DOUBLE SUPPLEMENT: HOW EUROPE COLONIZED THE AMERICAS

VOL. 152, NO. 6 DECEMBER 1977

NATIONAL GEOGRAPHIC

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IN THIS LAST ISSUE of 1977 we open one of the earliest chapters in the American family album, reliving that turbulent time when European powers were contending for the great prize of the New World.

It is a fitting close for a year in which people seemed more intent than ever before on finding a secure identity. It was no surprise that one of the most popular articles in 1977 was the story of a young man's trek across part of the United States in search of "the certainty he once knew." In the end, he found a reaffirmation of old values.

Nor was it a surprise that our members responded with such enthusiasm to our presentation on the Wild and Scenic Rivers System—part of a continuing inventory of America's natural heritage that commenced with the wilderness regions and will continue in 1978 with the wildlife refuges, and later the national parks. From colonial times an abiding fascination with wilderness, and with the vast and varied landscapes of our continent, has been an integral part of the American national character.

The rediscovery of beginnings involves facing unpleasant truths about the past, as well as achievements. This year we recounted the tragic epic of Chief Joseph and his Nez Perces. In our own time his winged words seem to bespeak the conscience of all men. Again, this story was high in reader esteem.

Articles that bring alive the ancient past—those on the Celts and on the dazzling treasures of the Egypt of the pharaohs—elicited a widely favorable response. Part of their appeal, I feel, is surely due to the sense of continuity that they impart, the realization that our cultural and intellectual endowment runs deeply through the past.

The editors, writers, and photographers who produce your magazine have always thought of NATIONAL GEOGRAPHIC as being a mirror of its times, reflecting the changes through which we pass. That we appear to be in step with change is evidenced in the gratifying membership total, now almost at 10,000,000, and by the record number of new members who joined us this year.

Now in its ninetieth year of publication, perhaps the GEOGRAPHIC itself represents a small part of the continuity we all seek from the past. Surely that is a goal we strive to achieve.

Gilbert M. Grosvenor

NATIONAL GEOGRAPHIC

THE NATIONAL GEOGRAPHIC MAGAZINE, VOL. 152, NO. 6

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COVER: *Undaunted by the North Atlantic's ice, fog, and gales, "Brendan" nears the coast of Newfoundland (pages 769-797). Photograph by Nathan Benn.*

Drowned cargoes surface to document the 250-year struggle between Spain and her rivals in their

Reach for the NEW WORLD

By MENDEL PETERSON

Photographs by DAVID L. ARNOLD

NATIONAL GEOGRAPHIC STAFF

Paintings by RICHARD SCHLECHT

DAVID DOUBILET (ABOVE); HARRY ELIS COLLECTION, DEVONSHIRE, BERMUDA (FACING PAGE)

CHIPPED from coral's grip, cannons bear a message: The ship they sank with off Bermuda in the mid-1700's was probably Dutch, vying for trade in the Americas.

IN A GREAT CORAL RAVINE twenty feet under the sea the glass beads glisten like tiny gems in a mine shaft. As I approach the bottom, pinpoints of iridescent blue, green, lavender, and gold flicker among the dark crevices of coral.

It is a colorful but sobering sight, for it speaks of long-ago tragedy. The beads belong to the cargo of a sailing ship lost during the mid-18th century, probably with all hands, on the treacherous reefs that surround Bermuda.

Yet there is an even darker side to the wreck, one that transcends accidental loss of human life. Among the profusion of beads I recognize ominous shapes: the distinctive copper arm bracelets known to historians as manillas (**right**). In exchange for these ornaments, once manufactured by the hundreds of thousands in Europe, African chieftains delivered people, sometimes of their own tribes, into the hands of slave traders bound for the Americas.

What lies beneath me is a monument to human cruelty and greed—part of the cost of development of the New World.

No one knows how the slave ship came to grief or whether anyone survived the wreck. I suspect that the vessel was an escort for other slave ships rather than an actual carrier, for it was armed with more than two dozen

cannons, probably too great a burden for a normal slaver. Most likely the ship was bound eastward, returning from a profitable voyage to the Caribbean and heading once again for the Netherlands before returning to the West African coast.

Whatever the circumstances, the discovery is a major one in the continuing search for clues to America's past. Dubbed the "Manilla Wreck" by its discoverer, veteran Bermudian diver Harry Cox, the ship represents the largest known collection of slave-trade currency, in the form of barter beads and manillas. Further salvage of the wreck will undoubtedly shed valuable light on an inhuman but nonetheless significant aspect of New World empire.

SUCH DISCOVERIES paint an increasingly graphic picture of what I call "the reach for the New World"—the period of two and a half centuries between Columbus's historic landing on the island of San Salvador in 1492 and the decline of Spanish power in the Americas. During those turbulent, heroic, and often brutal years the New World served as a vast arena for the Old in a struggle in which both paid a terrible price.

Nowhere is the price more thoroughly itemized than among the maritime victims of that historic struggle—the countless ships whose remains are strewn across the ocean floor of the New World.

Over the past 25 years I have explored a great many of those wrecks for the treasures they contain, treasures not in a monetary sense but in terms of knowledge. In many cases artifacts recovered from the sea are far better preserved than those ashore. In addition, they can often be more precisely dated through records of marine disasters. To have such exact dating adds immeasurably to the value of certain finds by establishing their relationship in historical patterns.

I tend to think of every shipwreck as a combination lock, a unique set of tumblers to be arranged in proper sequence for access

BOTH HARRY COX COLLECTION

*STOCKPILE of glass beads (**facing page**), found with the 18th-century Bermuda wreck, was the coin that delivered Africans into bondage. The ship, possibly an escort for slave carriers, also yielded a glass intaglio from a seal showing St. George and the dragon (**above**). Salvaged artifacts graphically recapture a fierce competition for New World trade. Spain asserted a monopoly in the Indies after the monumental voyage of Columbus in 1492, while other nations, chiefly England, France, and the Netherlands, successfully challenged her power.*

The author served as Curator of the Division of Historic Archeology and Director of the Underwater Exploration Project at the Smithsonian Institution in Washington, D.C., until 1973. Educated at Vanderbilt University, Mr. Peterson is a specialist in ancient and medieval coins, and an expert in naval history.

NATIONAL GEOGRAPHIC PHOTOGRAPHER EMORY KRISTOF (ABOVE);
NAVAL MUSEUM, MADRID (FACING PAGE)

*COMBING the bones of a 16th-century wreck, a diver works an air lift. Spaniards bent on salvage, as in a 1626 drawing (**facing page**), used free-diving Indians and Africans.*

to the vault of knowledge within. While I share others' excitement over the mere thought of sunken hoards of gold and silver, I have come to value the sea's gift of knowledge as a greater trove of buried treasure.

