ideal.

Antidote for Bureaucrats

Prague's second glittering period came after another defenestration, said Professor Poche. "Rebellious townspeople threw three Habsburg bureaucrats through a window of the Castle." This event marks the beginning of the Thirty Years' War, which devastated much of Europe. On the battlefield of Bílá Hora—or White Mountain, only a 15-minute ride away on streetcar Number 22—the imperial Catholic forces crushed the Czech Protestants.

That day in 1620 proved to be a momentous turning point. For three centuries, until the proclamation of the republic in 1918, Prague would be tightly ruled by the Habsburg bureaucracy, but the immediate consequence was forcible re-Catholicization and another great period of building and artistic creation—this time in the 17th- and 18th-century style called baroque. The word once meant aberrant, odd; it in fact means disciplined, yet full of dynamism and emotion.

"Aristocrats and leaders of mercenary

Tenderness in art and life fills the Renaissance-palace apartment of Professor Bohuslav Slánský and his wife, Ludmila, leading European art restorers. The government's reverence for the past is backed by multimillion-dollar five-year plans for the preservation of Prague's architecture and its adaptation to modern uses.

Prague has a ball in winter when social, professional, and political groups—such as the Czechoslovakian People's Party here—dress in dark suits and long gowns and whirl to waltzes, mazurkas, and polkas, as well as the latest dances.

soldiers, rich with war profits and lands confiscated from Protestants, put up dozens of palaces to impress each other. Jesuits built seminaries and churches with magnificent frescoes, gold-drenched altars, and exuberant sculpture—to dazzle people, using art as a weapon of the Counter-Reformation. Here, on the home ground of Jan Hus, where the church had to fight hardest, baroque is at its most dynamic and emotional. Have you been to St. Nicholas in Lesser Town?"

I had. It is one of the greatest achievements of baroque architecture. Inside, four gigantic marble bishops wield their staves to subdue reptilian shapes symbolizing heresy—stunning, impossible to forget.

Beauty Gets Priority Status

Further clues to the character of Prague came from the mayor (his traditional title is *primátor*), who beamed with pleasure while telling me that he has much to be proud of. Culture? For each of Prague's 18 theaters and three opera houses, the city contributes twice the cost of each ticket in subsidies! Industrial plants are being moved *away!* "You know that our word for Prague is Praha, a feminine name? So of course first comes beauty."

In the 19th century, he went on, when many European capitals were transformed by grand construction projects, Prague was not. "The Habsburgs had condemned this to be a provincial backwater, so there were few big public investments here. That's one reason why Prague is now so special."

Another is that the old city suffered relatively little damage in World War II.

"Now we are modernizing," said the primátor, "but we wish to keep all the beauty and reminders of our past in what we call the historic core. And so in 1971 we turned from the care of individual buildings to the preservation of the complete area."

That means some 1,700 structures—set in medieval street patterns on three square miles: What was essentially the Gothic Prague of Charles IV is now the Prague Historical Reservation. With 75,000 residents and jobs for about 200,000, it forms the hub of a modern metropolis of 1,190,000 inhabitants.

"Many organizations apply to move their offices into the historic core," concluded the primátor, "but usually we refuse, because its life should be preserved, and therefore living quarters must be preserved. We don't want our city center to be alive only from eight to five.

"And so we may spend twice as much to remodel substandard old apartments as it would cost to build new ones elsewhere. We do it step by step. Anyone used to living here

and wanting to stay just moves a little way, to a reconstructed apartment."

I found the historic core full of life from the first glance out my window in the reconstructed inn of the Three Ostriches.

There'd always be people with pitchers taking beer home from taverns, or stopping on Charles Bridge to throw bread to hungry sea gulls along the balustrade or hungry mallards below. Kindergartners in quilted jackets, hand-linked to teacher, trudged through Old Town Square for their morning walk (page 566). Unleashed dogs followed their masters, mostly middle-aged or older, and waited without fuss outside little shops.

And what busy places they were. Toiletry shops, a 600-year-old pharmacy, a bakery, sweetshops, all with pleasantly appropriate smells. A line would form rapidly, but move rapidly too, with three or four customers served and gone in a minute.

By early evening, crowds enlivened the Green Frog for wine, the Golden Snake for coffee, the Viola for poetry readings. Invited guests gathered in great mansions. At the Lobkovic Palace, now the embassy of the Federal Republic of Germany, the Bambini di Praga choir sang Schubert, Brahms, and Křička. The Colloredo-Schönborn Palace, now the United States embassy, featured *Star Wars*. Walking home, I'd pass couples kissing in the mist on Old Town Square and Charles Bridge.

Incredible that only recently Charles

Bridge was falling down, and pedestrians worried about masonry crashing on their heads from beautiful but decaying facades.

"You don't know the people here," said an old stonemason. "They wait till everything collapses before they'll do something." The director of the Center for the State Care of Historic Monuments smiled. "Let's just say systematic renewal began 15 years ago."

From the belfry of the 747-year-old Church of St. Jakub, where two warmly dressed workers were replacing the clock-faces, I looked over chimney pots and greenish copper domes at the evidence of renewal high and low. New gilding on the spheres attached to a multitude of spires, and on a pensive stucco knight atop a ministry; orange-painted steel roof beams on a medieval patrician's house. Far down, in a huge hole, men toiled on Prague's new metro.

In winter, work on facades tends to be suspended, and that hallmark of restoration, scaffolding made of rusty two-inch steel pipes, moves indoors. Planks and pipework nearly filled one lovely old church, supporting a platform high enough for experts to undo the outrage inflicted on the fifty-foot sculptured ceiling. Years ago it had been whitewashed.

Those beautiful baroque stucco rosettes, angels' faces, and double eagles would now be properly repainted, but first some preparation. What? Sponge three days with hot water. Apply equal parts of curdled milk, whole eggs, portland cement. Then smooth on beeswax, polish with flannel. . . .

Things were no simpler in a studio where altar carvings were under intensive care. A wooden sunburst covered with dull bronze paint was sponged with acetone, sandpapered, chalked, treated with reddish paste. And what was this strange flat brush the young lady held to apply these unbelievably thin little squares of gold leaf?

"I made it myself—from a squirrel's tail. The hairs are long and steady and very fine; they won't tear the gold."

The process hasn't changed since Gothic times, although now curved tools of smooth agate are used for pressing down the gold and polishing. It used to be boar's teeth.

Dirty Stuff Is Underfoot

I won't dwell on the intricacies of nursing enfeebled stonework, but old Prague had a lot of that too. Coal and coke were largely to blame; these are still the main fuels for heating and cooking, producing sulfurous exhalations that penetrate and corrode. By 1990, planners say, Prague will be heating with gas—but corrosive exhalations will still come from vehicles burning gasoline and diesel oil.

"Our climatic conditions will not change

Time's stately pageant makes its hourly pilgrimage around a 15th-century horologe, an astronomical clock on the Old Town Hall tower. Legend says the town fathers blinded the horologe's maker so that no other town would have a clock so fine. Clock watchers (**right**) gather a few minutes before each hour.

The clock's face is flanked by figures of Death and a Turk on one side, vanity and miserliness on the other. On the hour, Death turns its hourglass and pulls a bell cord. Two windows open and statuettes of the Apostles appear in succession. Then the windows close and a cock crows to mark the hour's passage.

either," said a restoration expert. "We sit in a valley, and when there's high pressure, there is inversion—for days, and sometimes for a week or more, not much fresh air comes in, especially in winter. The mist can be stifling, like a cushion stuck in one's face."

And so, what with frequent mist, periodic rain, occasional snow, and constant soot, I found myself walking most of the time in the blackest and most unforgettable goo.

No wonder good manners in Prague decree the removal of shoes when entering a friend's living room or kitchen. And when restorers replace decaying stonework darkened by time with new lighter-colored pieces, they sometimes mix water with that goo, to darken the replacements. They call it dog paint. It's natural, they say, and stone treated that way can't get dirty because it's so dirty already.

Politics: the Unavoidable

The longer I stayed, the clearer it became to me: In Prague, politics permeates everything; there was no way for me to ignore it.

Every official I talked to, every official publication I consulted, stressed that it was the KSČ, the Communist Party of Czechoslovakia, that led the way in the country's economic and social development—as set down by the 15th Party Congress in the sixth Five Year Plan (1976-80). All the restoration and modernization work I had seen was done with one basic aim invariably invoked—socialism! Daily life was full of it too.

Up in the Castle complex—in what was once the palace of the Habsburg-appointed governor, and is today the House of Czechoslovak Children—9-year-old Little Sparks of the Socialist Union of Youth received red scarves. Now they were Pioneers, pledged to the laws of the Young Pioneer Organization; law number one says a Pioneer loves his socialist country and the KSČ.

And at graduation ceremonies in the refurbished Carolinum, the seat of 631-year-old Charles University, proud parents watched new doctors of philosophy receive their diplomas; making a speech on behalf of all, a graduate promised loyalty to socialism that would set an example to others, including parents. Then pictures were snapped in the courtyard, before the statue of Jan Hus, who had once been the head of the faculty here, as Rector Magnificus.

I asked the present rector, a soft-spoken professor of constitutional law, about the importance of Hus today. He replied that the teachings of Hus fought shortcomings in the church, became the ideology of those oppressed by feudalism, and led to the Hussite revolution. "Thus it can be said that more than five hundred years ago the Czech nation was already in the forefront of social progress and world progress. We Communists are more or less the inheritors of these Hussite traditions."

Communists Celebrate 30th Year

One gray February day every shopwindow sprouted brand-new posters; gigantic portraits went up in Old Town Square—Marx, Engels, Lenin, Gottwald. At hand was the thirtieth anniversary of yet another historic turning point. The republic had seen quite a few.

It was established in 1918, as a parliamentary democracy in the Western mold. Swallowed by Hitler's Germany in 1939, and brutally repressed. Reestablished in 1945, and governed by a coalition of parties with the Communist leader Klement Gottwald soon heading the cabinet of ministers.

And then the crisis of February 1948!

Non-Communist ministers resign, expecting President Edvard Beneš to appoint a new non-Communist cabinet. Gottwald calls a mass demonstration in Old Town Square; from the balcony of the Kinský Palace he denounces reactionaries at home and abroad, calls for action committees. . . . The Communist-led People's Militia takes over factories.

Within four days the president allows those ministers who quit to be replaced by men agreeable to Gottwald; within four months there's a new constitution, Gottwald is president, the KSČ has all the power. . . .

The losers called it a Communist coup. The KSČ called it a takeover by democratic and constitutional means—the glorious February victory of the working people.

On February 24, 1978, I watched in Old Town Square (pages 564-5) as the color guard of the security police came marching in to the strains of the 15th-century Hussite battle hymn, *(Continued on page 567)*

Huddled in death as in life, Jews from Prague's Old Town ghetto rest in the Old Jewish Cemetery, used from 1439 to 1787. Several tombstones may mark each plot, since limited space ordained the layering of graves; some are 12 deep.

Anniversary of a turning point, the 30-year commemoration of the Communist Party takeover fills the Old Town Square. The tensions of Czech history have even

played Communist against Communist: "Socialism with a human face," the Prague Spring of 1968, flared briefly—until snuffed out by Soviet arms as "reactionary."

"Ye Warriors of God." The anniversary speaker was Gustáv Husák, general secretary of the KSČ and president of the Czechoslovak Socialist Republic.

The working people never had it so good, he said; enemies abroad may spread all the slander they want, but there'll be no crisis—the guideline of the 15th Party Congress is the basic truth of today's Czechoslovakia. "Forward and not one step backward."

I asked a young man why this commemorative rally was held on the 24th when the historic February victory had taken place on the 25th? Socialist *realismus*, he said. "This year the 25th is a Saturday. On the *vikend* a lot of people would rather go away to ski, or to their little country cottages."

Freedom of Graffiti Intact

At last a bright, sunny Sunday! The lacy branchwork of trees shines with ice, like glass. Exuberance is in the air, photographers hover on Charles Bridge, a roly-poly lady scoops snow off the balustrade and makes a snowball. She seems ready to throw it at me. "No, no," she shouts. "At my husband, if he doesn't behave!"

Below the bridge I walk along an arm of the Vltava River called the Čertovka, the Devil's Creek. Past a wooden mill wheel I head for the palaces on Grand Priory Square when I come upon a mass of handwritings on a wall. The expression of strong feelings here has become a Prague tradition too.

I see a promise of friendship "for as long as the Vltava flows through Prague."

A condemnation of the neutron bomb.

"In the whole country this is the only place where there is freedom."

And *CHARTA 77*.

Here's sensitive business indeed. The "charter" referred to, signed by about a thousand Czech citizens, criticizes the government. It harks back to an interlude a decade ago when Prague witnessed an astounding development within the Communist leadership itself—an unprecedented push toward liberalization. Many believed that surely another historic turning point lay ahead.

Writers, professors, party officials high and low proclaimed publicly what they thought had been wrong with the way the country had been run, what sweeping reforms should be instituted. Alexander Dubček, general secretary of the KSČ, endorsed "socialism with a human face."

Then one night in August 1968 troop transports of the Soviet Union landed at Prague airport; soon Soviet tanks rumbled into the city. Sooner or later those who had spoken for reform were thrown out of their jobs. To the losers the events had been the "Prague Spring." Those who welcomed the demise of the reforms called it all a counter-revolutionary attempt by revisionist and reactionary circles.

To this day the standard job-application forms—I ran across one in a shop selling assorted official forms and the texts of government regulations—inquire not only into an applicant's "social origin" and the political affiliations in the family down to those of the mother-in-law, but also into "political posture during the critical period 1968-69." Don't be surprised if a waiter lets you know that he used to be a bureaucrat and that the lady cashier used to edit a magazine.

Historic Beauty Will Survive

As I prepare to leave, men are digging trenches for cables along the sidewalks near the inn of the Three Ostriches. Another string of streetlights will soon be switched from gas to electricity. Will the lady lamplighter and her dog finally end their rounds?

"Oh, no," she says. "We'll be given another route." The old wrought-iron lamps, their insides modernized, will shine on much as before, like others I've seen in the historic core—thanks to an ingenious glass ring that diffuses light softly and romantically.

I'll remember those glass rings too. They are bright little tokens that beauty shall not vanish from the grand historical monument that is old Prague. □

Veiled by snow, a mosaic sidewalk paves the way for a living pattern of kindergartners as they head toward a carefully preserved Renaissance house decorated with sgraffito. Old Prague remains under the spell of its past. Its buildings immortalize in stone the flux of history in the city a visiting 19th-century writer called "a golden net of poems."

Old Prague in Winter

Massachusetts' North Shore

Harboring Old Ways

By RANDALL S. PEFFER
Photographs by NATHAN BENN

HUMBERTO Cardinal Medeiros stood in the stern of the police boat, forcing a smile and stifling a sneeze. He raised his arms and made the sign of the cross. The cheer "Viva San Pietro" sounded from more than 100 trawlers packing Gloucester Harbor. This was the blessing of the fleet, the climax of the St. Peter Fiesta, and something had gone wrong. A fish-meal plant was smothering guests with the stench of drying menhaden.

Sammy Linquata of the Fiesta Committee stood next to the cardinal and puzzled over the problem. Suddenly his tanned round face lit with inspiration: "Quick, Your Eminence, bless the fish plant."

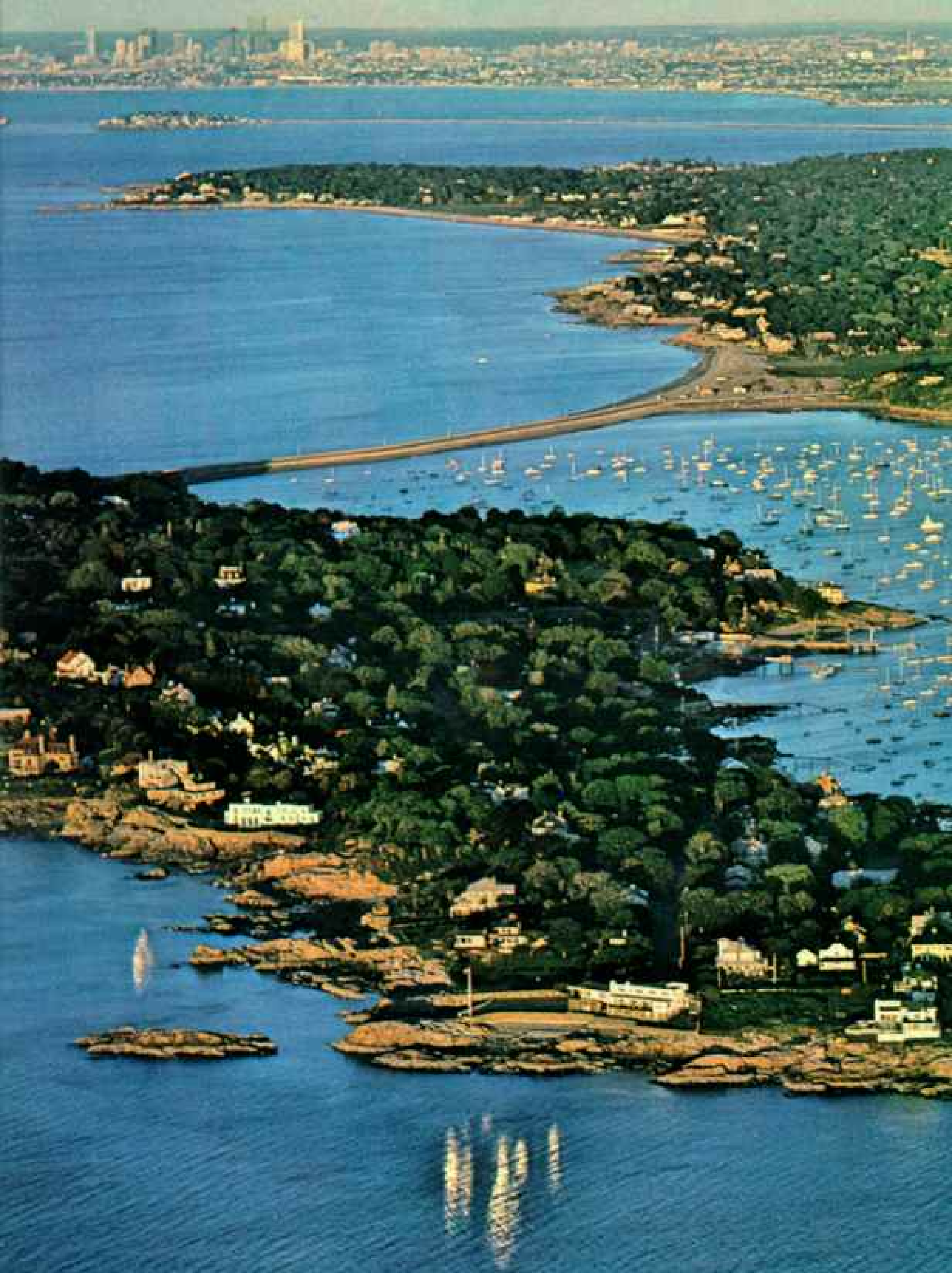
The cleric wrinkled his nose a bit and surveyed the rust-streaked trawlers and steaming seafood-processing factories that make Gloucester an important industrial port and not a quaint harbor. Medeiros smiled knowingly but shook his head, declining to make the blessing. The message was clear. There are some things that do not change easily on Massachusetts' North Shore, even in the name of St. Peter.

I was drawn to live in this area by the sharp contrasts and strong traditions I found harbored on the North Shore. This coast took its name from its position as the northern arm of land helping Cape Cod, the southern arm, bracket Massachusetts Bay. The North Shore begins at some debatable point north of Boston and stretches past Marblehead and Salem and around Cape Ann to Newburyport near the New Hampshire border (map, page 572). From Cape Ann south the shoreline is granite; from the cape north, rolling sand. Large numbers of Finns, Swedes, Portuguese, and Nova Scotians immigrated to the Gloucester area before the turn of the century. Now Sicilian fishing families are the largest ethnic group.

The blessing of the fleet asks the Lord to bring bounty and safety to Gloucester fishermen. The fiesta began 51 years ago, after Sicilians had started immigrating to join Gloucester's fishing fleet. Since then the fiesta has grown as thousands of Sicilians settled in Gloucester. Today's fiesta is not just an Italian event. Portuguese and Nova Scotian fishermen march proudly in the parade. The Italians traditionally carry the heavy statue of St. Peter. The June fiesta is one of the few times during the year that the entire fishing fleet comes home. Thousands of tourists come to Gloucester to dance in the streets, watch rowing contests, and attend outdoor Mass.

But the 1978 fiesta barely masked the bitterness that the fishing families felt over Government quotas restricting the catch of cod, haddock, and yellowtail flounder. The quotas, tied to the 200-mile-zone law that became effective in 1977, have been imposed to help *(Continued on page 574)*

THE SPORTING LIFE wears well with Neil Ayer, Master of Foxhounds for the Myopia Hunt in Hamilton, one of the oldest in America. Colonized by the middle 1600's, the North Shore of Massachusetts breeds a trust in tradition as inhabitants follow time-tested ways on land and sea.



Backyard to Boston—12 nautical miles away at upper left—Marblehead entices sailors with one of the East Coast's premier harbors; its registry counts some 1,800 boats.

The North Shore was Boston's "Gold Coast" in the 19th century when affluent residents summered there, beginning at Nahant in 1820. The aristocratic grain still runs deep.

INDEBTED TO THE SEA, Gloucesterman Santo Militello (**above, right**) hauls back a net with a payload of several thousand pounds of fish. The Sicilian-American's catch will be trucked overnight to New York City and sold fresh to wholesalers. Gloucester fishermen have been helping feed the country since 1630, when 11 shiploads of Puritans from England landed on the North Shore, designating it the Massachusetts Bay Colony.

On March 1, 1977, after years of declining catches caused in part by foreign fishing competition offshore, the boatmen received an apparent blessing: The U. S. fishing zone was extended from 12 to 200 nautical miles. Within a year commercial fishing licenses rose by 40 percent. Linked to the wider zone, however, are strict catch quotas on depleted species—cod, haddock, and yellowtail flounder. Gloucestermen grumble about their restricted take.

The fishing boats come home in June for the St. Peter Fiesta. A blessing is bestowed on the boats and their crews—Sicilians, Portuguese, Nova Scotians, and Yankees alike. Excess energy is devoted to seineboat racing (**right**).

(Continued from page 568) North Atlantic fish stocks recover from overfishing.

Angela Sanfilippo is the fiery young leader of the Fishermen's Wives Association, and she disagrees with the quota approach to conservation. "Our husbands have no time for fighting Government changes," she says. "We do. Why is the Government trying to change the way the men can fish? Quotas are between the fishermen and Jesus. Today my husband, Johnny, says he has never seen so many fish in the ocean. One tow with his net and he can catch 20,000 pounds of fish. The Government says he can keep maybe 7,000 pounds. That will not even pay the boat's mortgage."

Capt. Santo Militello of the dragger *Maureen* also spoke of the fishermen's dilemma as he towed his net in the fog ten miles off Gloucester: "Quotas? It's crazy. The Government gives us the 200-mile zone, then says we cannot fish for certain species. I got no time to fight the quotas. Got to make some money; got to find other fish [besides those under quotas]. Today maybe Santo gets lucky. Maybe we find whiting and flounder around this little rock I know."

The captain lighted his tenth cigarette of the morning, tapped for good luck on a picture of the Madonna hanging in the wheelhouse, and thrust a tape into an eight-track player. Sentimental Italian music began blaring from speakers wired all over the boat. Belowdecks two teenage boys who had been sleeping roused themselves and joined the rest of the crew on the work deck

to help haul in the net. It spilled several thousand pounds of whiting and flounder around our legs.

Twelve hours later *Maureen* steamed back to Gloucester and unloaded a non-quota catch worth more than $500. The stocky 46-year-old captain laughed. "Today Santo has the luck of the old country." He pointed to an Italian flag flying next to the Stars and Stripes on the mast. "But tomorrow, who knows?"

During 1977 the federally authorized New England Fishery Council set stringent quotas, upon the recommendation of marine biologists who favored a rapid rebuilding of the fish stocks. By late summer of 1978 the council proposed loosening quotas to improve the fishermen's economic situation while slowly rebuilding the depleted species. In addition, federal biologists have begun to ride Gloucester trawlers to learn the fishermen's perspective. Skippers do not think the council initiatives have solved the fishery's problems, but now fishermen no longer feel overlooked.

Rugged Coast Stirs Creative Minds

Art has been almost as great a fixation as fish on the North Shore. The China trade by venturesome captains from Salem and Newburyport filled homes with Oriental art and fostered the work of important local talent. In the mid-19th century the granite seacoast inspired Gloucester-born artist Fitz Hugh Lane, and later attracted painters like Winslow Homer and Maurice Prendergast. Large art colonies still exist in Rockport and Gloucester.

On Gloucester's Rocky Neck, oldest of the North Shore's art settlements, the late Emile Gruppe painted Gloucester and its boats beginning in the twenties. Just last summer Gruppe told a gathering of fifty people who had come to his weekly demonstration: "Now I can paint with my eyes closed." Then he told his guests about the day President Franklin D. Roosevelt sailed into Gloucester in 1933 and accepted a Gruppe painting of the racing schooner *Gertrude L. Thebaud*. "The President shook my hand and held up the painting for all the photographers to see. 'I'll put this on my office wall,' he told them. And, by God, he did. He hung my painting." Gruppe finished the story and laid color over the last blank on his canvas. "I'll take it—that is my painting," shouted a guest. Others sighed with disappointment. Gruppe told his audience: "See, you got to be fast in this business. I can't make a good painting if it takes longer than two hours."

Walker Hancock is not a fast artist, but at 77 he is one of America's best-known

KEEPING STRIDE, rider and horse splash toward a water-hazard jump at the Ledyard Farm International Horse Trials in Wenham. The three-day event puts horses through tests of obedience, jumping, speed, and endurance. The world-champion U. S. Equestrian Team trains at a nearby estate.

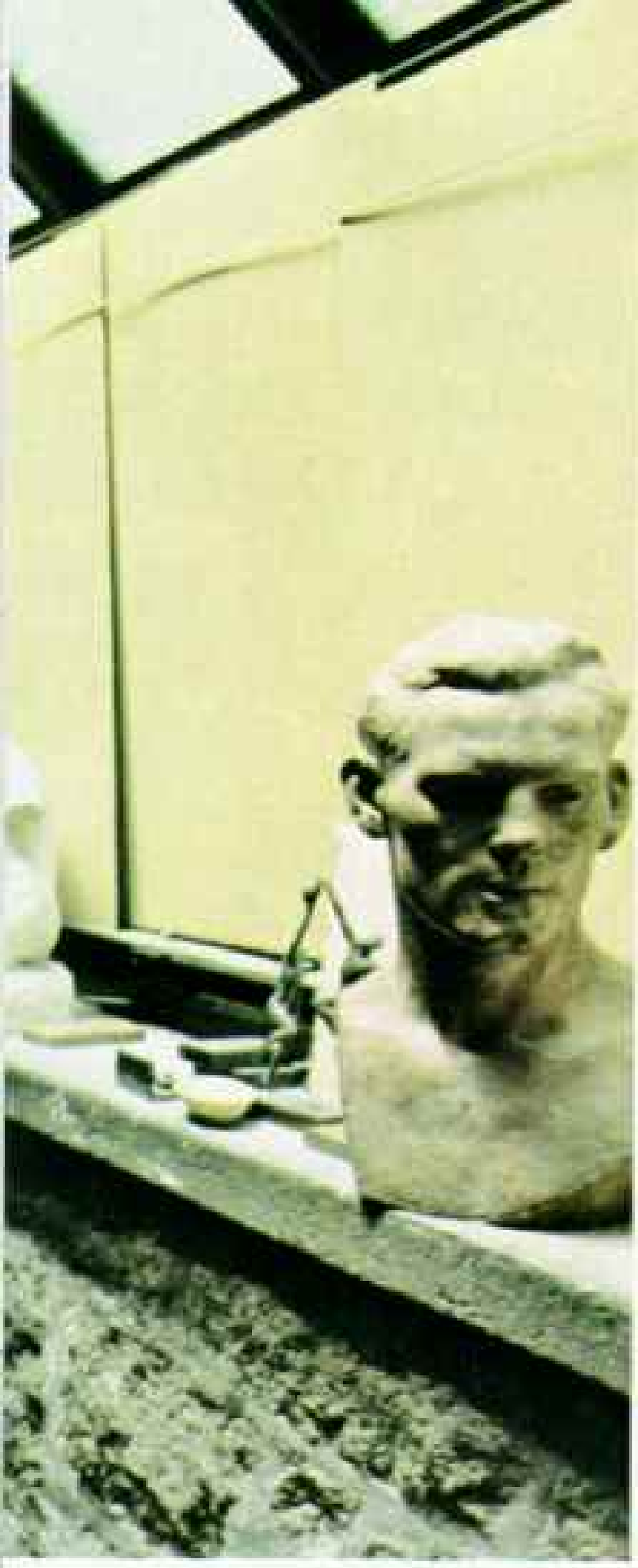
sculptors in marble and bronze (above). I met him at his studio perched on the edge of a water-filled granite quarry in the woods near Rockport. As he led me through his studio, I saw plaster models for some of his famous works, including Douglas MacArthur and Booth Tarkington. The sculptor was working on a statue of James Madison that will be the centerpiece for the new Madison building of the Library of Congress.

"I came here from St. Louis to study sculpture in 1920," Hancock told me, "and I was immediately captivated by the ruggedness of the coast. I knew this was where I wanted to live. Robert Frost sat for me while I modeled a bust of him. Frost loved the granite here and wrote a poem mentioning the action of earth that moved these granite boulders around." *

Cutting Rockport granite once was the job of thousands of Finns and Swedes. Karl Persson, a Swede who operated the last active Rockport granite quarry until the early 1960's, stood with me on a surf-blasted cliff and pointed out the lines of stone breakwaters that protected a series of small coves indenting the craggy north coast of Cape Ann. During the heyday of Rockport's granite industry these coves harbored scores of sailing ships loading granite building blocks and paving stones destined for the streets of eastern cities.

The scene reminded Persson of his immigration to America. "I lived on a little

*Archibald MacLeish defined the essence of Robert Frost and Dewitt Jones gave visual form to the New England poet's words in the April 1976 NATIONAL GEOGRAPHIC.



THE MUSE OF CREATIVITY has long inhabited Cape Ann, judging from the many artists, including Winslow Homer and Maurice Prendergast, who over the years have found their way to this easternmost point of the North Shore. Splendid light, busy harbors, and a sea-lashed granite coast all fire the imagination. Working in his Lanesville studio, sculptor Walker Hancock (**left**) finishes a clay model for a bronze to be cast for Philadelphia's Civic Center. In Rockport (**below**) tourists leave with mementos of the sea.

island in Sweden that looked just like this area. Every man there was a fisherman or a stonecutter. But there wasn't much work, and young fellows like me heard about the good granite industry in Rockport. I sailed here with 25 bucks in 1923. Lots of us like that. Couldn't speak a word of English, but somehow we got to Rockport. The U. S. was growing so quickly that we couldn't keep up with the demand for paving blocks."

Before the turn of the century, Finns by the hundreds came in to work Rockport's quarries; afterward the Swedes came to man the stonecutting benches. But most of the men lost their jobs when the quarries closed during the 1920's and '30's. The Depression and the rising popularity of concrete greatly reduced the demand for Rockport granite.

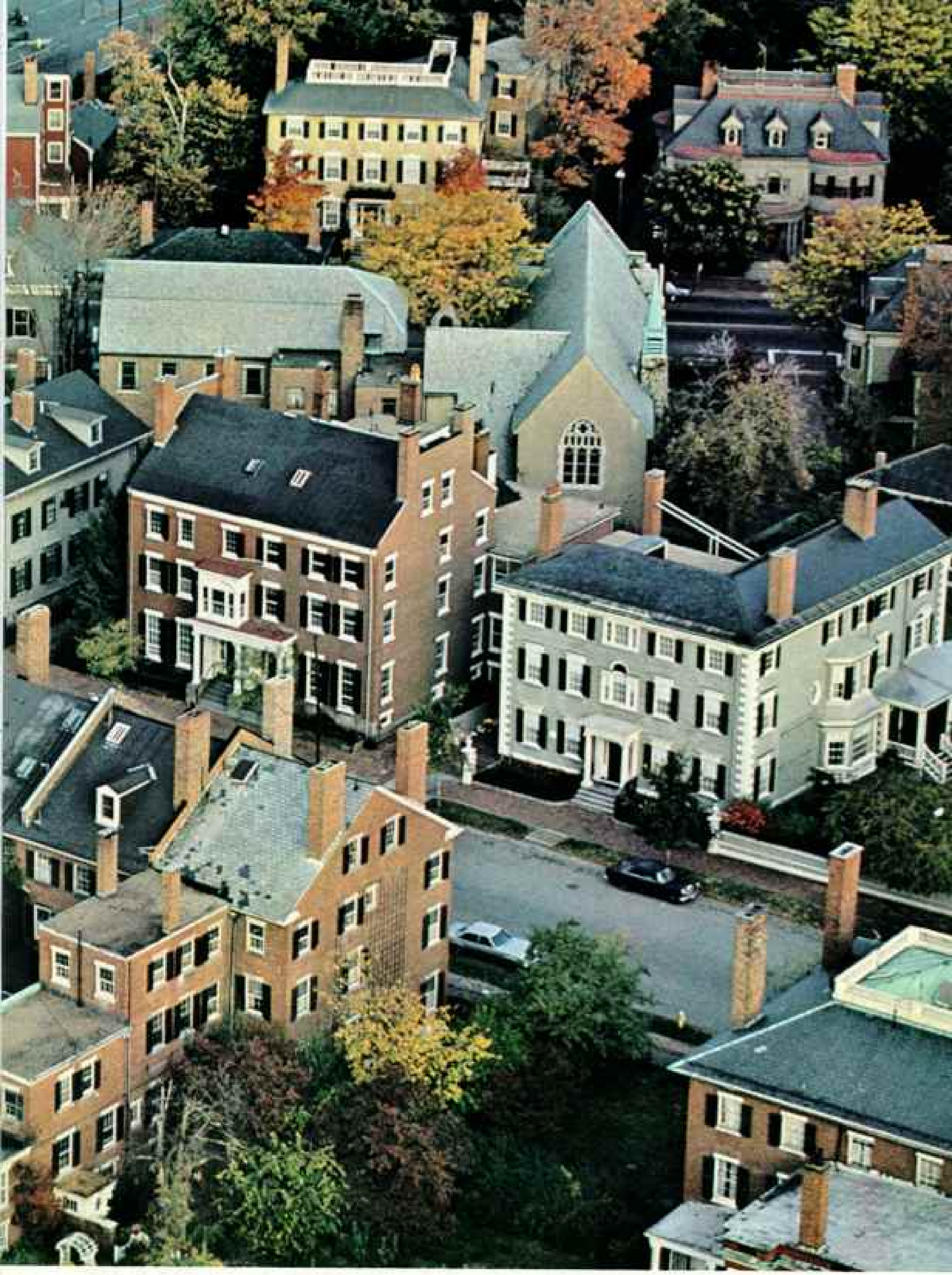
Karl Persson was able to keep his private quarry alive by selling building granite. "My biggest job was cutting the granite facing for New York's George Washington Bridge," he told me. "So after the granite industry was all but dead in Rockport, I still made my living at it. Even though my quarry is closed, I sometimes go over there and cut some pieces for friends."