COLUMBUS, of course, was not the first European navigator to lay eyes on the New World. We know that the Vikings preceded him, and it may well be that they followed in the wake of others. One fascinating possibility, explored in the following article on the legendary voyage of St. Brendan, is that seafaring Irish monks reached the New World in the sixth century, some 400 years before the Vikings.

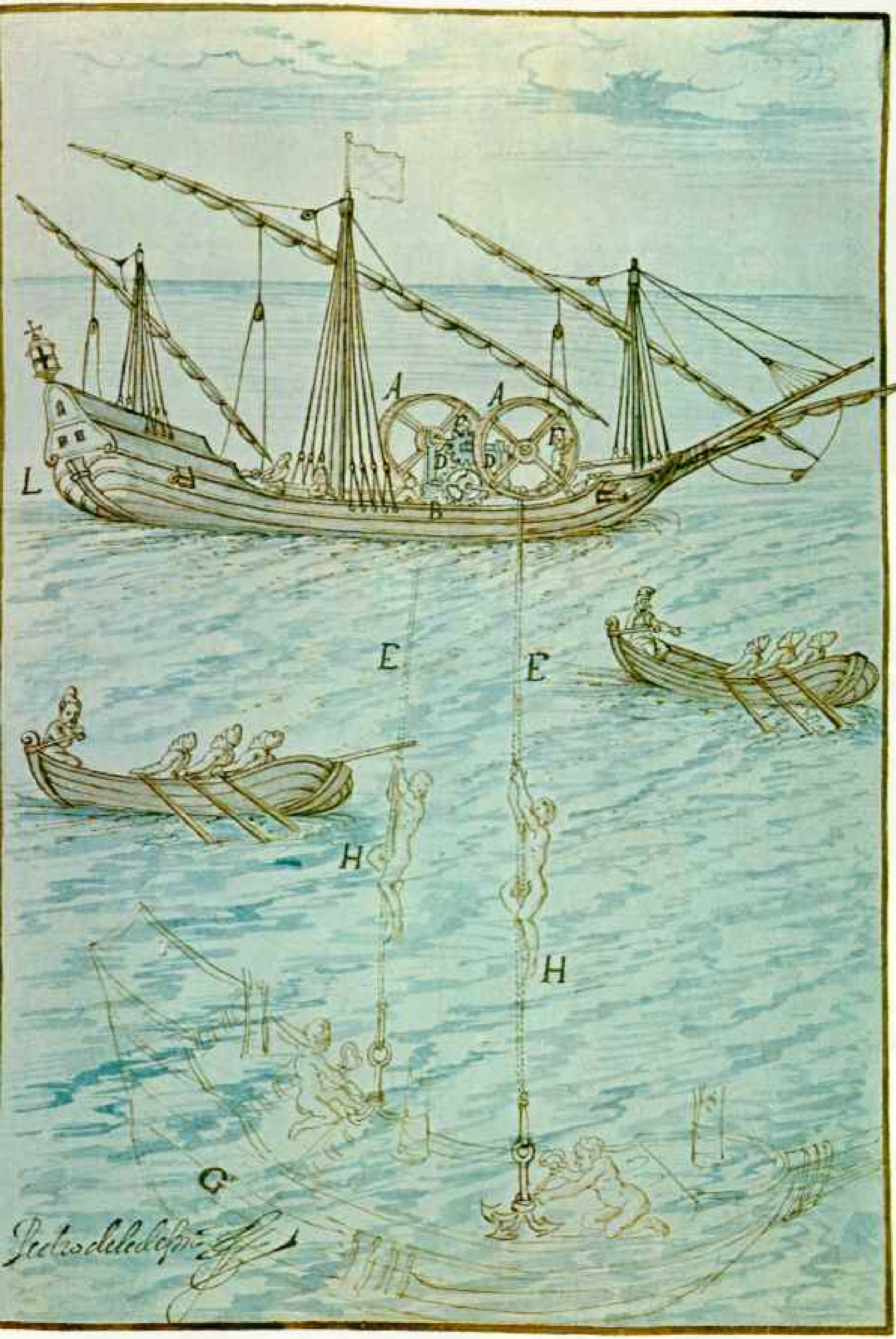
But from all the evidence, such visits were short-lived. It remained for Columbus—an Italian genius sailing under Spanish colors—to inspire what was to become the greatest land grab in history.

At its outset at least, the reach for the New World was essentially a twofold effort: one by Spain to bring home the wealth of the Indies, and the other by rivals, notably England, to relieve her of that wealth. Hardly had Columbus returned home with his breathtaking news of lands beyond the sea than the race to plunder them was on.

The first round went to Spain and Portugal, who promptly claimed the New World between them. With the Treaty of Tordesillas in 1494, based on a papal decree, they agreed upon a north-south line through the Western Hemisphere, reserving everything east of the line for Portugal and everything west of it for Spain. In effect the treaty declared all of North America a Spanish colony.

Spain's rivals would have none of it. During the next two centuries England, France, the Netherlands, Denmark, and Sweden all established footholds in the New World and took to raiding one another's claims. The first casualty was Sweden, whose small colony in Delaware was abandoned in 1655 under Dutch pressure. Denmark did better, holding out for more than 200 years in the Virgin Islands until the United States purchased the Danish portion in 1917.