Many Swedes like Persson have joined Spiran Lodge, a Scandinavian organization in Rockport. I met lodge leader Hakan Olsson, his wife, Inga-lill, and their teenage sons after watching Olsson lead twenty dancers around a maypole in a hilltop park overlooking the ocean. Olsson stood thin and blond in knee breeches and a vest.

"This is a good way for the Scandinavian community to honor the promise of the summer solstice," said Olsson. "Scandinavians

Tea from China and pepper from Sumatra helped build houses in Salem in the early 1800's. The town ranked among the nation's leading ports when it sent its

National Geographic, April 1979



sailing ships racing to the Far East for exotic goods. Chestnut Street, above, exhibits many of the handsome Federal-period homes built by sea captains and merchants.

love to dance. Dancing to the old songs reminds us of our heritage."

Not far from this Midsummer Fest I found another group celebrating the summer solstice and the heritage of the North Shore. This ritual was a sabbat, and its participants were a coven of Salem witches (pages 584-5). Dressed all in black, they circled an altar and heard Laurie Cabot, whom former Massachusetts Governor Michael S. Dukakis declared the "official Salem witch," calling upon the ancient Egyptian goddess Isis.

The witch says she is descended from Massachusetts' well-known Cabot family. Ten years ago she felt drawn to Salem from her home on the West Coast. Shortly after settling in the town, she announced herself to the mayor as a witch. Since then Laurie Cabot has made a living lecturing on witchcraft and selling herbs, astrological charts, and magic mirrors.

During the sabbat Laurie Cabot gave her view of witchcraft. "It has a scientific explanation. Everyone has the power to communicate through alpha waves if they allow themselves to become sensitive to alpha energy."

One evening I accompanied her and several other witches on a blueberry-picking expedition to Dogtown, on a heath outside Gloucester. As I walked the trail to this ghost town, through a maze of glacial boulders, I was following the course of early settlement. First had come the so-called Dorchester Company from England in

AMID WRAITHS OF STEAM, workers at John Flynn & Sons' tannery in Salem stack wet lambskins as part of the process of turning hides into leather. The skins, which come from New Zealand, go on to garment manufacturers in the United States and over the world.

1623, settling conveniently along the shore. Later colonists pushed inland to Dogtown, but its harsh, unrewarding terrain was gradually abandoned.

In the final years before the last resident was taken to the poorhouse in 1830, women dominated Dogtown because many men had been killed in wars and at sea. The women lived poorly, and there is a story that they kept dogs for protection (whence the town's name). Another story is that Dogtown's last residents were witches.

Learning to Think Like a Lobster

A few miles from Dogtown, on the shore south of Cape Ann, a black man who sells lobsters has become a one-man institution. Seventy-five-year-old Bruce Leseine sells his lobsters from a matchbox-size shed in Manchester. He calls himself "Captain Dusty," and he and his wife are proud to have been the only permanent black residents of Manchester for many years. Some local citizens regard Leseine and Henry Cabot Lodge as the two most respected men in the area.

I met Captain Dusty one afternoon when he came ashore after eight hours of hauling lobster pots. At his tiny yellow-frame lobster market he sells his catch and entertains customers with tales of "life among the wealthy and famous," whose manors dominate the coastal bluffs and woodlands of Manchester, Prides Crossing, and Beverly Farms.

The most repeated story tells of Leseine's beginnings on the North Shore. "I came here from South Carolina in 1924 as a porter on a rich man's private train," he relates. "In those days this area was loaded with folks they called Boston Brahmins—blue bloods. My man died right before the stock-market crash. The Depression was coming on, and lots of the blue bloods were firing their help and closing up their mansions. There was no work ashore. I knew that, Depression or not, people had to eat, so I took the little money I had and bought a dory. Then I found an old fellow who showed me how to make lobster traps.

"I put my heart and soul into trying to think like a lobster. I've done everything in this business but crawl on the bottom of the ocean. Why, in the thirties I sold my lobsters by going door to door with a wheelbarrow. This town has taught me something: It's not the color of your skin or the size of your wallet that makes a good man."

Henry Cabot Lodge agrees. The former U. S. senator and ambassador to the United Nations calls the North Shore home. As we walked along the grounds of his oceanfront estate in Beverly, I mentioned the fact that Lodge was born a member of two of

AN EYE FOR MISTAKES keeps Amy Drinker (**above**) absorbed as she checks the cut and reinforces the edge of a custom jib at Hood Sails in Marblehead. Company president Ted Hood pioneered the manufacture of synthetic sails in the 1950's, replacing cotton with Dacron because of its superior stretch and rot resistance. The various sailmakers in town see their products in action during summer races sponsored by Marblehead's four yacht clubs. A fleet of Etchells 22 sloops, one of the fastest classes (**right**), prepares to start.

America's oldest, most respected families. In reply, he quoted his grandfather: "We do not talk about family in this country. It is enough for you to know that your grandfather is an honest man." And after a few seconds, Lodge added: "Think of me as the old fellow who loves swimming with his grandchildren and who is taking up cross-country skiing. Please don't label me an aristocrat."

There are, however, parts of the North Shore that are for the rich, if not for aristocrats. Among them is Marblehead, a town built on a rock peninsula that holds a narrow, deep harbor like a cupped hand. Rambling Victorian mansions spread over Marblehead Neck, while glossy colonial townhouses and expensive shops cluster along the narrow streets of Old Town.

One July morning I saw Marblehead's harbor master, Augie Wolfgram, begin his patrol of the harbor. "I can't miss a morning of this," he said. "It's inevitable that someone has his boat on the wrong mooring, two boats are rubbing together, or a vessel has gone adrift. You have to expect it; we register 1,800 yachts—mostly sailboats—in this harbor. It's only 1¼ miles long and half a mile wide. It is so full that we are now setting moorings outside the mouth of the harbor. I wouldn't keep my boat out there, but people are fighting each other for the chance. It's a status thing, I guess, to say you keep a boat in Marblehead [pages 570-71]."

The boom in small-boat yachting has meant good business to Marblehead sailmaker Ted Hood. With 165 employees, Hood's sail loft is one of Marblehead's largest businesses. Hood Sails has branches in

five other U. S. locations and ten foreign ones. Hood himself is an international celebrity, a victorious *America*'s Cup skipper.

After I watched a crew of men and women testing sails from a boat mast fixed on the roof of the loft, I talked to Ted about the success of his business. He told me that he taught himself to make sails by repairing sails for friends. He opened his loft as a young man in 1950. "I quickly discovered that synthetic fabrics had advantages over traditional cloth like cotton," said Hood in a quiet New England accent. "I began making synthetic sails early in the game. I didn't have all the prejudices that a lot of the older sailmakers had. Once my sails began appearing on successful racing boats, my reputation was established."

Hood's idea of joining the contemporary and the traditional applies well to North Shore equestrian sports too. The towns of Hamilton and Wenham are little more than crossroads surrounded by horse farms. Planted in the middle of this rolling countryside is the Myopia Hunt Club. It fields one of the oldest organized hunts in America and sponsors summer polo matches. Actor Steve McQueen rode the polo sequences for *The Thomas Crown Affair* at Myopia, and Tatum O'Neal filmed portions of *International Velvet* at Wenham's Ledyard Farm International Horse Trials. The United States Equestrian Team that won the 1976 Montreal Olympics trains at a Hamilton estate, and the tax assessor says there are more horses per capita in Hamilton than in any other town in Massachusetts.

A key figure here is Neil Ayer (page 569) of

Ledyard Farm, organizer of the Ledyard Farm Horse Trials, former polo captain, Master of the Myopia Hunt, and nephew of the late Gen. George S. Patton. On a rainy morning before the Ledyard Trials, I helped Ayer mark galloping lanes over a manicured course of fences and water jumps.

I had expected Ledyard's organizer to be a wispy Anglophile wearing tweeds, directing a brigade of laborers with a riding crop in his hand, and talking as if he had hot potatoes in his mouth. What I found was a tan, burly 50-year-old wearing a sweat-stained undershirt. He looked and talked more like a construction boss than a familiar of England's royal family.

Ayer drove marking posts by hand and talked about the North Shore and horses: "This is one area where all who show an interest in riding are encouraged to ride. Both polo and hunt have been democratized. You don't have to live in a big house on the hill to play polo. Unknowns have become stars."

Stardom is far from the minds of most people on the North Shore. Essex clammer Frank Goucher (page 590), who has been digging the shellfish beds along the Essex River for 52 years, gave me a workingman's perspective. "The combined businesses of diggers, shuckers, wholesalers, retailers, and restaurants make clamming the biggest industry in Essex and Ipswich. In the old days people in Essex used to say that all you needed to dig clams was a strong back. Folks held clammers in such low esteem that they were not spoken to by the good people in town. That never bothered me. I've learned more out on the clamflats about livin' than I would ever have in the village." During the days of Prohibition, Goucher remembers

stumbling onto cases of whiskey, rum, and brandy. "They were discarded to lighten boats and destroy evidence when revenue agents surprised bootleggers smuggling liquor to mansions ashore."

"You Can Hear the Grass Grow"

One manor overlooking the clamflats stands on Castle Hill. It was built by Richard T. Crane, Jr., whose name became famous on plumbing fixtures. I heard much about the family's life-style. Mrs. Crane didn't like the first house they built—an Italian villa—so after ten years they tore it down and built a Georgian palace, based on two English manor houses, with woodwork from the library of the Earl of Essex. There were fifteen year-round servants.

Lewis Kilborn, a retired fisherman called the "Grape Island Hermit," remembers attending picnics given by the Cranes for their children on Crane Beach: "It didn't matter whether we were rich or poor; Mr. Crane wanted us all to come. He was real generous to us kids who lived across the river here on Grape Island."

Today Grape Island is a wildlife refuge, and Kilborn's lifetime permit to inhabit his paintless clapboard dwelling there has made the stocky old man the only resident among the green thickets of the marsh island since 1946. "Sometimes I think about moving ashore, but I couldn't stand the noise. Out here you can hear the grass grow. When I die, that'll be the end of Grape Island. Who's goin' to remember man was out here? Who's goin' to know we made a living shooting seals with shotguns for a bounty of five dollars a tail? We thought we had struck it rich when we learned to make three seals' tails

WITCHES of Salem find a more tolerant reception today than in 1692, when 150 townspeople were jailed under suspicion of witchcraft, with 19 eventually hanged. Now, on nights of new and full moons, a group of serious-minded people defining themselves as witches meets safely in homes to chant and form a magic circle. "A witch was originally a seeker of knowledge," says Laurie Cabot, the state-designated Witch of Salem. There are 350 witches in the area, she reports, all said to exhibit psychic power.

Nothing is simple with these witches. Across the bottom of the group portrait at left runs what Eastman Kodak describes as an infrequent phenomenon on modern film, static electricity. "No," counters Ms. Cabot, "that electricity is actually in the room. It forms the perimeter where our magic circle was. No question about it."

out of one! Soon enough there will be nothing to see of the houses, hotel, and school we made from lumber off schooners that washed ashore in storms. That's why I guess I'll just keep my house standin' a little longer. I can live as long as my friends or relatives bring my Social Security check and supplies."

Old Newbury Crafters on the banks of the Merrimack River in Newburyport is a celebrated custodian of another North Shore tradition—handwrought silver. Two hundred years ago Newburyport was noted for its fine silverware. Today Old Newbury Crafters is one of the few United States producers of handwrought flatware. Swift Barnes, Old Newbury's president, showed me his one-room shop with a line of worn benches facing out on the river. Here craftsmen hammer bars of silver with hundred-year-old wood and metal hand tools. Twenty years ago only two artisans worked in the shop; now there are eleven.

Barnes sells his silver through prestigious retailers like Cartier, Neiman-Marcus, and Marshall Field. An order that makes Barnes particularly proud went to former Secretary of State Henry Kissinger, who carried a locker of Old Newbury silver on diplomatic missions. Kissinger gave the silver to his hosts around the world.

South of Newburyport, in the country town of Rowley, the George E. Daniels Wagon Factory is reviving the art of carriage making (left). "This is the only carriage factory in the country that is working in its original location with its original tools," the 30-year-old owner, Bruce Tompkins, explained as he led me through the milling, forging, and painting shops built in a complex of weathered sheds and barns along a rural road. "The old fellow who used to own this place never knew that the carriage business had collapsed. He made a living cutting lumber and making wheels for farm machinery. Amesbury, just down the road, was the carriage-making capital of the world just before the turn of the century. This little shop is the only survivor of that era."

Tompkins raised horses on the North Shore and stumbled upon the wagon factory five years ago when he went looking for a place to buy wheels for a carriage. He could find no one in the country who was making fine carriage wheels, and he discovered that the Daniels factory had all the tooling to do such a job. Tompkins sensed a national demand for recreational and competition carriage wheels. Soon he and partner David Desjardins bought the old Yankee factory and began learning from Mr. Daniels the art of wheel making. Now the factory makes or fixes 500 to 2,000 carriage wheels a year.

"We can't keep up with the demand for wheels. I don't know why we've gotten into building buggies," said Tompkins, showing me a maroon, two-wheeled, satin-finished gig he had built. "You're looking at a $4,500 sports vehicle. The market is good enough for me to sell a couple of these a year."

A Yankee's Definition of a Yankee

Dana Story, the 59-year-old proprietor of the Story Shipyard in Essex, has a firm grasp on his Yankee heritage. He showed me his yard, a field full of sheds and boats that stretched from the church on the hill to the salt marsh that opens onto Ipswich Bay. The boatbuilder looked over the yard, the river, and the marsh as he spoke.

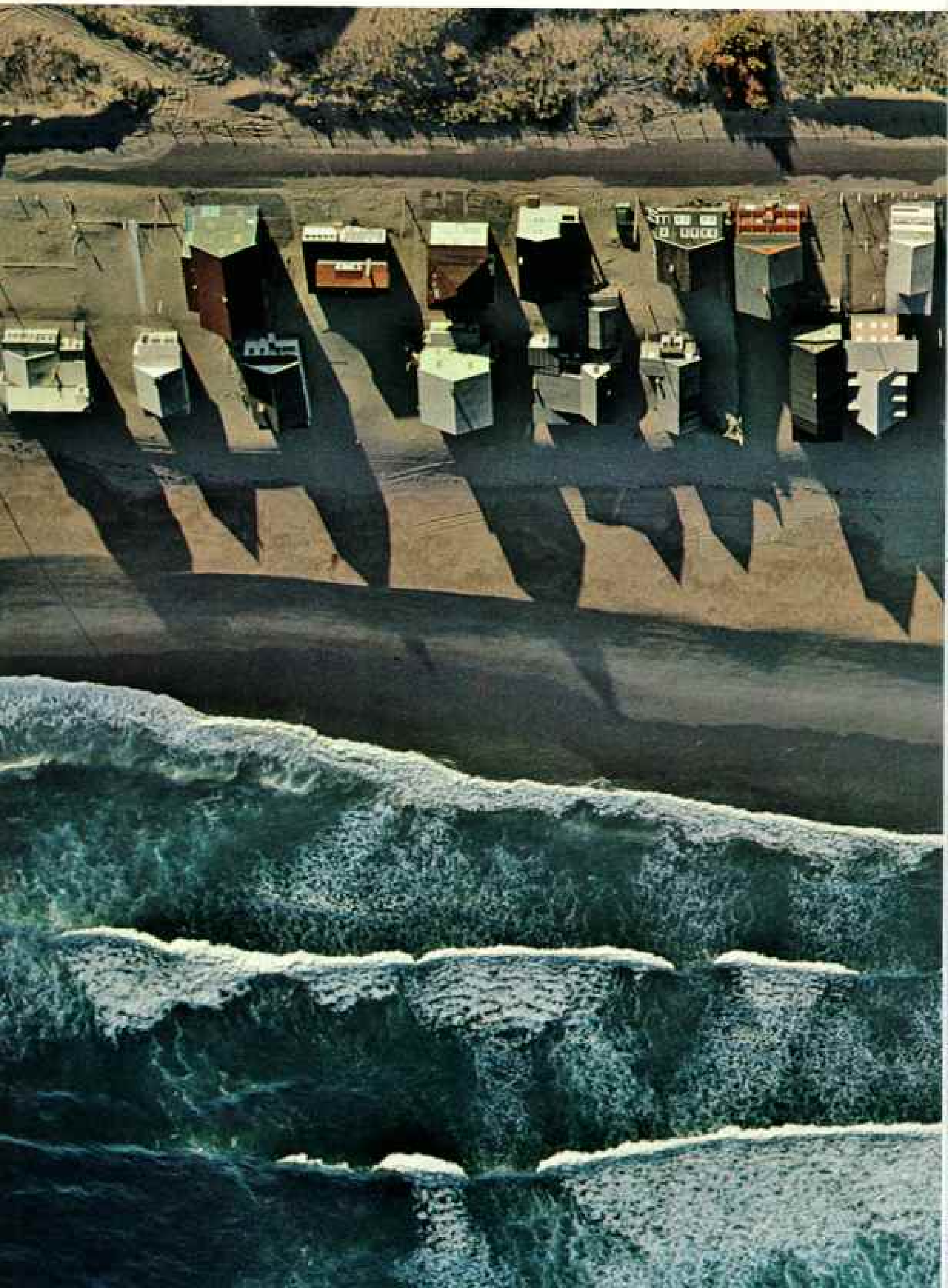
"Storys have been on this spot since 1813. Six generations of shipbuilders. Yankees. In my mind the definition of Yankee is a limited one: A Yankee is a person of Anglo-Saxon descent whose ancestors arrived here prior to 1700. Several of my family on both sides trace their roots back to the *Mayflower*. This place has shaped me. The water has always been our way of life. My father alone built 425 vessels, most of them fishing schooners. He also built the great racing schooners *Henry Ford*, *Columbia*, and *Gertrude L. Thebaud*."

When I visited the shipyard, Story's son, Brad, was working in a shed on a 29-foot sloop. He said he had built 11 boats since he had "come back home." "Come back home" was Brad Story's allusion to his return after

BUSINESS ROLLS ALONG for David Desjardins and Bruce Tompkins, who revived a 19th-century wagon factory in Rowley. Shrinking a steel tire around a wooden rim, David finishes a wheel likely to be bought by a Boston pushcart vendor.

Skyline of shadows stretches across open sand, and surf plays to empty houses during off-season at Salisbury Beach. North of Cape Ann the coast opens up into beach and

marsh, where the salt air can still turn visitors giddy, as it did one settler who wrote, "A sup of New England's Aire is better than a whole draft of old England's Ale."



spending four years earning Phi Beta Kappa honors as an art major at Kenyon College in Ohio. Why did he come back to Essex? Brad planed a piece of wood and shook his head. "My father offered me a job; it feels good. Startin' a small schooner this fall; that'll be like old times, won't it?"

Brad Story's reference to schooners, and the tradition of boatbuilding and fishing they represent, reminded me of a scene I had stumbled across one night on a wharf in Gloucester. For me the scene epitomizes the importance of traditions to people I know on this sliver of coast.

The Canadian schooner *Bluenose II* was tied alongside a wharf. This vessel is a copy of the Nova Scotian schooner that dominated the International Fishermen's Races between Canada and Gloucester in the 1920's and '30's, when motor-powered trawlers were replacing sailing schooners. Two old men, Norm Monroe and Reggie Snow, looked over *Bluenose II*, shared some whiskey, and recalled leaving their Nova Scotia homes and becoming Gloucester fishermen.

"Those days are over, chum," said Norm.

"Not entirely," said Reggie. "The Grand Banks still be there. And men are still fishin', ain't they?"

"Right alongside the Yanks, the Italians."

"Still makin' money?"

"A little."

"Then a toast," said Reginald Snow. "To fishin'. It's all me father taught me." The two raised their glasses. Snow declaimed in a rough Nova Scotian brogue:

Let those who eat fish
and growl at the price
Take a trip off of shore,
shovel snow, and pound ice,
And one good beatin'
on a cold winter's day
They never will growl
at the fisherman's pay.

Norm Monroe laughed: "You been sayin' that one since 1912, and I've been listening. We don't change an old way, chum. Why should we?" □

SIGNATURE OF A CLAM DIGGER is left on an Essex River tidal flat by Frank Goucher as he departs with his harvest. Clamming since 1927, he is the rare New Englander who welcomes severe winters, asserting that thick ice allows for healthy clam beds. And for the people of the North Shore, if it's a living, who's to argue?

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THE NATIONAL GEOGRAPHIC SOCIETY is chartered in Washington, D. C., in accordance with the laws of the United States, as a nonprofit scientific and educational organization. Since 1890 the Society has supported 1,845 explorations and research projects, adding immeasurably to man's knowledge of earth, sea, and sky. It diffuses this knowledge through its monthly journal, NATIONAL GEOGRAPHIC; its books, globes, atlases, filmstrips, and educational films; *National Geographic WORLD*, a magazine for children age 8 and older; information services; technical reports; exhibits in Explorers Hall; and television.

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This no-nonsense kit is specifically designed to help you take a realistic look at whether a company airplane is right for your company.

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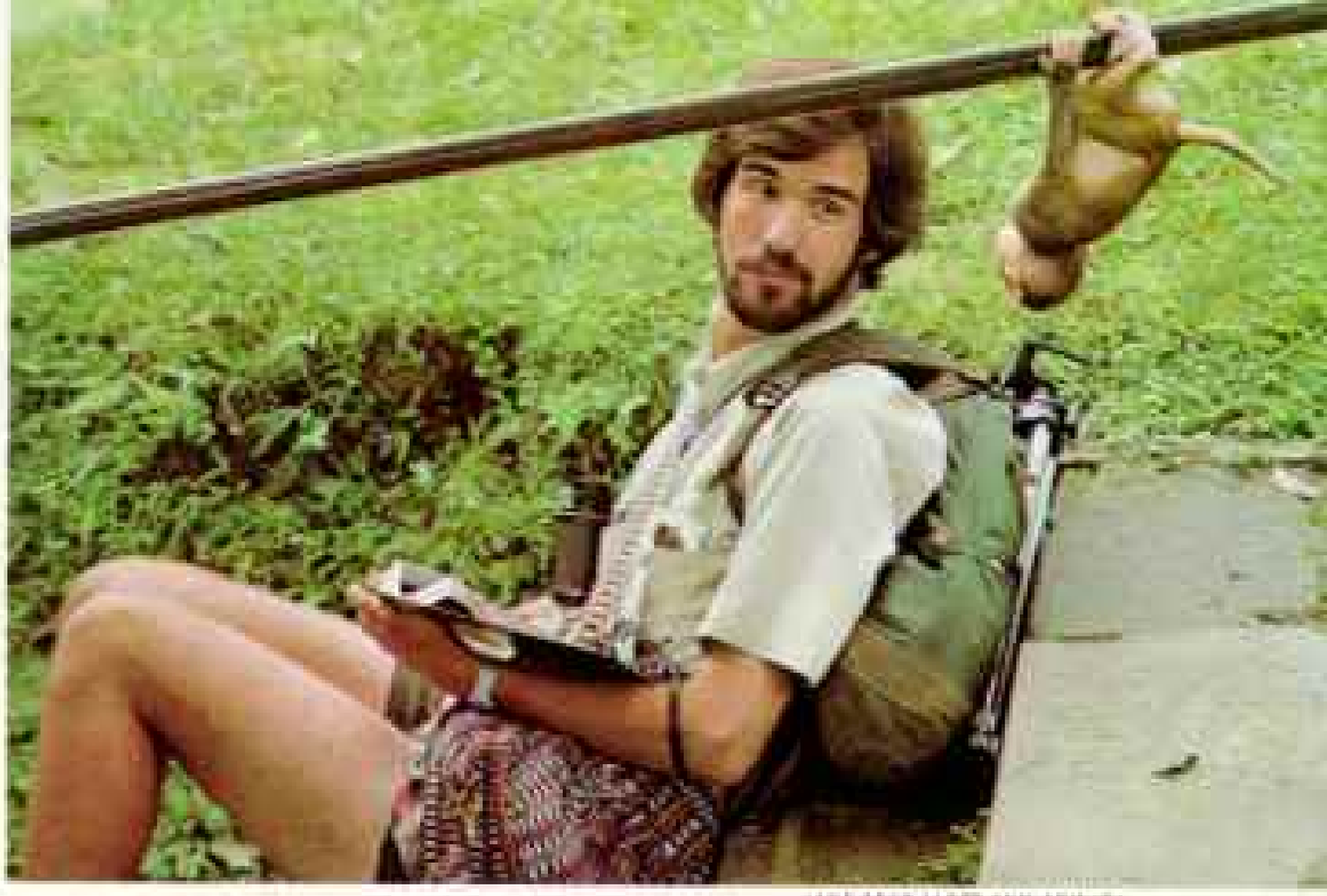

JANE TEAS (LEFT AND ABOVE)

CARL TAYLOR (LEFT); THOMAS L. RICHIE

Natural lab for primate research

FOR MEDICINE, a key monkey is the rhesus, widely studied in the laboratory. But what of its life in a free environment? With National Geographic Society support, Dr. Charles Southwick (**above right**) directed a three-year study on the outskirts of Kathmandu, Nepal's capital. There, protected as sacred creatures, about 600 monkeys dwell tamely in and around two temples, where a team from the Johns Hopkins University of Baltimore investigated their social behavior. "They have settled down contentedly to live in the company of man," says team leader Dr. Jane Teas (**above left**), who shares observation duties with students Thomas Richie (**top left**) and Henry Taylor (**top right**). If you would like to help support such work, complete the form below.

18-MONTH NATIONAL GEOGRAPHIC SOCIETY MEMBERSHIP

JULY 1979 THROUGH DECEMBER 1980

EIGHTEEN-MONTH DUES in the United States and throughout the world are $14.25 U.S. funds or equivalent, which is 1½ times the annual fee. To compensate for additional postage and handling for mailing the magazine outside the U.S.A. and its outlying areas, please remit: for Canada $21.18 Canadian or $18.00 U.S.; for all other countries $20.70 if paid in U.S. currency by U.S. bank draft or international money order. Upon expiration of the 18-month term, memberships are renewable annually on a calendar-year basis. Eighteen-month membership starts with the July 1979 issue. Eighty percent of dues is designated for subscription to the magazine.

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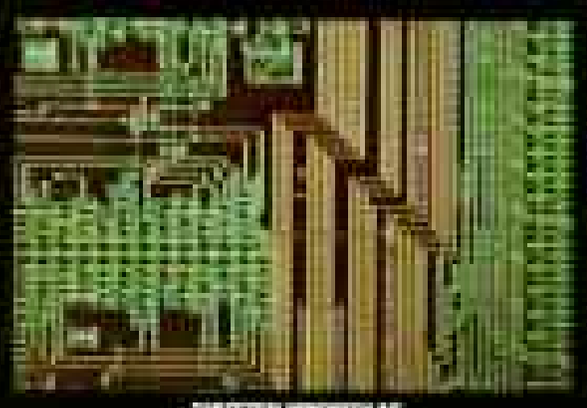

The incredible new Canon A-1. It's on the cutting edge of technology, with state-of-the-art electronics and computerized operation.

Yet, although the way we build it is complex, the way you use it is the ultimate in simplicity. If pushbutton-easy fine photography is what you're after, the A-1 can give it to you six ways.

1 Shutter Priority automation: You pick the speed to freeze or blur action or prevent camera shake, the A-1 picks the perfect aperture automatically.

2 Aperture Priority automation: Select the aperture you want for a soft background or total overall sharpness, the A-1 will give you the speed that's correct.

3 Programmed automation: On the A-1, this unique exposure mode picks *both* aperture and speed in ideal combinations depending on the light. You don't have to set *anything*.

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5 Flash automation: The A-1 has the easiest electronic flash of any camera of its type. With special Canon

flash units, your aperture *and* speed are set automatically. Just mount the flash, turn it on and shoot for perfect exposures every time.

6 For any type of photography that's not already covered, there's a manual.

There's more. Digital control and viewfinder display. Versatile control features. Accessories like a rugged motor drive, compact motorized film winder and interchangeable date/data back. Plus forty Canon FD lenses for unsurpassed image quality and scope.

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They want attention. And they want to be left alone. They want to put their trust in long experience. And they want a lot of new ideas.

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And they want an airline that stays great by knowing how to get better.

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PAN AM

"We need more wilderness."

Some people tramp the woods, are refreshed and want more lands preserved. Others see needs for woodland resources escalating and want more commercial latitude. Who's right?

Many dream of wilderness, to visit occasionally, for recreational experience. To escape the rush and pressure of today's world. To be relaxed by recollections of crystal waters, misty alpine meadows. To save for the future, often for unexpressed reasons. Wild. Beautiful. "Let's expand this wonderful heritage," they say, "put more lands away in wilderness holdings."

Others see impounded wilderness lands as entombed. No roads, shelter, communications, conveniences. No mineral exploration or woodland harvests. Today, wilderness covers nearly 19 million acres. Another 105 million Alaskan acres have been set aside by executive order. And 56 million other national forest acres are under study. Those acres supply over a quarter of our softwood timber. Woodsmen in particular say "lock up that much potential and lumber costs will climb. Jobs will be lost. Let's have expanded commercial acreage, not less."

What's the answer? We desire forest recreation, wildlife sanctuaries. We want wood products too. But these seeming opposites needn't be incompatible. Though woods are upset in cutting, the 25 to 50 years between harvests offer beauty, serenity, wildlife cover. Not that all our woodlands should be put into lumber. Some areas—unique ecosystems, remote valleys—should be preserved. But those recommendations should come from professional forest managers. With legislators making the final decision on land use to balance aesthetic needs with sustained outflow of forest products.

Caterpillar equipment is used to cultivate, harvest and transport forest products and build forest roads. We're convinced the multiple use character of our forests can meet wood and recreational objectives.

There are no simple solutions. Only intelligent choices.

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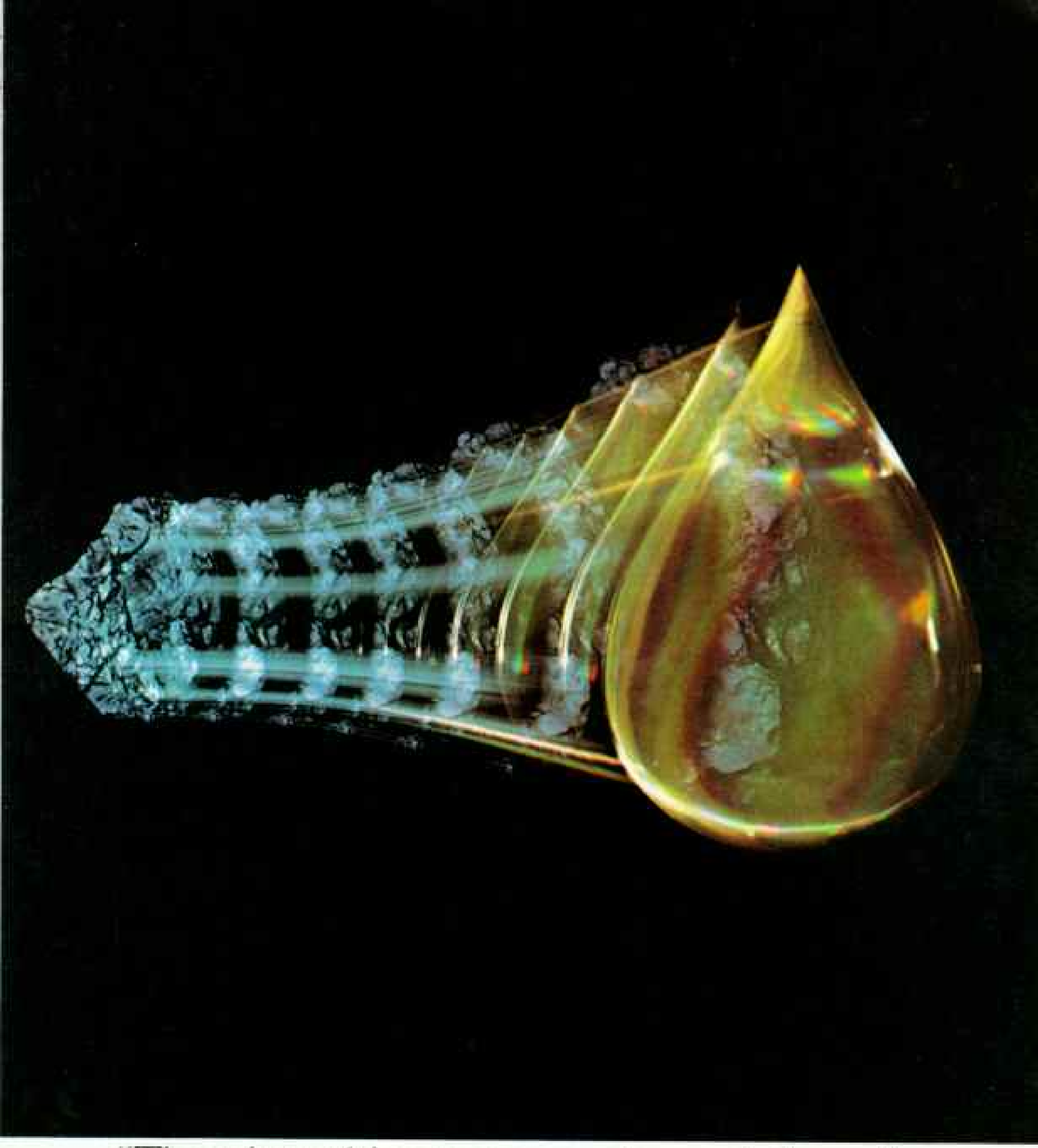

"There is nothing permanent except change."