Spain was the principal target of early attack for an obvious reason—treasure. While Portugal struggled to finance her colonies in the New World, Spain reaped enormous profits from hers and *(Continued on page 733)*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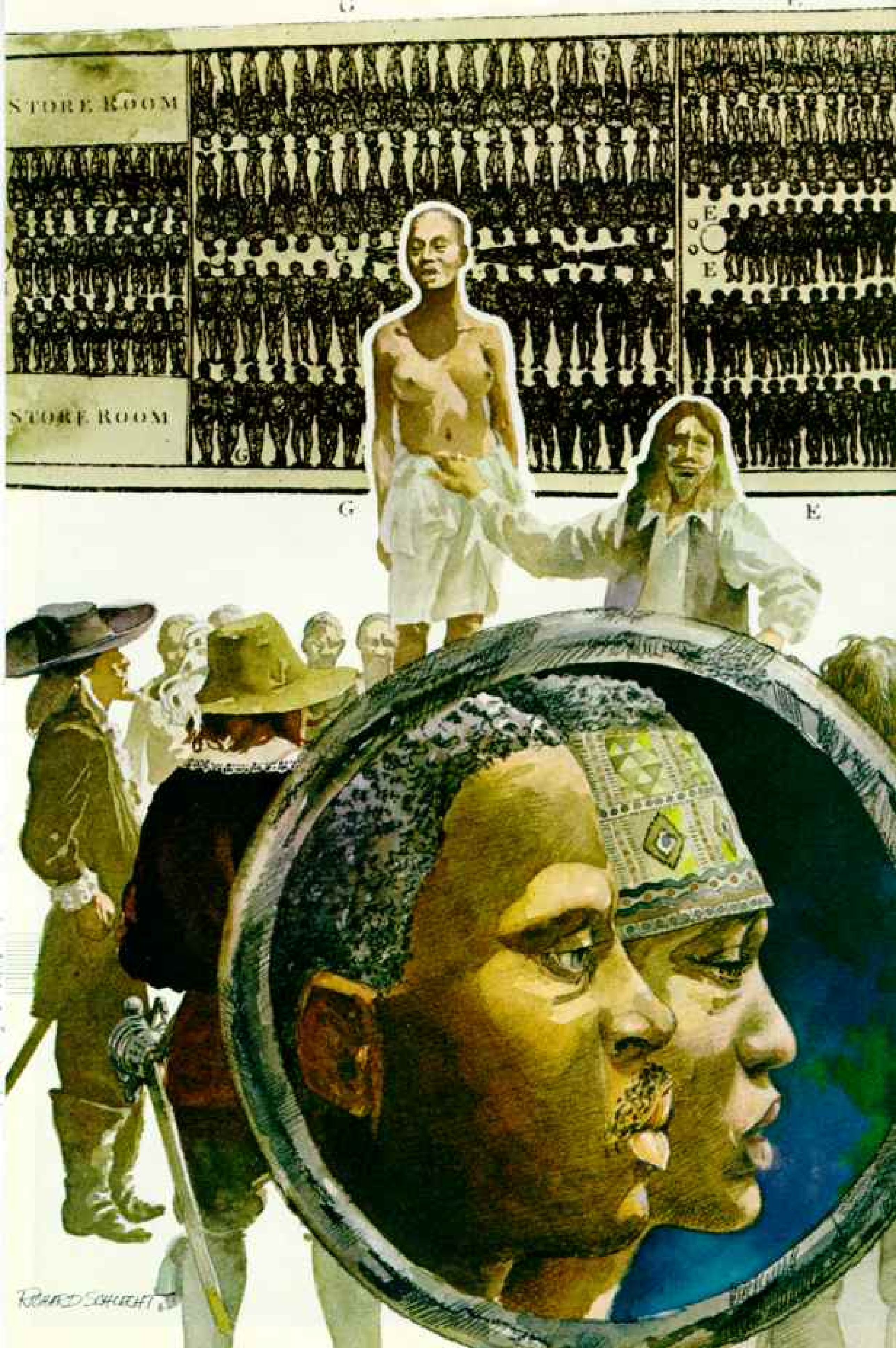
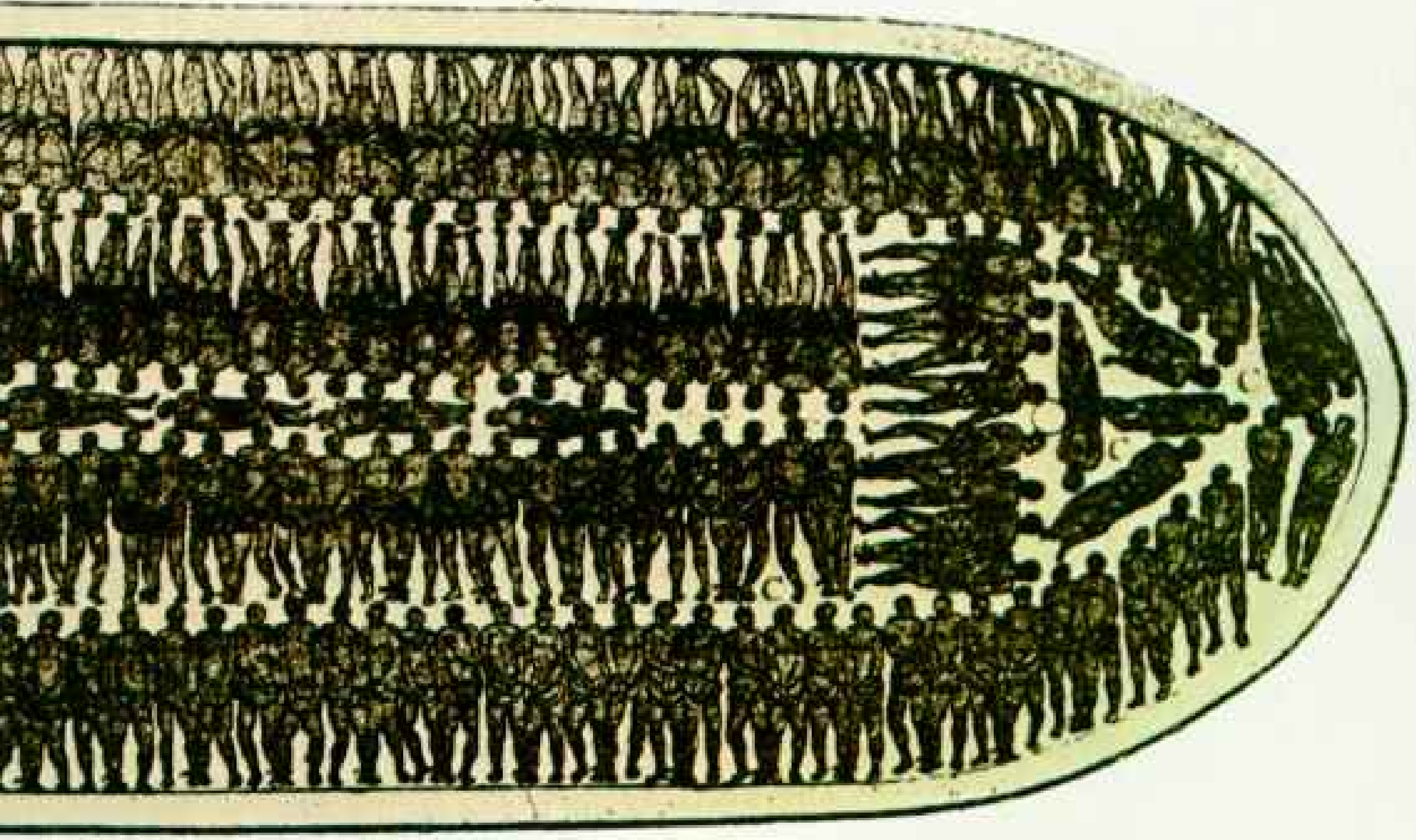
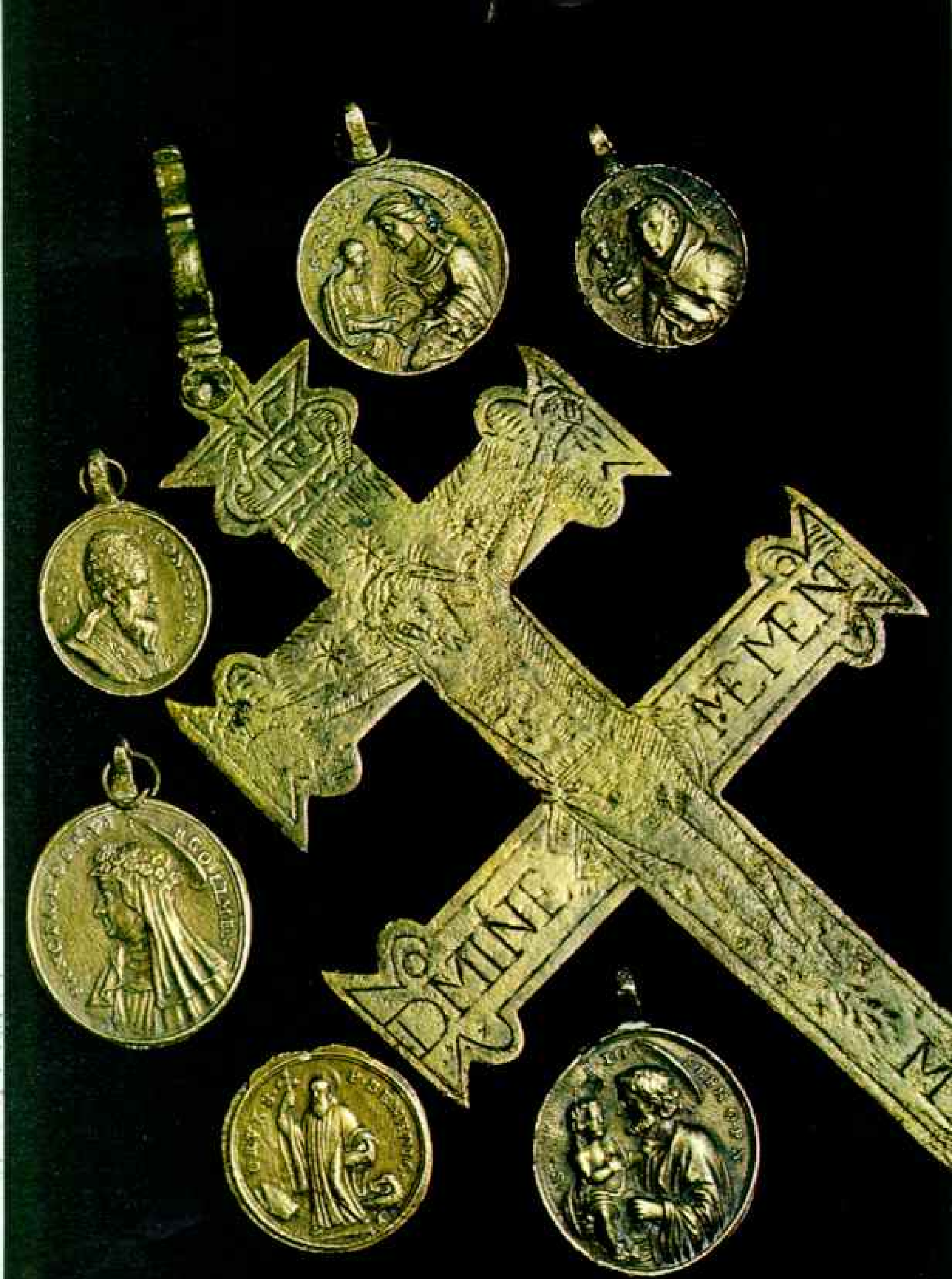