Heraclitus

The Greek philosopher said it 2500 years ago. And all the changes since then have proved him right.

Consider America's energy situation: As petroleum becomes harder to find, we are turning to that old standby—coal. But today Conoco is producing coal with technology that yesterday's miners never dreamed of.

For example, working together, our petroleum and coal engineers have developed an underground pipeline system that mixes coal with water and pumps it out of the mine, safer and faster.

We're also working on ways to change coal into other useful forms, such as synthetic gas and oil.

And since America's need for energy will continue to grow, Conoco is active in other fields as well—from producing uranium to developing oil from tar sands.

At Conoco, we don't just adapt to change: we help shape it.

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To learn more about what we're doing with energy, write Dept. G, Continental Oil Company, Stamford, Conn. 06904.

How to help a firefighter save someone you love.

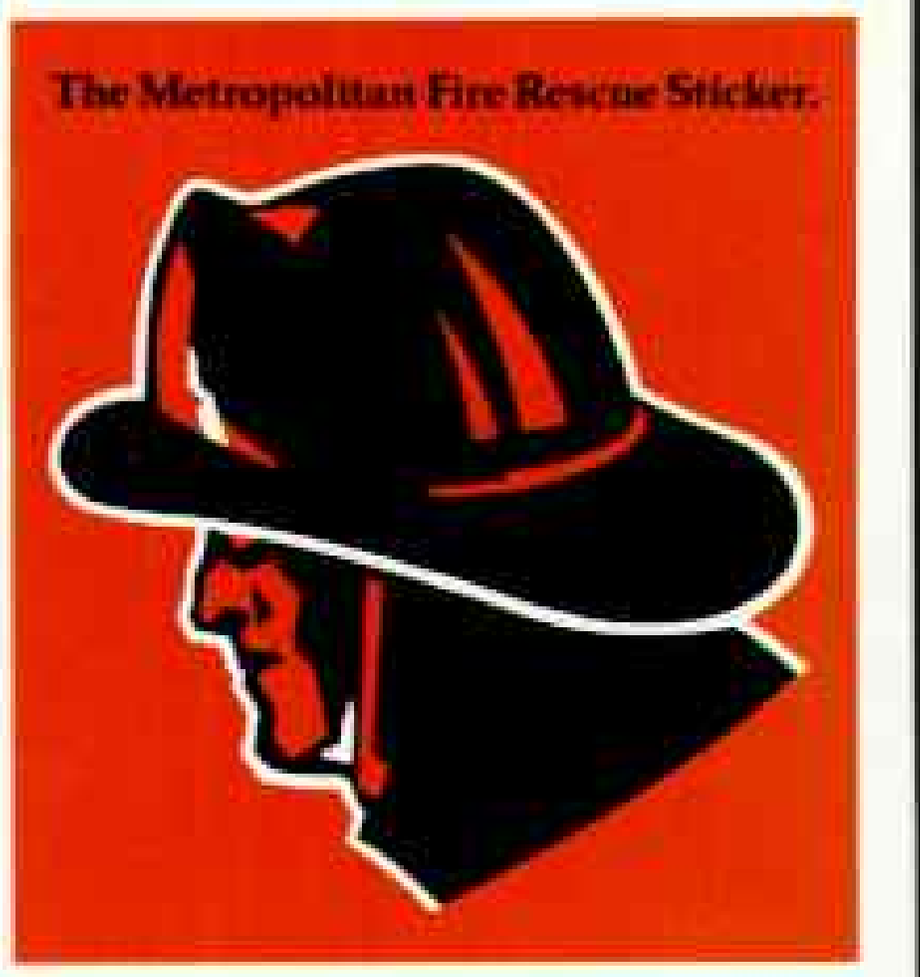
Just make sure that special person has the Metropolitan Fire Rescue Sticker. It's part of Metropolitan's Fire Safety Program.

And in case of fire, it could identify someone who'd need extra assistance. Like a child. An elderly person. A blind person. Or an invalid.

You simply place the sticker on that person's bedroom window or door. It's a signal to the firefighter that someone special may be inside.

A signal that could bring help to that person in time. Instead of too late.

And all you have to do to get one, free of charge, is contact a Metropolitan Representative. Contact a participating fire department. Or use the tear-out sticker in the April Reader's Digest.



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Metropolitan

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You can do business in a distant city for only $16* a month.

Thanks to the new miracle of Remote Call Forwarding–RCF–you can open a "branch office" in a distant city where there is potential business for your firm. Without investing in office space, equipment or additional help.

Your cost? Only $16* a month, plus the low direct dial rate for each incoming call.

How RCF works.

The Bell System will assign your firm a local telephone number in the city where you want to develop new roots. And to establish your identity in this city, your company will be listed in both the white and yellow-page directories. *At no additional cost.*

Your customer in the remote city simply dials your local number, and the call is automatically forwarded *directly to you... with no waiting and without operator assistance.*

All you pay for your new "branch office" is the low monthly service charge of $16* plus the low direct dial rate for each incoming call. Since your RCF number is connected to your regular business phone, *no telephone is needed in the distant city.*

RCF–fast, convenient, inexpensive.

RCF establishes your identity in another city. Your customers and field representatives can call you locally and directly.

Though you're physically located in a distant city, to your customers you're only a local phone call away.

Now you can grow with your market.

RCF offers you the opportunity to explore new markets–practically without investment.

You may want to start with RCF in a single market. Later, you may want to open additional markets. No problem. You simply add RCF as needed.

As you'll find out from a Bell Account Executive, there are countless applications for RCF.

Find out from the Bell System how we can help your business grow.

Your business has special needs. This is why you should talk to a Bell Account Executive. We can tailor service to *your* specific needs.

There's no obligation, of course. Call our toll-free number right now–while you're thinking about RCF.

*$16 is the typical monthly rate for your first RCF number, with slight rate variances in some locations. In addition, a nominal service connection charge usually applies. Each call forwarded is charged at low direct dial rates and is applied to your RCF bill. Your Bell Account Executive will advise you on the availability of RCF in the market area you choose.

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Or, if you prefer, just complete and mail the coupon below.

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YES! I'm interested. Tell me more about Remote Call Forwarding and how it will benefit my firm. I understand there is no obligation on my part.

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Bell System

The Honda Prelude: a sports car for grown-ups.

Sports car. It may be the most abused term in the English language.

To some, it's a car that can accelerate away from a stoplight at blinding speed so that its neighbor is left to feel compromised and impotent.

To others, a sports car is measured differently. The roofline should not exceed waist height.

At Honda, as with all our endeavors, we see things a little more simply. As evidence, we proudly introduce the Honda Prelude.

We like to think of it as a sports car for grown-ups. People who are realistic about things like 55 mph speed limits and their personal comfort during a long trip.

This doesn't mean that a sports car for grown-ups has to be sedate. For the performance minded, the Prelude has a new advanced 4-wheel independent suspension system. Add to that our proven

front-wheel drive, rack and pinion steering, 1751cc CVCC® engine and drive train and you have one of the most nimble Hondas we've ever made.

But here's the fun part. The Prelude is delivered with our version of a "moonroof." It's really a power-operated tinted-glass sunroof.

Then we've rethought the speedometer-tachometer and put them on the same axis. So both are larger and easier to read.

The AM/FM stereo radio (standard) is located closer to the driver so you select a station with the same ease you select a gear. Honda's 5-speed stick shift is standard. Our manually-selected 2-speed Hondamatic is optional.

Now the best part. Stop holding your breath, it's all at a Honda price.

We invite you to step inside a Honda Prelude. Once you get in, you may never want to get out.

And isn't that really what a sports car should be?

HONDA
We make it simple.

Without chemicals, millions more would go hungry.

Millions of people around the world already don't get enough to eat. Without chemicals, the problem would be much worse.

We need chemical fertilizers to add nitrogen to the soil. Chemical weed-killers and insecticides to help save the 45 percent of the world's food production now being destroyed by weeds, insects and other pests.

Some people think that anything grown with chemicals is "bad." And anything grown naturally is "good." Yet nature itself is a chemical process. (Interestingly, your body cannot tell whether a chemical was made in the laboratory or was made by Mother Nature.)

So the real need is to differentiate between safe uses for chemicals and potentially dangerous ones.

No chemical is totally safe, all the time, everywhere. The challenge is to use them properly. To help make life a lot more livable.

For a free booklet explaining the risks and benefits of chemicals, mail to: Monsanto, 800 N. Lindbergh Blvd., St. Louis, Mo. 63166. Dept. A3NA-NG3.

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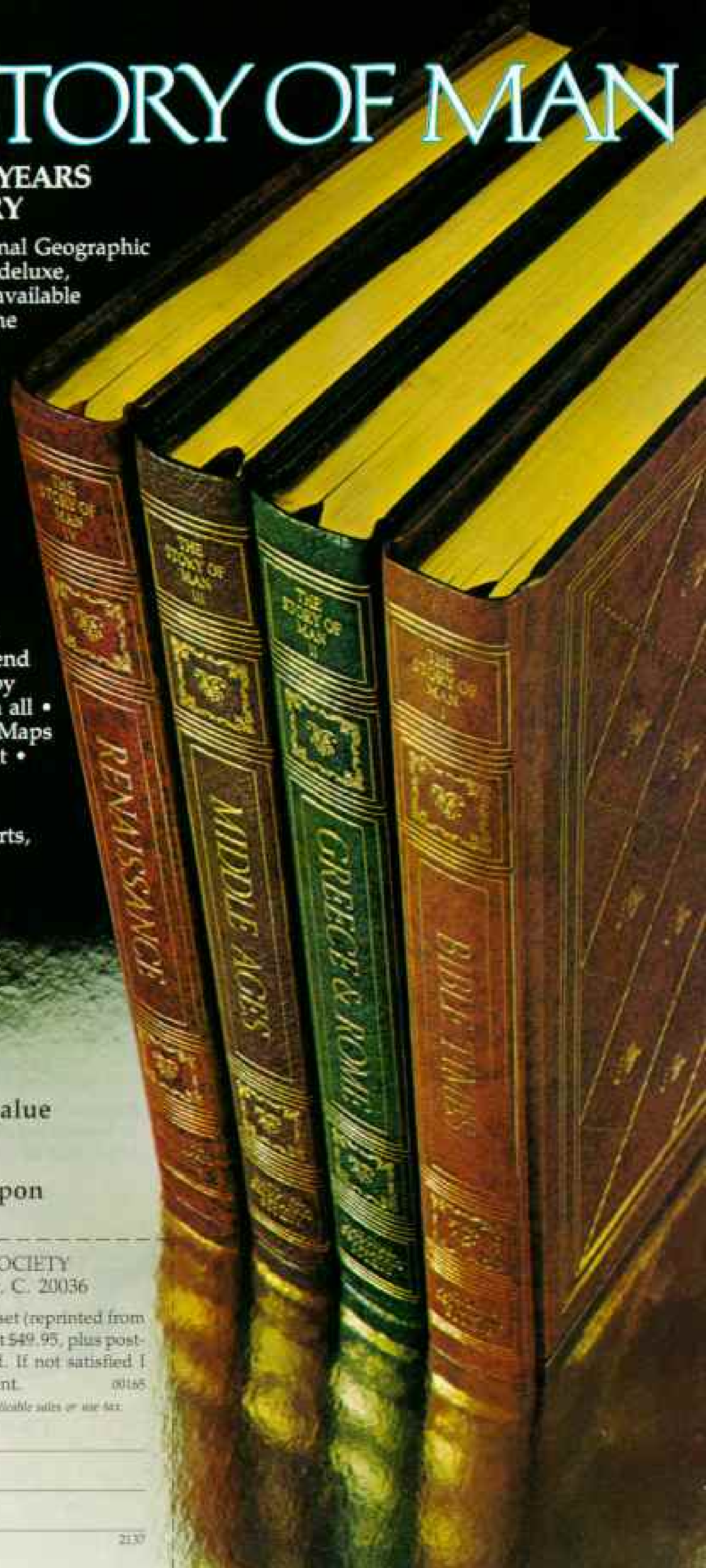

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And makes owning one a love affair . . . that never seems to end.

GM

THE 1979 PONTIACS OUR BEST GET BETTER

New York is all wet... and wonderful.

"Vacationers are constantly looking for places with super beaches, lovely lakes, or especially scenic rivers. Isn't it great to find a single state that has them all!"

by Steven Birnbaum, Travel Editor of Esquire Magazine. Today Show, CBS Radio, and Editor of the new Get In and Go! travel guide series.

What's your special water-borne pleasure? Swimming in pounding Atlantic surf, water skiing on a mirror-like lake, or wading into a trout-filled stream to cast a newly-tied fly? What about sailing in waters that challenge America's Cup skippers and dinghy enthusiasts alike, or just sitting in an old inner tube while the current moves you downriver at less than a snail's pace? How about a ride on a paddle-wheeler, a canoe trip down an old canal, or the challenge of really treacherous white water? There's no need to girdle the globe to find all these diverse aquatic delights, since they're all right here—and lots more—in New York State.

135 Miles of Beaches

No need to fly to Bali or even Bermuda, since the nearly endless strands of sand along the Long Island shores—from Coney Island and the Rockaways to Montauk point—are the kinds of beaches of which legends are made. Or at least legendary vacations.

And while we're at it, what about the less well-known (but not less compelling) beachfronts along such lakes as Erie, Ontario and Champlain?

Sail On

Long Island is home for the world's largest private armada—including boats of both the wind-driven and power variety. These are the waters in which the most prestigious international regattas are constantly and fiercely contested.

Less competitive sailors need not despair, however, for the tranquility of a Rhone Valley voyage is easily duplicated on the majestic Hudson. Early explorers first thought it a passage to the East Indies, but contemporary visitors know it better as one of the world's most scenic waterways.

Similarly, lovers of short cruises across and around European lakes like Constance and Como may be very pleasantly surprised by the serenity of a ferry trip across Lake Champlain.

Fabulous Fishing

Where would you most like to cast your line? In pursuit of salmon on the River Shannon or for bigger game off Australia's Great Barrier Reef? A waste of time and money, don't you think, when the breadth and variety of fishing right here in New York is all and sometimes a bit more than the rest of the world can offer.

Deep sea fanatics can choose from the huge fleet of charter and party boats sailing from virtually every Long Island cove and harbor.

Further inland, the variety of finny fare is almost infinite. We've got 4,000 lakes that cover 4 million acres, supplemented by about 70,000 miles of rivers and streams. This is where the trout live. Fly fishing for trout in this country began in the Catskills, still the Mecca for trout fishermen. Lakes Ontario and Erie are fast becoming famous for their huge trout and salmon.

There's smallmouth bass in the Mohawk, bass and pike in the Finger Lakes; Oneida Lake is the world's greatest walleye fishery; and for salmon fanciers, try trolling a fly or two in virtually undiscovered Lake Champlain. Chautauqua Lake, of course, is legendary for its fighting "muskies."

Island Idylls

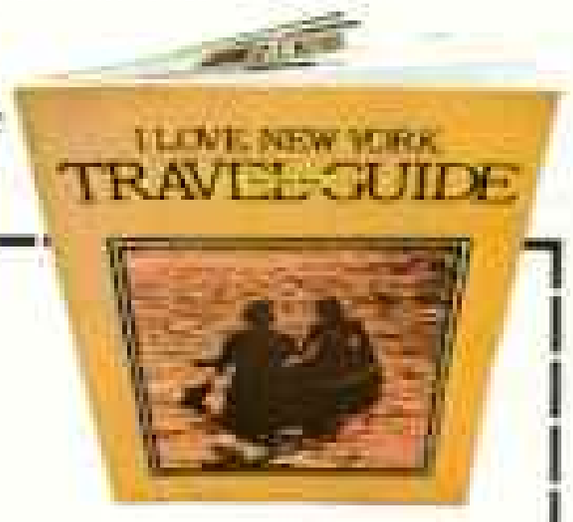
Why long for Greek islands when New York boasts more than 1,800 isles in just the Thousand Islands Seaway area alone, varying in size from mere rock outcroppings to islands more than 20 miles long. And if you crave castles on the Rhine, we've got one of our own, plus the somewhat more modest opportunity to make a houseboat your own castle as you cruise the Saint Lawrence.

Water For Watching

Sometimes our waters are awesome just in prospect, as the more than 5,000,000 sightseers who annually stare at the cataracts at Niagara will gladly attest. Such lesser legends as Victoria and Angel Falls pale by comparison, and it's no accident that Niagara is the most visited natural wonder in the United States. There is something especially dramatic about seeing the globe's greatest waterfall firsthand and hearing its thunder roar and feeling its own misty spray right on your face.

Send For Free Book

To describe the really endless variety of the State's vacation wonders would take a book. Well, that's just what we want to send you. A big, 64-page guide to where it's at and how to get there all over New York. It's packed with pictures and maps and travel tips and little known facts and hundreds of ways to make your "I Love New York" vacation the best one you've ever had.



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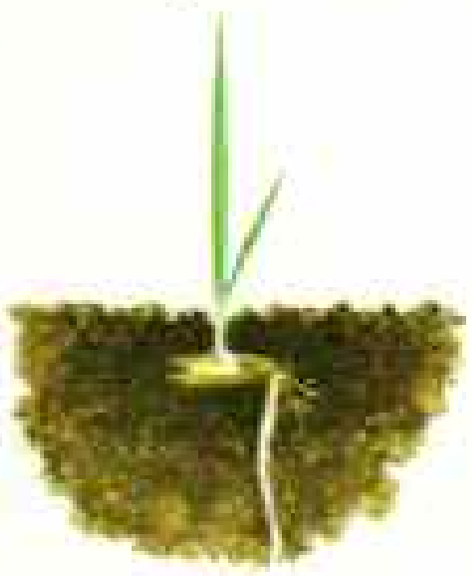
There are four stages in the life of every grass plant where its future could be in doubt. And the seed you put down in the first place generally makes the difference. Chiefly, it depends on the seed's heritage and the condition it's in.

How our plump healthy Family® Seed grows safely through these 4 failure zones.

The seed's condition is especially important in the beginning. It takes a pretty robust seed to germinate and survive. That's why we sort the seed in our mixtures. We get out most of the weak immature seeds that won't make it and keep the plump, mature seeds that are full of vigor.

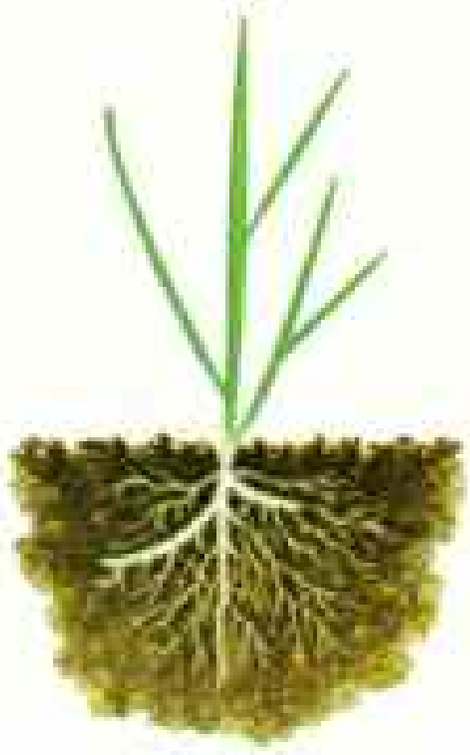
Germination.
The critical days where seed fails the most.

We also give you aged seed. Freshly harvested bluegrass seed takes longer to germinate. Nature's way is to age the seed so more of it germinates and comes up at the right time. We're so particular about the seed we choose, last year we rejected over five million pounds of grass seed that didn't measure up to all our standards.



Emergence.
Breaking through the soil to the light and air.

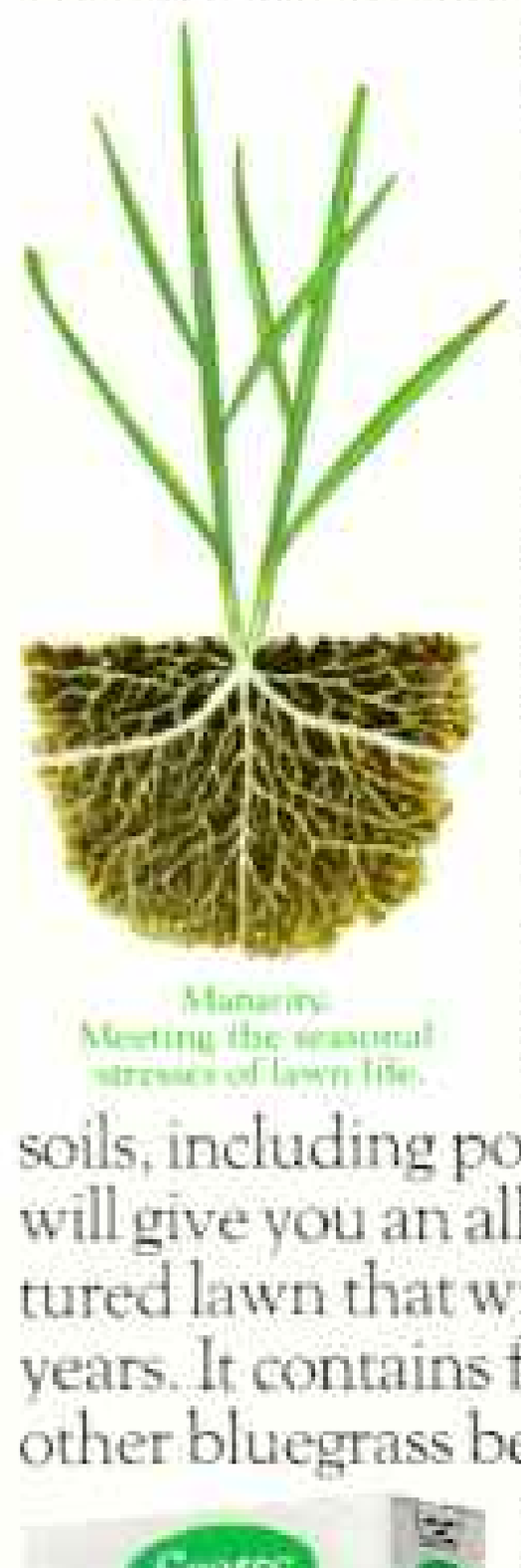
The plump, healthy seeds in our Family® mixture have food reserves (starches and so on) to help them sprout and grow faster. Seeds buried deeper can fight their way up to sunlight. These vigorous seedlings have more power to force their way through crusted soil or around clods. They grow into grass plants with a strong will to live. And since they get established quicker than less mature seeds, they're better able to fight weedlings later on.



Growth.
Rooting and spreading to thicken your lawn.

They also have roots that can dig down faster for food and water (your grass is only as good as its roots). So more seedlings survive till they can start producing their own foodstuffs. Then tillers and rhizomes reach out to start new plants and thicken your lawn.

The heart of our Family mixture is Victa Kentucky bluegrass. It's a hardy, disease and drought resistant plant. We tried some 5000 different bluegrass strains to find Victa. And we grew Victa on our research farms for 12 years just to be sure of it.



Maturity.
Meeting the seasonal stresses of lawn life.

As lawns mature, their true character shows through. Some will come on strong for a while and then fold up on you. Our Family seed can grow in medium shade and in a wide variety of soils, including poor soils. Family seed will give you an all-purpose fine textured lawn that will reproduce itself for years. It contains fine fescues and another bluegrass besides Victa. We sell other seed mixtures too, for special purposes. That's the kind of business we've been in here in Marysville, Ohio, since the year 1864.

Georgia History. It takes one nice turn after another.

In Georgia, you can see history in progress at the most famous hometown in America, then go back to the Civil War at nearby museums. All in a day. But don't. Rushing through Georgia is squeezing centuries into hours.

Our heritage goes way back. A lot happened here before the city of Savannah was founded and Georgia became an Original Colony. The events that followed are preserved beautifully, and you can see our history in any part of the state on any day.

Take in an outdoor drama. Visit an antebellum home. Our colorful vacation guide will lead you to all the places to see, and describe exciting things to do along the way. For your free copy, just mail in the coupon on the reverse side of this flap. Today. So you'll have plenty of time to plan your trip.

And when you reach Georgia, be sure to stop at a Visitors Center for the latest information and directions. We'll help you enjoy your trip into time.

Georgia

See it in the making every day.

Our free 76-page guide will tell you where.

"This Way To Fun" is a complete listing of all the things to see and do in Georgia, with colorful photographs and interesting descriptions of attractions, campgrounds, state parks, historical sites and more. Send for your free copy today. And start enjoying your trip to Georgia, even before you get here!

Georgia Department of Industry & Trade
Tourist Division
P.O. Box 1776, Dept. NG-92
Atlanta, Georgia 30301

Name

Address

City, State, Zip

Georgia

YOU WON'T FIND MANY GRAVELYS IN THE GRAVEYARD.

In an era that finds most Americans expecting their machines to meet with untimely deaths, Gravelys are a pleasant surprise.

Every year we get letters about Gravelys 10, 15, even 25 years old still on the job.

That may surprise you. But it doesn't surprise us.

Because we've never tried to just scrimp and produce our tractors to sell for less.

A Gravely won't wear you out. It's got instant forward and reverse, eight speeds for almost any job.

Our tractor can work for you 12 months a year with over 20 attachments, from mowing to cultivating to snow removal.

We always try to make them work better and last longer.

Which is why you'll find something on Gravelys you won't find on other lawn and garden tractors: an all-gear drive direct from the engine through the transmission to the attachments.

So there are no belts to break, slip or wear out.

We also precision-cut the gears, which operate in an oil bath for less friction and an extended life.

For greater durability, we use cast iron for the transmission housing as well as the pivoting front axle.

For improved efficiency, we bolt the engine directly to the transmission in the rear.

In short, we build our tractor to be out mowing grass long after most machines its age are out pushing up daisies.

For your nearest dealer, check your Yellow Pages.

For the full story, write to Gravely, 0439 Gravely Lane, Clemmons, N.C. 27012.

GRAVELY
CLARKE-GRAVELY CORPORATION
A Studebaker-Worthington Company

If you're traveling in California, Ohio or Florida, plan a day at Sea World.

Have you ever seen a killer whale or a live shark up close? Have your children ever touched a real dolphin?

There are so many things in the world to experience. And so little time to do it in. So this year when you plan your vacation, save a day for Sea World. We'll give you a day so full of adventures that the memories you share will last a lifetime.

You'll enjoy hours of shows. Starring dolphins. Sea lions. Otters. Walruses. Waterskiers. And Shamu,® the famous killer whale.

You'll share touching experiences with all the rare and beautiful creatures of the sea. Shake hands with a starfish. Or take a walrus to lunch. Your children can run free in Cap'n Kids World,® America's most creative playground. And the whole laughing, learning, loving day is yours to enjoy for one low price. You've waited a year to get away with your family. And you want to make the most of it. So plan a day at Sea World, the world's largest and finest marine life park. It's more than just another attraction. It might be the best day of your vacation.

SEA WORLD®
ORLANDO · SAN DIEGO · CLEVELAND
(Opens May 26)

For more information, contact your travel agent

THE BEST VACATIONS TO WALT DISNEY WORLD START WITH THE AIRLINE THAT KNOWS IT BEST.

Eastern is the official airline of the Walt Disney World Vacation Kingdom. And because we're a member of the Walt Disney World family, it's like our second home. So it isn't surprising that we have more ways to give you the time of your life there than anyone else. At surprisingly low prices.

SAVE GETTING THERE.

Our Super Saver fares are still available. So take advantage of them and get super savings, whether you're going for a long weekend or a week.

MORE VACATION CHOICES THAN ANYONE ELSE.

With almost 100 Walt Disney World vacations, and a variety of discount fares, we can help plan a trip that's just right for you.

We have vacations for families. Honeymooners. Golfers. Tennis players. We even have vacations that take in other parts of Florida, or the Bahamas.

Prices range from $116 to $227* plus airfare for a family of four, for 4 days and 3 nights at a selected hotel, and Eastern's exclusive Walt Disney World Ticket Books, each good for one day's admission as well as 9 fabulous attractions.

MORE FLIGHTS THAN ANYONE ELSE.

Besides having the most vacations at the best possible prices, we also have more flights, from more cities, to Orlando than anyone else. In fact, last year alone, we flew over one million people there.

If you've been thinking about a Walt Disney World vacation, call your travel agent. Or us. A vacation to a fantasy world isn't something you do every day. So it makes sense to talk to the people with the most experience.

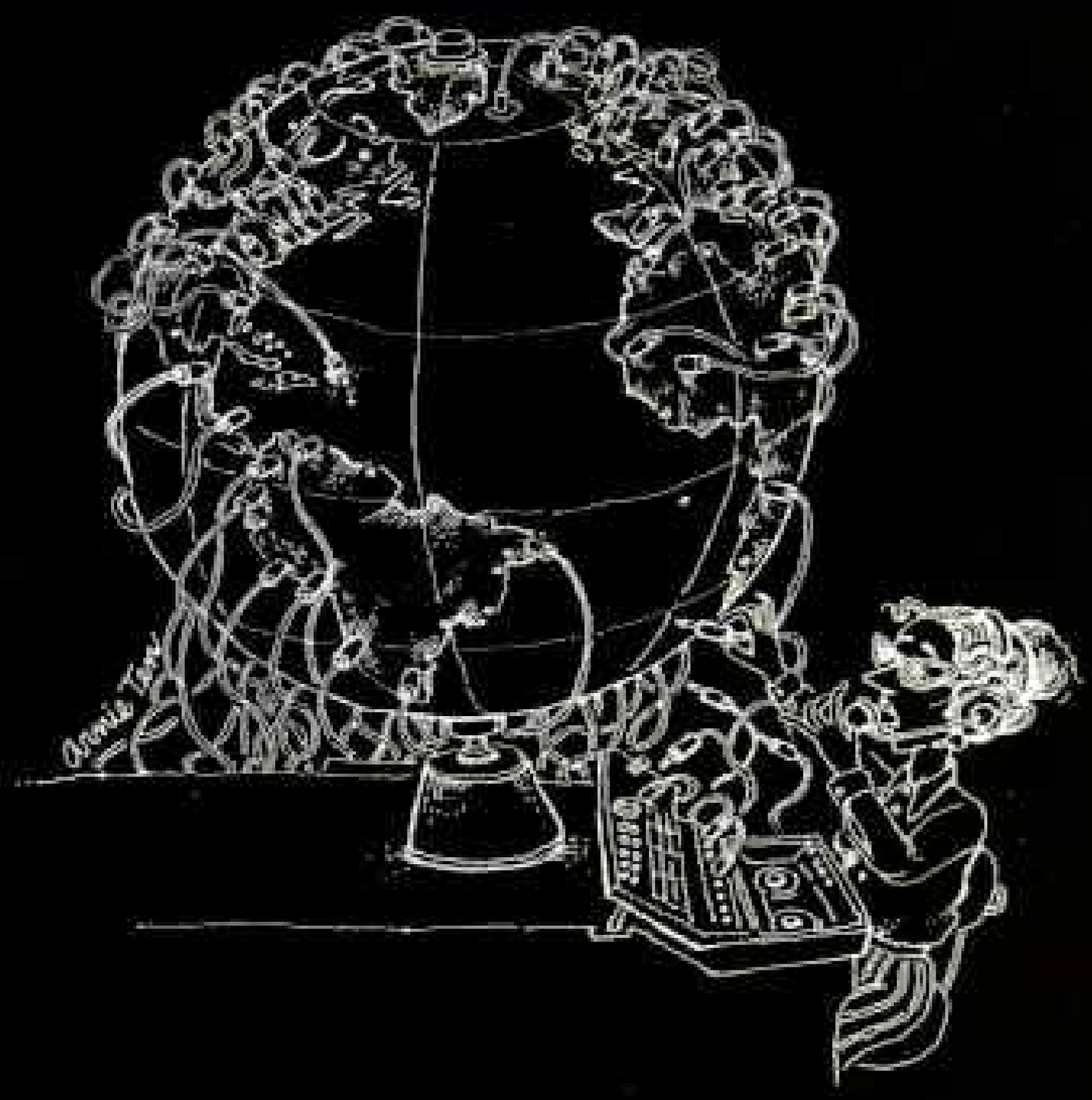
EASTERN. THE OFFICIAL AIRLINE OF WALT DISNEY WORLD.

EASTERN

WE HAVE TO EARN OUR WINGS EVERY DAY

*Prices do not include airfare, meals, transfers or local taxes and are subject to change. Prices and hotel space are subject to availability and apply to family with 2 children under 17 all sharing a room. Valid 4/16/79-12/15/79.