The slave trade: shiploads of agony

TEN MILLION AFRICANS or more endured the horrors of long ocean crossings to New World mines and fields from the late 15th through the 19th centuries. Early shipments supplanted native Americans decimated by disease and overwork under the Spanish yoke. Portuguese, English, Dutch, and French marauders bought their victims on Africa's west coast, then chained and crammed them like cordwood into their ships' holds. All told, a slaver like this one from an 18th-century English engraving (above) could carry about 450 men, women, and children. The death rate sometimes exceeded 20 percent. In the Caribbean, Mexico, and North and South America, survivors were herded to the auction block—passport to labor on a plantation.


MEMENTO
MORI

(Continued from page 728) fought a running battle to hang on to the loot.

The story of the Spanish treasure galleons is a familiar one to readers of NATIONAL GEOGRAPHIC. The special map supplement **Colonization and Trade in the New World,** which accompanies this issue, traces the historic routes of the galleons and pinpoints major wreck sites as well as the principal ports in the New World. The reverse side of the supplement depicts a galleon both above and below decks, with the types of cargo that flowed east and west across the Atlantic.

FOR ALL ITS VALUE, treasure was merely the spur to far more valuable trade to come. As early as the beginning of the 16th century, Spain was importing a variety of New World products and raw materials from across the Atlantic in the holds of her cargo ships. A good many of those ships, including *San Antonio,* never reached home port.

She met her end not far from the site of the Manilla Wreck on the same reefs that claimed hundreds of other transatlantic victims. Bermuda stood both as a beacon and barrier across the favored route home to Europe on the westerly winds. Like many, *San Antonio* raised the final landfall in the New World, only to founder on it. The year was 1621.

For a month one summer I explored *San Antonio*'s remains with Teddy Tucker, an authority on Bermuda's history. Gliding through crystal water at 30 feet, we found the ship's well-preserved cargo laid out among the coral heads almost as if for inspection.

One colorful item stood out among the rest, a block of bright blue material the size of a large paving stone, with a slightly pebbled surface. Inspecting it with Teddy, I suddenly realized what it was: a chest of indigo dye whose boards had rotted away and whose contents, in the shape of uniform balls, had been fused together by seawater. Teddy pointed at a small area of the surface, and to my surprise I noted several fingerprints—obviously those of the worker who had packed the indigo more than three centuries earlier!

In the end *San Antonio* supplied us not only with samples of her cargo but also with a look at life aboard an average 17th-century ship. During a day's diving, Teddy and I discovered fragments of tanned hides, pieces of

PABLO BUSH ROMERO—CEDAM, MUNAL, QUINTANA ROO, MEXICO (FACING PAGE); EMORY KRISTOF, COURTESY GOVT. OF BERMUDA, 2 3/4 IN. X 1 5/8 IN. (ABOVE)

*FOUND AND LOST: Gold cross studded with emeralds worth more than $200,000 is the most valuable piece of jewelry ever recovered from New World waters. In a Bermuda museum in 1975, a thief pulled an incredible switch, substituting a plastic imitation. The real cross, photographed in 1970 (**above**), is still missing. In exchange for South America's gold and emeralds, Europe sent back mere trinkets. Brass medals and crucifix (**facing page**) were bound for Mexico.*

EDMUND DOWNING COLLECTION, SOMERSET, BERMUDA

BRIMMING with history, a fancifully decorated jug carried by English colonists bound for Jamestown sank with the Sea Venture, *wrecked in 1609 off Bermuda. The passengers made it to shore and a few became permanent settlers.*

tortoiseshell, logs of lignum vitae—a dense wood used for rigging blocks and deadeyes—and curious, foot-long sticks, each tapered at both ends.

The mystery was solved when Teddy discovered a stick that was still wrapped with layers of paper-thin dark brown leaves—one of the New World's most famous, or infamous, gifts to the Old—tobacco.

One pathetic find spoke of suffering aboard *San Antonio*. From a niche in the coral I extracted a bean-size lead musket ball that had been partially flattened and indented by what obviously were human teeth. The discovery recalled early accounts of flogging aboard ship, a punishment common among the fleets of all nationalities. Before the ordeal a merciful shipmate often slipped a musket ball between the victim's teeth lest he bite his tongue in two out of agony.

Surgery at sea was equally heroic and almost as much feared. A musket ball often served, along with a double measure of rum, as the only comfort during a shipboard amputation or treatment of a serious wound.

It remained for Teddy to make the most bizarre find. On one of *San Antonio*'s rotted timbers his sharp eyes spotted a tiny brown capsule that later proved to be a cockroach egg case.

"A real treasure," he remarked proudly as we examined the case on deck. "You're looking at the world's most persistent stowaways."

OTHER STOWAWAYS on early transatlantic voyages could strike terror into passengers and crew alike. An account by Father Antonio Vázquez de Espinosa of a voyage in 1622 describes a fearful infestation of rats:

"To see such a multitude of rats frightened everyone, for they were all over the ship in great numbers, doing harm everywhere: on deck, in the hold, in rooms, in the pilot's chair, and although we watched for them they ate the sea chests of the soldiers and everything in them. . . . They chewed off the tops of the food jars, entered and ate, and died because they could not escape."

Such episodes must have been common, for among all the shipwrecks I have explored, not one has lacked the telltale tooth marks of rats on various fragments of bone, wood, or pottery.

Those who ventured across the Atlantic in Father Vázquez' day risked their lives as well as their comfort. The ships themselves were often unseaworthy, owing in large measure to human greed. As trade with the New World increased, so did demand for shipping, and more than one rotting hulk was pressed into service for a hazardous voyage that rarely included the vessel's owner.

Once in the New World, such derelicts were often burned for their iron fittings, to be sold at a handsome profit at one of the great trade

centers—Havana, Veracruz, or Portobelo. The result was a further shortage of ships. Spain stripped her forests bare of heavy timber in a vain effort to fill the demand. Many a Spanish merchant resorted to foreign charters despite a royal decree that all goods shipped to the country's overseas colonies be of Spanish manufacture and travel only in Spanish hulls.

On one 18th-century wreck off the Dominican Republic divers found a consignment of unused marine iron fittings obviously destined for a colonial shipyard. The discovery indicates that Europe eventually turned to the vast forests of the New World for the means to carry off its other treasures.

Gradually those treasures acquired a price tag. As more and more colonists settled the New World, Europe was forced to pay or barter for what it once simply seized. The annual summer trade fair at Portobelo on Panama's Caribbean coast transformed a normally quiet village into a brawling center of newfound wealth, a sort of 17th-century Klondike (pages 738-9).

At Veracruz, Portobelo's counterpart in Mexico, goods converged not only from Europe and the New World but also from points as distant as China. The latter were transported by galleon from the Philippines to Acapulco and thence overland across Mexico.

Equally exotic but deadly imports accompanied the merchandise: a variety of fevers, viruses, and bacteria that decimated both colonists and Indians. So great were the profits to be had at Portobelo, yet so high the mortality rate, that merchants bound for the annual event sometimes requested the last rites of the church.

THE IMMENSE VARIETY of trade between Europe and the New World was illustrated in 1957 by discovery of the Spanish ship *Nuestra Señora de los Milagros*—Our Lady of Miracles. Lost off the coast of Yucatán in 1741, she was salvaged by my friends Robert Marx and Pablo Bush Romero.

Nuestra Señora de los Milagros was on her way to the market at Veracruz with Europe's latest offering in the transatlantic trade. The offering, now assembled at a museum in Akumal, on the Yucatán Peninsula, never fails to impress me with its variety and with a sense of living history that mere documents can never capture.

My first surprise in cataloging the collection lay in its international flavor. Despite the fiat that only Spanish goods travel in Spanish ships, *Milagros*'s cargo included brass spoons from France, religious medals from Italy (page 732), German needles, and an assortment of English pewter. Clearly, Spanish merchants had found ways around a law that threatened to moor their ships at home with veritable hawsers of red tape.

One could envision some colonial tailor's delight over his share of the vessel's bounty, had it only arrived. In addition to the needles, there were hoards of bone and pewter buttons, spools of thread, cuff links, knee buckles in dozens of patterns, and doubtless bolt after bolt of cloth that had rotted away after more than two centuries beneath the sea.

AT LEAST ONE SERIOUS ITEM had accompanied the finery. A lead papal seal in perfect condition indicated that an official document from the Vatican had failed to reach its addressee in the New World.

Particularly poignant was the contrast between the "jewelry" that Europe unloaded on the New World and what she or her colonists received in exchange. *Milagros*'s cargo ran heavily to brass crucifixes, and to rings, pendants, brooches, and earrings set with cheap glass brilliants.

Sifting through such trinkets, I have often pictured a colonial French or Spanish noblewoman, resplendent in New World gold and precious stones, being served by an Indian maid wearing worthless imitations shipped from far across the sea.

One form of colonial jewelry served a practical as well as decorative purpose. The gold chains commonly worn by wealthy travelers in the New World could be instantly converted into cash, one link at a time. Such chains have been recovered in recent years by several divers, including Harry Cox, Teddy Tucker, Mel Fisher of *Atocha* fame, and the late Kip Wagner, discoverer of the fabulously rich 1715 treasure fleet off the coast of Florida.