HOW TO RING AROUND THE WORLD



DIAL DIRECT

If your area has International Dialing, you have the whole world at your fingertips, and you can reach anywhere—in no time! Here's how it works to London, for instance. Dial:

INTERNATIONAL ACCESS CODE + COUNTRY CODE + CITY CODE + LOCAL NUMBER

011 + 44 + 1 + 1234567

Take advantage of your International Dialing Service. It not only saves you time, but money. Like, 90¢ on a 3-minute call to London—that's more than 16%. And there are comparable savings around the world.

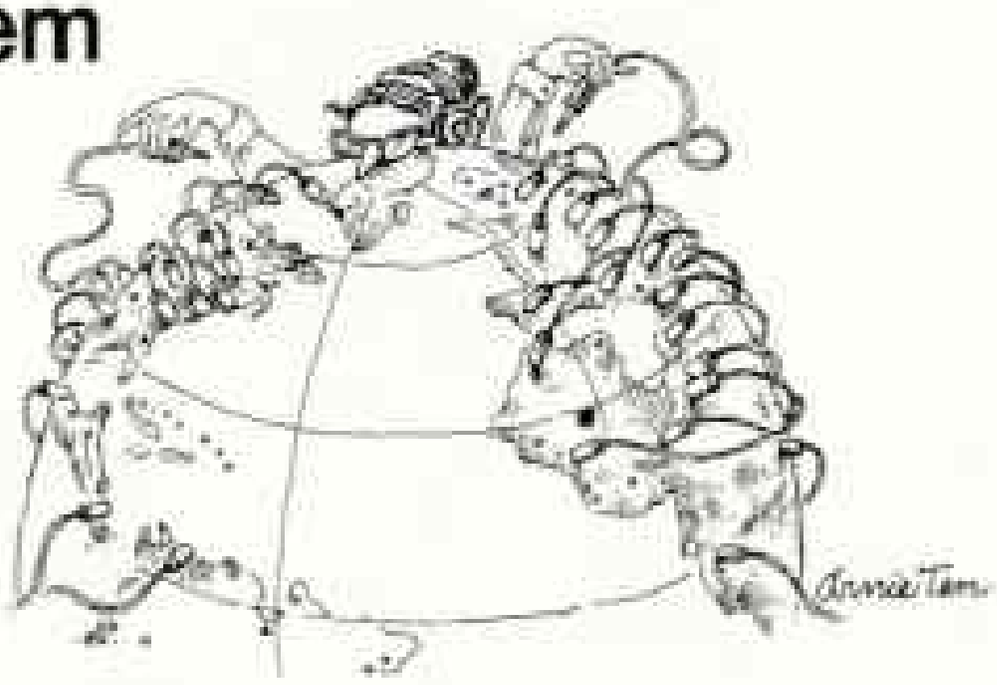
ALMOST DIRECT

Until you get International Dialing, here's the way to speed up your overseas calls. Dial O, and be ready to tell the Operator the country, city and local number you want. Specify Station or Person. The faster you give your information, the faster you reach your party—and that helps free the Operator for the next call, and the next time you want to call. By the way, if it's a Station call, you qualify for the same low rates as International Dialing.

P.S. Everyone can dial direct to Canada and the Caribbean, to Alaska and Hawaii and to parts of Mexico—just as you dial direct to cities inside the continental U.S.

Announcing a new line or a new heir, you can tell the world faster if you keep a record of the codes you use—and use them.

Bell System



KEEP THESE INTERNATIONAL DIALING CODES

DIAL DIRECT—Dial 011 + Country Code + City Code + Local Number

ALMOST DIRECT—Dial O and tell the Operator the country, city and local number

ANDORRA	**33**
All Points	078
ARGENTINA	**54**
Bahia Blanca	91
Buenos Aires	1
Cordoba	51
La Plata	21
Mar del Plata	23
Merlo	220
Moreno	228
Resistencia	711
Rosario	41
Santa Fe	42
AUSTRALIA	**61**
Adelaide	8
Brisbane	7
Canberra	62
Hobart	02
Melbourne	3
New Castle	49
Perth	9
Southport	75
Sydney	2
Townsville	77
AUSTRIA	**43**
Baden Bei Wien	2252
Bludenz	5552
Graz	316
Innsbruck	5222
Kitzbuhel	5356
Klagenfurt	4222
Krems/an der Donau	2732
Linz	732
Neunkirchen	2635
Salzburg	6222
St. Polten	2742
Vienna	222
Villach	4242
Wels	7242
BAHRAIN	**973**
All points	*
BELGIUM	**32**
Antwerp	31
Bruges	50
Brussels	2
Charleroi	71
Courtrai	56
Ghent	91
Hasselt	11
La Louviere	64
Liege	41
Louvain	16
Malines	15
Mons	65
Namur	81
Ostend	59
Verviers	87
BELIZE (BRITISH HONDURAS)	**501**
Belize City	*
Belmopan	08
Dangriga	05
Independence	06
Orange Walk	03
Punta Gorda	07
San Ignacio	09
BRAZIL	**55**
Belem	91
Belo Horizonte	31
Brasilia	61
Campinas	192
Curitiba	412
Florianopolis	482
Fortaleza	85
Goiania	62
Juiz da Fora	32
Londrina	432
Niteroi	21
Pelotas	532
Petropolis	242
Porto Alegre	512
Recife	81
Ribeirao Preto	166
Rio de Janeiro	21
Salvador	71
Santo Andre	11
S. Bernardo do Campo	11
S. Caetano do Sul	11
Sao Jose dos Campos	123
Santos	132
Sao Paulo	11
Vitoria	27
CHILE	**56**
Chiquayante	42
Concepcion	42
Penco	42
Talcahuano	41
San Bernardo	2
Santiago	2
Talcahuano	42
Valparaiso	31
Vina del Mar	31
CHINA, REP. OF	**86**
Changhua	47
Fengyuan	45
Kaohsiung	7
Keelung	32
Lotung	39
Pingtung	87
Taichung	42
Tainan	62
Taipei	2
Taitung	89
Taoyuan	33
COLOMBIA	**57**
Armenia	60
Barranquilla	5
Bogota	*
Bucaramanga	71
Cali	3
Cucuta	70
Ibague	82
Manizales	69
Neiva	80
Palmira	31
Pasto	301
Pereira	61
COSTA RICA	**506**
All points	*
CYPRUS	**357**
Famagusta	31
Kyrenia	81
Lapithos	8218
Larnaca	41
Lefka	7817
Limassol	51
Morphou	71
Nicosia	21
Paphos	61
Ruskharbasa	3613
DENMARK	**45**
Aalborg	6
Aarhus	6
Copenhagen	1 or 2
Esbjerg	5
Holbaek	4
Holstebro	7
Nykobing	3
Odense	9
Randers	6
Sonderborg	4
ECUADOR	**593**
Ambaro	2
Cuenca	4
Esmeraldas	2
Guayaquil	4
Ibarra	2
Loja	4
Machala	4
Manta	4
Portoviejo	4
Quito	2
EL SALVADOR	**503**
All points	*
FIJI	**679**
All points	*
FINLAND	**358**
Espoo-Ebbo	15
Helsinki	0
Jyvaskyla	41
Kuopio	71
Lahti	18
Oulu	81
Pori	39
Tampere	31
Turku-Abo	21
Vantaa	14
FRANCE	**33**
Bordeaux	56
Clermont-Ferrand	73
Dijon	80
Grenoble	76
Le Havre	35
Lille	20
Limoges	55
Lyon	78
Marseille	91
Mulhouse	89
Nancy	28
Nice	93
Orleans	38
Paris	1
Reims	26
Rennes	99
Rouen	35
Toulouse	61
St. Etienne	77
Strasbourg	88
GERMAN DEMOCRATIC REP.	**37**
Berlin	2
Dresden	51
Erfurt	61
Gera	70
Halle (Saale	46
Karl-Marx-Stadt	71
Leipzig	41
Potsdam	33
Rostock	81
GERMANY FED. REP. OF	**49**
Aachen	241
Augsburg	821
Berlin	30
Bochum	234
Bonn	2221
Bremen	421
Dortmund	231
Duisburg	203
Dusseldorf	211
Essen	201
Frankfurt	611
Hamburg	40
Hannover	511
Heidelberg	6221
Karlsruhe	721
Kiel	431
Mannheim	621
Munich	89
Nurnberg	911
Oberhausen	208
Stuttgart	711
Wiesbaden	6121
Wuppertal	202
GREECE	**30**
Argos	751
Athens	1
Corinth	741
Hydra	298
Iraklion	81
Kavala	51
Larisa	41
Patrai	61
Piraeus	1
Rhodes	241
Salonica	31
Sparta	731
Thessaloniki	31
Tripolis	71
Volos	421
GUAM	**671**
All points	*
GUATEMALA	**502**
Amatitlan	33
Antigua	32
Guatemala City	2
Quezaltenango	61
Villa Nueva	31
HAITI	**509**
Cap Haitien	3
Gonaive	5
Port-au-Prince	1
HONDURAS	**504**
All points	*
HONG KONG	**852**
Castle Peak	12
Cheung Chau	5
Fan Ling	12
Hong Kong	5
Kowloon	3
Kwai Chung	12
Lamma	5
Lantau	5
Ma Wan	5
Peng Chau	5
Sai Kung	12
Sha Tin	12
Tai Po	12
Ting Kau	12
Tsun Wan	12
IRAN	**98**
Abadan	631
Ahwaz	61
Esfahan	31
Hamadan	281
Kermanshan	431
Mashad	51
Rasht	231
Shiraz	331
Tabriz	41
Teheran	21
IRAQ	**964**
Baghdad	1
Basrah	4021
Derwaniya	3662
Hilo	3022
Mosul	6081
Najaf	3333
IRELAND, REP. OF	**353**
Cork	21
Drogheda	41
Dublin	1
Dundalk	42
Galway	91
Kilkenny	56
Sligo	71
Tralee	66
Waterford	51
Wexford	53
ISRAEL	**972**
Afula	65
Akko	4
Ashkelon	51
Bat Yam	3
Beer Sheva	57
Dimona	57
Hadera	63
Haifa	4
Holon	3
Jerusalem	2
Nazareth	65
Netania	53
Rehovot	54
Tel Aviv	3
Tiberias	67
ITALY	**39**
Bari	80
Bergamo	35
Bologna	51
Catania	95
Florence	55
Genoa	10
Milan	2
Naples	81
Padua	49
Palermo	91
Rome	6
Trieste	40
Turin	11
Venice	41
Verona	45
JAPAN	**81**
Amagasaki	6
Chiba	472
Fuchu	423
Fukuoka	92
Higashi	98043
Hiroshima	822
Kanazawa	762
Kawasaki	44
Kitakyushu	93
Kobe	78
Kumamoto	963
Kyoto	75
Nagasaki	958
Nagoya	52
Naha	988
Okayama	862
Osaka	6
Sakai	722
Sapporo	11
Sasebo	956
Sendai	222
Tachikawa	222
Tokyo	3
Yokohama	45
Yokosuka	468
KENYA	**254**
Kabete	2
Kiambu	284
Kikuyu	283
Kitumu	35
Mombasa	11
Nairobi	2
Nakuru	37
Shanzu	11
Thika	151
Uthiru	2
KOREA	**82**
Inchon	32
Jeonju	32
Kwangju	62
Masan	73
Mokpo	63
Pusan	72
Seoul	2
Taegu	82
Taejeon	42
Ulsan	74
KUWAIT	**965**
All Points	*
LIECHTENSTEIN	**41**
All Points	75
LUXEMBOURG	**352**
All Points	*
MALAYSIA	**60**
Alor Star	4
Bamahang	3
Dengkil	3
Ipoh	5
Kajang	3
Kuala Lumpur	3
Port Dickson	6
Seremban	3
Sungei Besi	3
Sungei Renggam	3
MONACO	**33**
All Points	93
NETHERLANDS	**31**
Amsterdam	20
Arnhem	85
Breda	76
Eindhoven	40
Enschede	53
Groningen	50
Haarlem	23
Heemstede	23
Hilligersberg	10
Hoensbroek	45
Hoogkeek	50
Hoogvliet	10
Leiden	71
Leeuwarden	79
Nijmegen	80
Oud Zuilen	30
Rotterdam	10
The Hague	70
Tilburg	13
Utrecht	30
NETHERLANDS ANTILLES	**599**
Bonaire	7
Curacao	9
Saba	4
St. Eustatius	3
St. Maarten	5
NEW ZEALAND	**64**
Auckland	9
Christchurch	3
Dunedin	24
Hamilton	71
Invercargill	21
Napier	70
Palmerston North	63
Rotorua	73
Tauranga	75
Wellington	4
NICARAGUA	**505**
Chinandega	341
Diriamba	42
Granada	72
Jinotepe	41
Leon	31
Managua	2
Masaraye	44
Masaya	71
Matagalpa	6
Rivas	61
NORWAY	**47**
Bergen	5
Drammen	3
Fredrikstad	32
Haugesund	47
Oslo	2
Sarpsborg	31
Skien	35
Stavanger	45
Tonsberg	33
Trondheim	75
PAPUA NEW GUINEA	**675**
All Points	*
PERU	**51**
Arequipa	542
Callao	14
Chiclayo	7423
Chimbote	4432
Cusco	8423
Huancayo	8423
Ica	0423
Lima	14
Piura	7432
Trujillo	44
PHILIPPINES	**63**
Angeles	55
Bacolod	34
Baguio	442
Cebu	32
Davao	35
Iloilo	33
Manila	2
San Fernando Pampanga	45
San Pablo	43
Tarlac	47
PORTUGAL	**351**
Almada	19
Barreiro	19
Braga	23
Coimbra	39
Evora	69
Guimaraes	23
Lisbon	19
Montijo	19
Porto	29
Setubal	15
SAN MARINO	**39**
All Points	541
SAUDI ARABIA	**966**
Abha	7
Al Khobar	31
Dhahran	01
Jeddah	21
Khamis Mushait	7
Mecca	22
Medina	41
Najran	7
Riyadh	1
SINGAPORE	**65**
All Points	*
SOUTH AFRICA	**27**
Bloemfontein	51
Cape Town	21
Durban	31
East London	431
Johannesburg	11
Pietermaritzburg	331
Port Elizabeth	41
Pretoria	12
Vereeniging	442
Welkom	17
SPAIN	**34**
Barcelona	3
Bilbao	4
Cadiz	56
Granada	58
Igualada	3
Las Palmas/de Gran Canaria	28
Leon	87
Madrid	1
Malaga	52
Palma de Mallorca	71
Pamplona	48
Santander	42
Seville	54
Torremolinos	52
Valencia	6
SWEDEN	**46**
Boras	33
Goteborg	31
Helsingborg	42
Linkoping	13
Malmo	40
Norrkoping	11
Stockholm	8
Sundsvall	60
Uppsala	18
Vasteras	21
SWITZERLAND	**41**
Aarau	64
Baden	56
Basel	61
Berne	31
Biel	28
Davos	83
Fribourg	37
Geneva	22
Interlaken	36
La Chaux-de-Fonds	39
Lausanne	21
Lucerne	41
Lugano	91
Montreux	21
Neuchatel	38
St. Gallen	71
St. Moritz	82
Solothurn	65
Winterthur	52
Zurich	1
TAHITI	**689**
All Points	*
THAILAND	**66**
Bangkok	2
TURKEY	**90**
Adana	711
Ankara	41
Bursa	241
Diyarbakir	8311
Eskisehir	221
Gaziantep	851
Istanbul	11
Izmir	51
Kayseri	0511
Konya	331
UNITED ARAB EMIRATES	
ABU DHABI	**979**
Abu Dhabi Town	2
Al Ain	3
Jebel Dhana	5
AJMAN	**971**
All Points	29
DUBAI	**978**
Awir	*
Faiq Ampla	96
Khawaraj	*
FUJAIRAH	**971**
All Points	1
RAS-AL-KHAIMAH	**971**
All Points	7
SHARJAH	**971**
All Points	5
UMM-AL-QUWAIN	**971**
All Points	69
UNITED KINGDOM	**44**
Belfast	232
Birmingham	21
Bolton	204
Bournemouth	202
Bradford	274
Brighton	273
Bristol	272
Cardiff	222
Coventry	203
Durham	358
Edinburgh	31
Glasgow	41
Ipswich	473
Leeds	532
Leicester	533
Liverpool	51
London	1
Manchester	61
Newcastle upon Tyne	632
Nottingham	602
Portsmouth	705
Prestwich	392
Sheffield	742
Southampton	703
VATICAN CITY	**39**
All Points	6
VENEZUELA	**58**
Barquisimeto	51
Catimos	64
Caracas	2
Ciudad Bolivar	85
Cumana	90
Maracaibo	61
Maracay	43
San Cristobal	76
Valencia	41
YUGOSLAVIA	**38**
Belgrade	11
Ljubljana	61
Maribor	62
Mostar	88
Novi Sad	21
Rijeka	51
Sarajevo	71
Skopje	91
Sole	58
Zagreb	41

* No city codes required

Meet a philatelist face to face.