Of varying lengths and values, the chains were fashioned of unsoldered links so that one or more could easily be twisted off. All the owner needed *(Continued on page 741)*

NATIONAL GEOGRAPHIC PHOTOGRAPHER JAMES L. STANFIELD, GALERÍA CANO, BOGOTÁ, COLOMBIA (ABOVE AND BELOW)

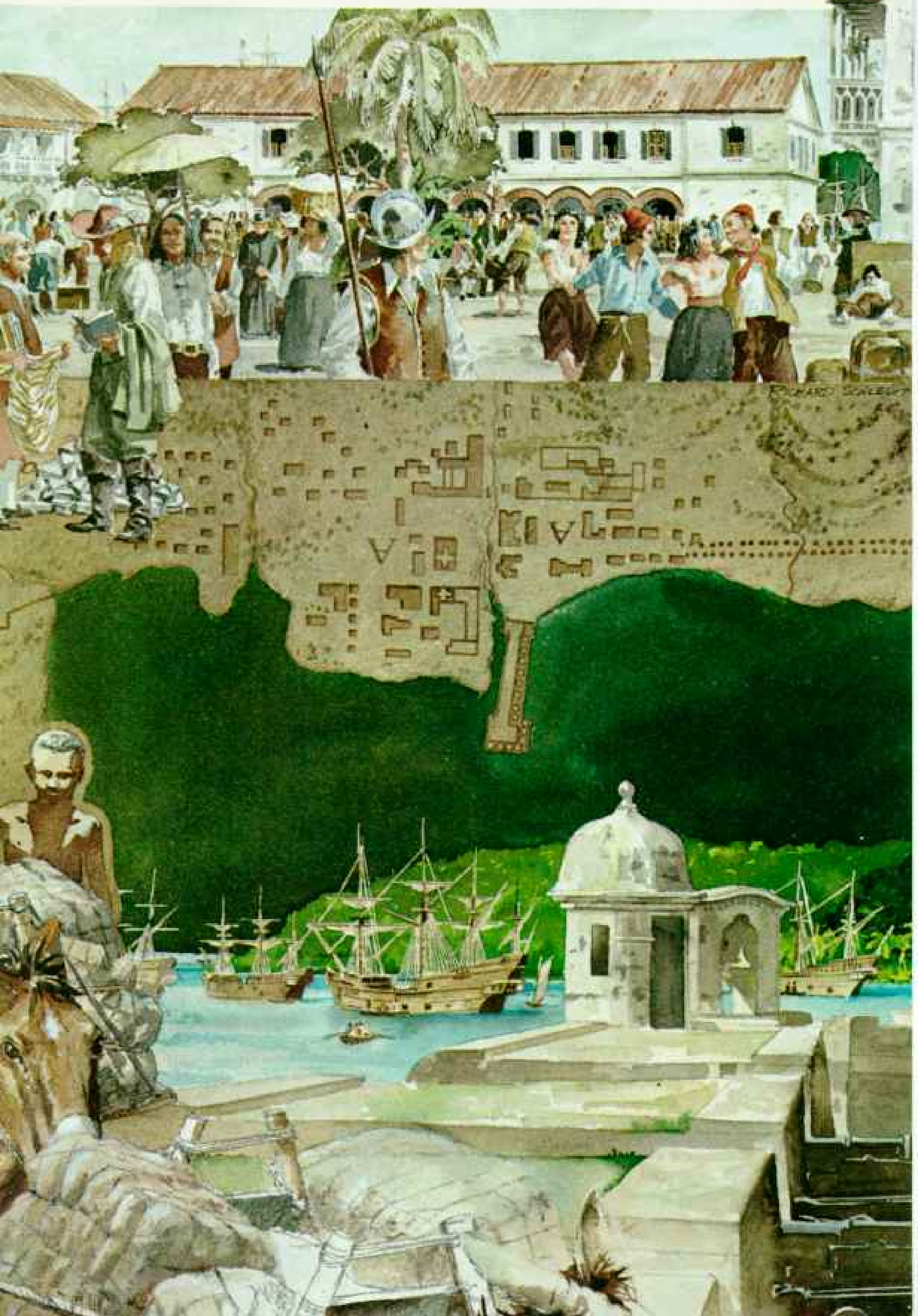
GOLD FEVER *spurred Spanish conquests. From* Nuestra Señora de las Maravillas, *sunk in the Bahamas in 1656, a ten-foot-long gold chain frames a gold ingot brimming with emeralds and amethysts (right). These quarter doubloons are among the earliest gold coins struck in the Americas.*

New World art became cold cash when Spaniards melted down Indian masterworks. Some survive, recovered from grave sites. A gold necklace adorning a clay cup (above) and a gold warrior (left) show the genius of Colombia's Tairona people.

SEAFINDERS, INC.,
TULSA, OKLAHOMA

Portobelo: crossroads for trade and treasure

"THERE IS NO GREATER FAIR," declared Thomas Gage, an English friar, than the one he witnessed in 1637 at Portobelo, Panama. As the annual treasure fleet approached the Spanish Main, Inca wealth stored in Panama City was packed by mules and floated by barges to Portobelo or the fair's earlier site, Nombre de Dios (map). There, colonial merchants met those from Spain in a hubbub of haggling, as gold bars and silver wedges were exchanged for finished goods. The fleet, bursting with treasure, departed to run a gantlet of storms, reefs, and privateers.



(Continued from page 735) was an assayer's scale to weigh a given link and an unglazed porcelain plate on which to rub it. The rubbing left a streak whose color determined the fineness of the gold.

The chains were frequently long and heavy, perhaps because personal jewelry was exempt from some of the taxes levied on gold bars or bullion. Such early forerunners of the tax shelter would have had one notable disadvantage at sea. One can imagine some luckless nobleman being washed overboard in a storm and speeded to the bottom by his own tax-free wealth.

Historians tend to dwell on Europe's impact upon the New World, yet the reverse effect was incalculable. The flood of gold and silver that began to reach the Old World by the mid-16th century forever altered Europe's social and economic structure.

Large coins struck from either precious metal, gold or silver, were still a rarity during the 14th and 15th centuries, and trade depended heavily on smaller coins and the barter system. Almost overnight such coins began to appear in circulation, providing a universal standard of commerce.

In addition to stimulating trade, the flood of money created a powerful new class of merchants, who proceeded to challenge, and often replace, the old nobility. Many of Europe's great ruling families never recovered.

NOWHERE was the change more evident than on Europe's dinner tables. Among New World additions to Old World cuisine were corn (or maize, as it was known), potatoes, a variety of squashes, new types of beans, and chocolate. One can scarcely imagine today's Italian cookery without the tomato, another New World contribution. Spaghetti, of course, had been introduced to Europe by Marco Polo at the end of the 13th century in the form of the Chinese noodle. Yet the all-important ingredient of spaghetti sauce failed to arrive from the New World until two centuries later!

Despite the success of the tomato in Italy, it was largely rejected as food by people in the United States until the mid-19th century. The fruit was considered ornamental but poisonous.

Contrary to popular belief, that indispensable American item, coffee, originated in the Old World. Its introduction to the Western Hemisphere, however, vastly increased the crop and gave rise to a European intellectual institution, the coffeehouse. Thus it was that the New World's endless variety of treasures filled the purses, the stomachs, and the spirits of the Old.

Throughout my career in undersea archeology I have been struck by a singular tragedy: the wholesale loss of original native treasures from the New World. How often I have seen a colleague emerge smiling from the depths with a gold coin or bar in his hand and heard the familiar shout, "Mendel, come

ALL MAPS INC.

*TASTE FOR LUXURY: Lost off the Bahamas, a 17th-century Spanish ship carried a silver ewer (**above**), spoon, fork, and gilded charger (**facing page**). Perhaps they graced the captain's table—or perhaps they were bound for a grandee in Spain.*

see what I've got!"—only to find that what he has is the result of long-ago vandalism, the deliberate conversion of a priceless gold relic into a unit of currency for a supposedly more civilized world.

In their senseless greed the Spaniards and others who followed them to the New World melted down almost everything of precious metal they could lay hands on, regardless of its cultural value.

One of the greatest losses undoubtedly occurred when Cortés's men melted down much of the royal treasure of the Aztec emperor Montezuma in 1520. The treasure contained not only the great masterpieces of Aztec civilization but those of other peoples from whom the Aztecs demanded tribute. In their ignorance Cortés's men assumed that gold was plentiful throughout the New World, when in fact the Aztec treasure represented centuries of accumulation and craftsmanship.

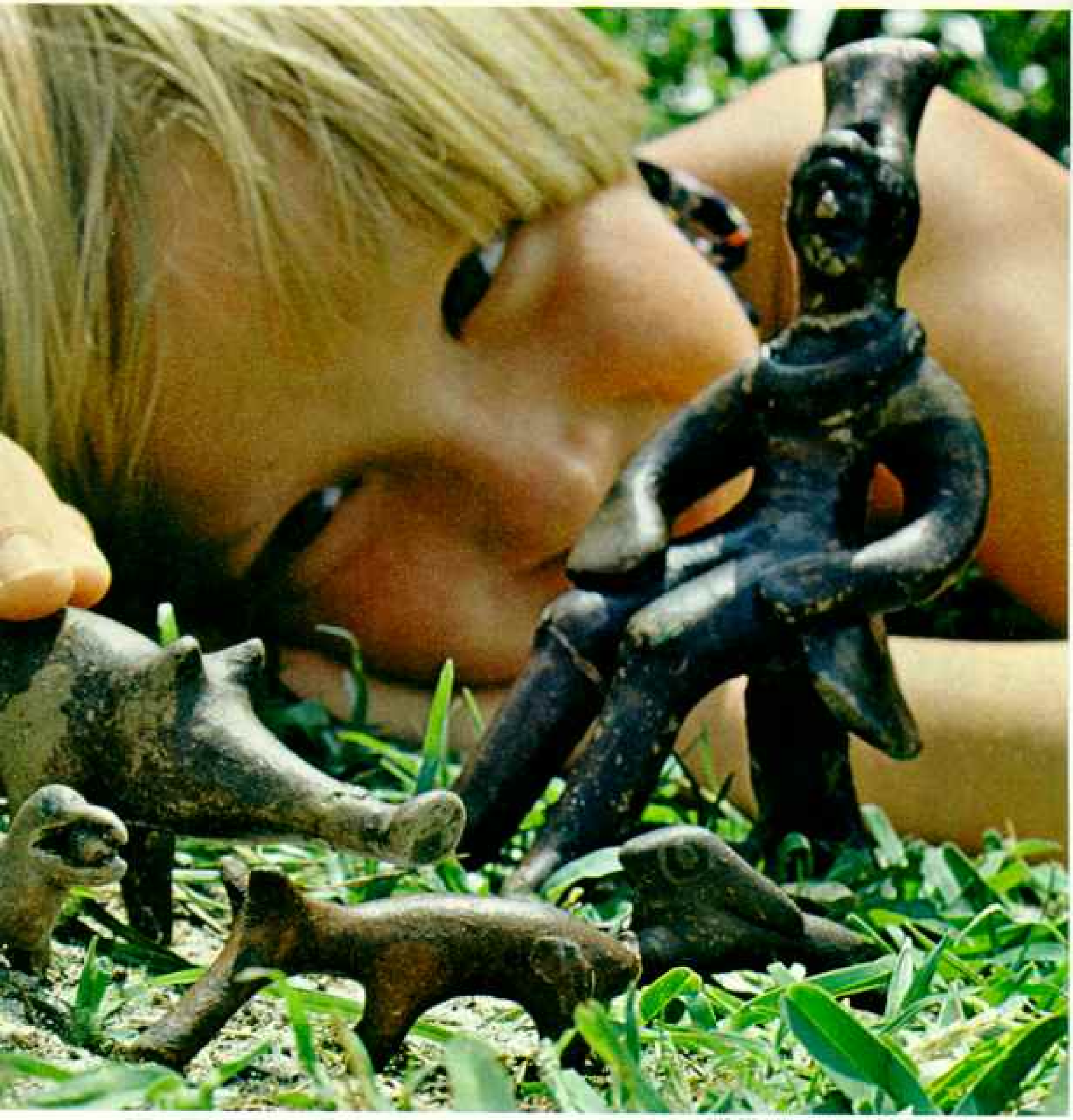
Only recently the discovery of what may well be original Aztec treasures was made by a fisherman in the shallows off the coast near Veracruz. The Mexican National Institute for Anthropology and History is now conducting a careful study of the treasure. With luck the find may prove to be evidence of a rare exception in a shameful chapter of New World history.

AMONG THOSE WHO JOINED the rush to the New World, Spain held no monopoly on greed. Almost from the first homeward voyage of a Spanish treasure galleon the wolves of Europe picked up the scent. They were a hybrid pack, drawn from the fleets of various rival powers and from the ranks of those without formal allegiance to any flag. One of the latter came to light through a chance discovery off the Bahamas in 1966.

Even today no one knows her name, though careful detective work suggests she was a French or English privateer. The wreck was discovered by three Americans—Bob Wilke, Clint Hinchman, and Jack Robinson—during a skin-diving expedition at Highbourn Cay in a group of Bahamian islands known as the Exumas.

From initial finds brought to me by Bob Wilke, I estimated the ship's date as prior to the 1550's, making it one of the earliest known wrecks in the Americas. Intrigued by the discovery, the National Geographic Society generously offered to support further exploration.

During my first dive on the wreck I very nearly shared her fate. Lodged in shallow water between two keys, her remains were swept by powerful tides that threatened even the most experienced diver. I finally solved the problem with that ancient marine device, an anchor. With a small grapple and a length



CAPT. BOB KLEIN COLLECTION, KEY LARGO, FLORIDA

of line around my waist I moored myself to the bottom. In like manner I was joined by my old friend Teddy Tucker.