The face behind the mask belongs to Linda Stolow, competition fencer. And philatelist. Which means that when she's not crossing swords, she's collecting stamps.

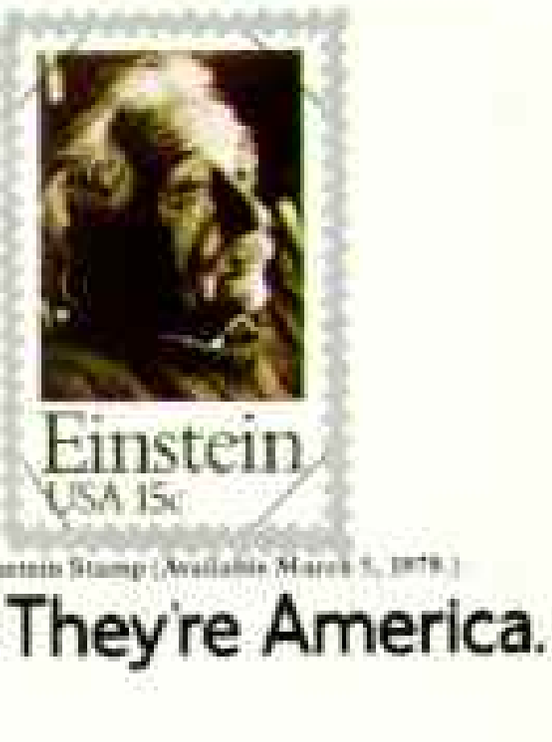
She likes the way U.S. Commemorative stamps introduce her to pioneers and presidents. To medalists and masterpieces. And to the exciting spirit that makes America, America.

U.S. Commemoratives are as easy to find as your Post Office. There are new issues every few weeks. And the new Albert Einstein Stamp, available in March, makes a great beginning or addition to your own collection.

There's even a guidebook called *Stamps & Stories* that brings you up to date on all U.S. stamps. This informative, colorful and easy-to-read collector's guide is available at your Post Office.

"My son Michael is three," says Linda. "And we'd love to see him become our family's third-generation stamp collector."

U.S. Postal Service



Albert Einstein Stamp (Available March 5, 1979.)

Collect U.S. Commemoratives. They're fun. They're history. They're America.

Orient Escapade $1633

15 DAYS
Japan, Taiwan, Hong Kong

Our 15-day Orient Escapade tour includes:

- **Money-saving group air fare**
- **Wide-cabin 747 comfort**
- **Deluxe hotels, such as Tokyo's New Otani**
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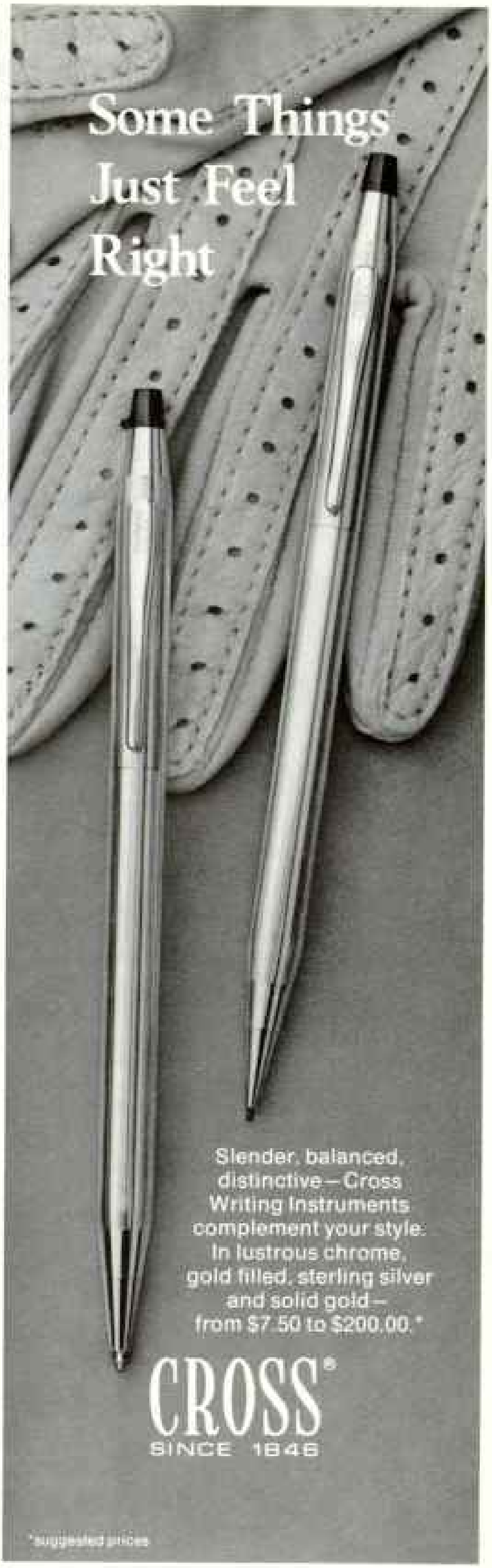

Why are so many manufacturers putting this much information on their labels?

Under Food and Drug Administration regulations, the labels of food products for which nutritional claims are made must contain lists of important nutrients including vitamins, minerals, protein, carbohydrates and fats, as well as calories. Vitamins, minerals and protein are expressed as percentages of the U.S. Recommended Daily Allowance (U.S. RDA)—the daily amounts established by the Food and Drug Administration as essential for maintaining good nutrition.

Even when a listing is not required, many food manufacturers voluntarily provide this information. They realize how this kind of information lets shoppers like you compare ingredients and buy the most nutritious foods.

Good nutrition. More important than ever.

Even though our country enjoys one of the highest standards of living and is the largest producer of food products in the world, there are serious gaps in our national diet, most frequently because of poor eating habits. These deficiencies are not limited to low income groups, but cut across all economic and social levels.

According to the most recent information, twenty to fifty percent of Americans run some risk of not meeting the U.S. RDA for at least one or more of the vitamins C, A, B_1 (thiamine), B_2 (riboflavin), and folic acid. Minerals such as iron and calcium are also likely to be insufficient.

Other ways you may be robbing your body of vitamins.

Recent studies show that blood plasma levels of vitamin C in heavy smokers were as much as 30% lower than in non-smokers.

Chronic heavy consumption of alcohol, including beer and wine, may interfere with the body's utilization of vitamins B_1, B_6 and folic acid. In addition, excessive drinking is frequently accompanied by poor eating habits, which compounds the problem by reducing vitamin intake. If you're dieting or skipping meals, you may be eliminating foods that contain many vitamins, including C, E and B-complex.

Sickness, including fevers and colds, may very well lower the level of vitamins in your blood. And women who take birth control pills could need extra vitamins B_1, B_2, B_{12}, folic acid and from two to ten times the normal amount of vitamin B_6. These increased nutritional needs have been demonstrated in several studies, but your own physician should be consulted.

How to get the extra vitamins you may need.

When shopping for foods, be sure to read the nutritional panels on the side or back labels of the package. Select those that give you and your family a well-balanced diet, and will add up to a daily intake of at least 100% of the U.S. RDA for vitamins, minerals and the required amount of protein. Just to be sure, you can also take vitamin supplements daily. There are a number of different formulations including multiple as well as individual vitamins.

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For geologist Marsha Green, it was a case of reviewing the evidence just one more time and coming up a winner. After only two years with Gulf Oil, Marsha discovered a new and untapped gas field.

Her find was near Victoria, Texas, which 20 million years ago was a seashore, rich in the marine life that creates natural

Marsha persuaded Gulf management to drill a series of exploratory wells.

gas. There were plenty of producing wells in this general area. The drilling record of each one tells a geologist something new about the earth's structure.

Marsha persuaded Gulf management to drill five exploratory wells. Four were dry. But on one, the instrument that detects natural gas went right off the scale. "A real textbook curve," Marsha says.

Such moments are rare. But Marsha is a dedicated professional. "I like to try to figure out what happened millions of years ago and put the whole picture together," she says. Marsha Green. One of 52,000 Gulf people, meeting the challenge.

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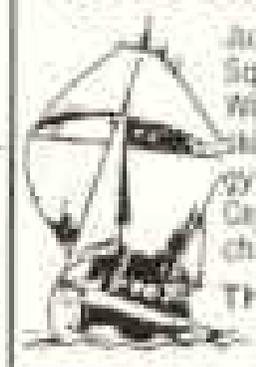

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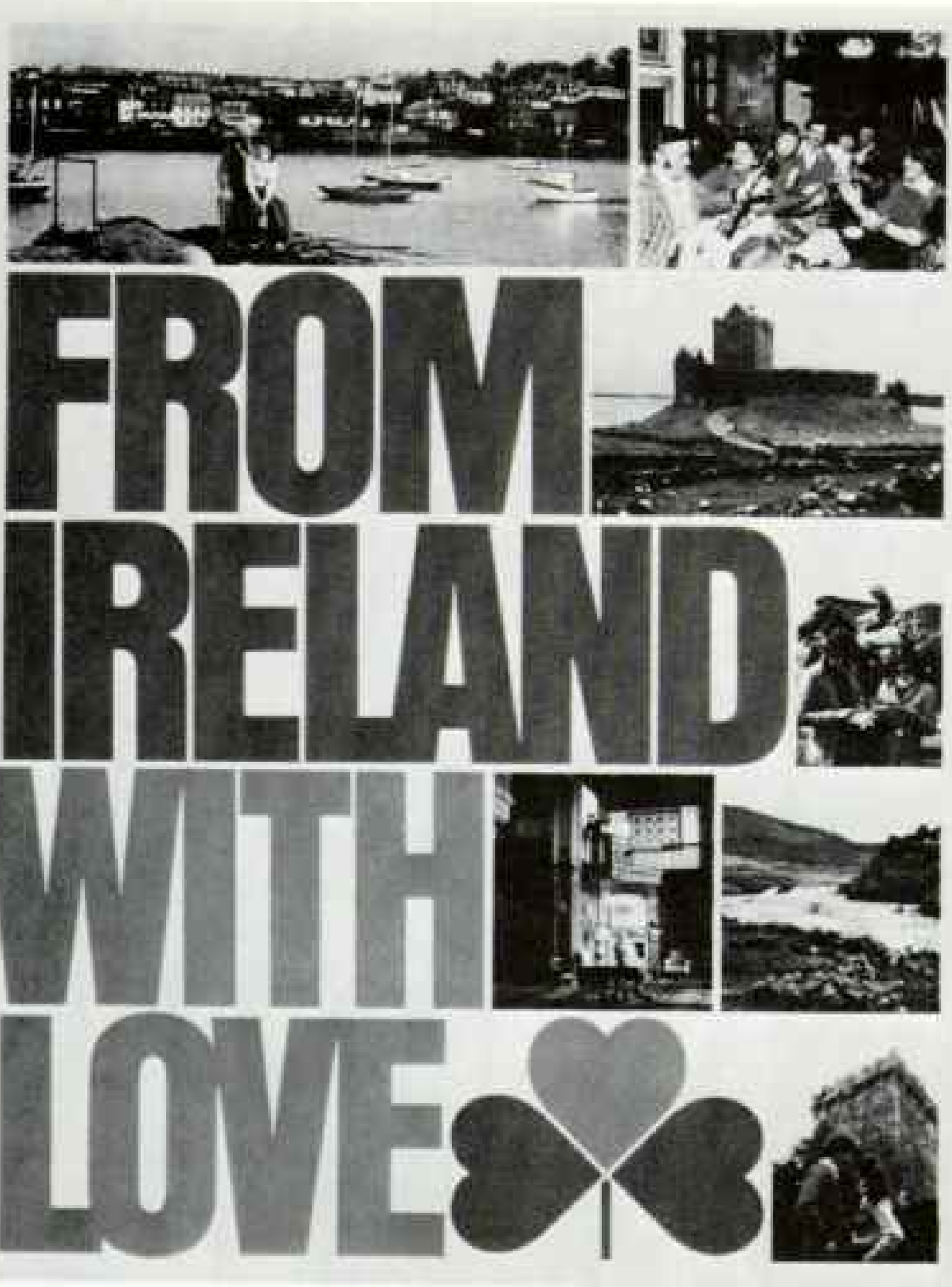

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The Dominican Republic

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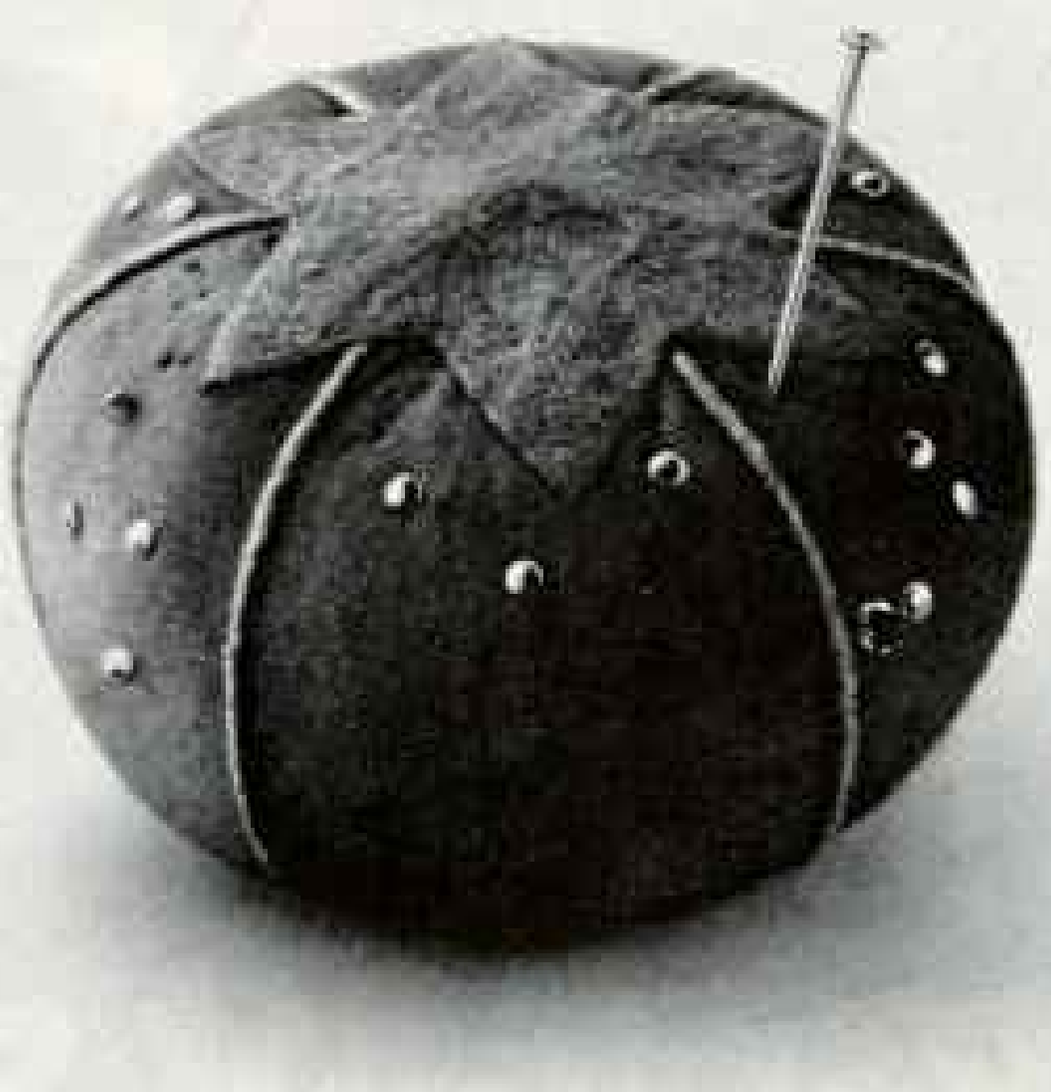

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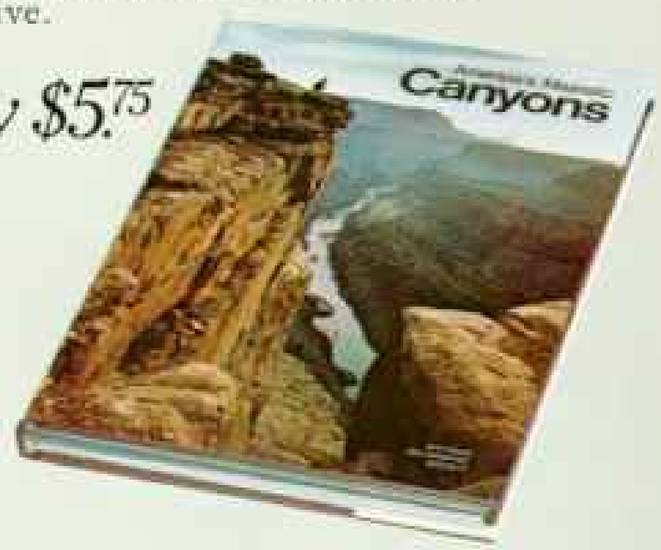

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