The weeks of diving that followed produced a fascinating profile of the ship and her possible cause of death. Her lead cannonballs and her cannons—all of them wrought-iron breechloaders rather than the later type made of cast iron—placed the ship at no later than the mid-16th century. Two long-barreled

FANCIFUL AMULETS made of clay by skilled Indian hands must have delighted Spanish youngsters, just as they fascinate 7-year-old Alyssa Bantle today. Many crossed the Atlantic; these sank with a Spanish fleet in 1733 off Florida.

BOTH FLORIDA STATE DIVISION OF ARCHIVES, HISTORY, AND RECORDS MANAGEMENT, TALLAHASSEE

UNBROKEN LINK to a far-flung empire, a Chinese porcelain bottle was shipped from the Spanish Philippines to Acapulco, hauled across Mexico to Veracruz, and packed aboard a vessel in the 1733 fleet. Off the Florida Keys, a hurricane wrecked the convoy. Recovered from the same ship, a majolica dish (facing page) shows the handiwork of a New World artisan.

pieces known as *bombardettas* lay in the bow area of the wreck, and 11 smaller swivel guns had gone down amidships. Both types of armament were typical of early New World privateers, mostly French or English.

To get at the remains of the hull, we pumped away tons of sand, and Teddy produced scale drawings of her lines. "I'd say she was fast," he remarked after studying the results. "Probably she was lateen rigged, from the look of that narrow beam. Not many ships of the day could outrun her."

From the pile of rock ballast estimated at 55 tons, we projected a vessel of about four times that displacement, carrying a crew of some 35. Gradually the portrait emerged of a ship designed for pursuit of slower victims, with the capability of damaging them by means of her long-range bow armament and then closing to rake them broadside with the swivel guns before boarding and capture.

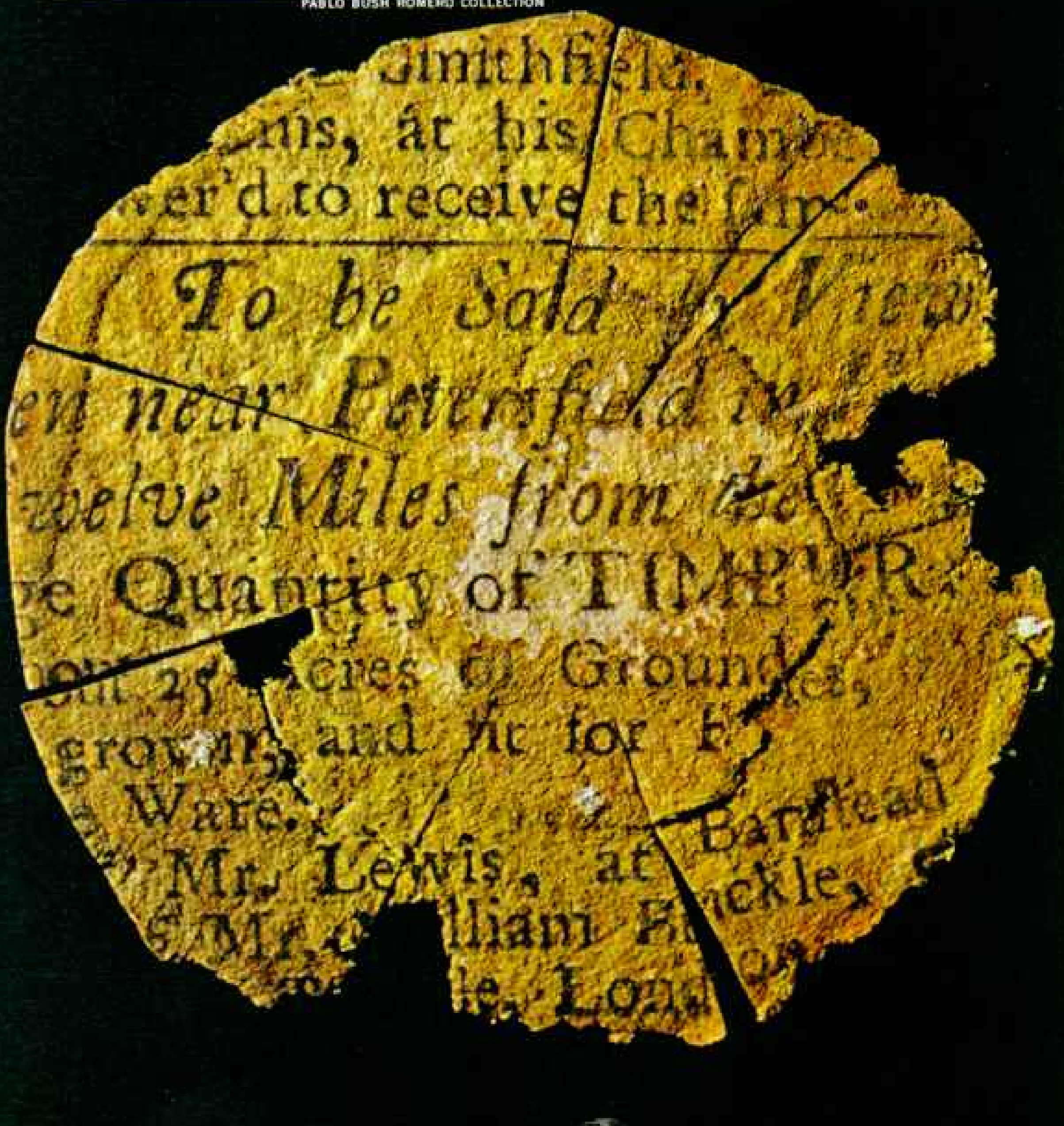
Several features of the wreck suggested a slow and peaceful end. We found two bow anchors some 200 yards forward of the site, indicating a stationary ship or one that had dragged anchor in the final moments before her death. Still more revealing was the almost total absence of portable items aboard—small arms, ship's stores, personal possessions—which the crew presumably had time to unload. What they did with them or whether the men survived in the end remains a puzzle for archeologists ashore. The sea seldom holds clues to such mysteries.

AMONG SPAIN'S countless enemies at sea, a memorable few sailed not only for personal gain but on behalf of their countrymen as well. Such names as Hawkins, Drake, Cabot, and Hudson speak of England's daring raids in the Spanish Caribbean and her exploration and eventual settlement of North America. In Portugal's service there was the great navigator Pedro Álvares Cabral, and France boasted Cartier, Ribault, and La Salle. The Netherlands is memorialized in the New World by a heroic figure named Pieter Pieterszoon Heyn.

An admiral in the Dutch West India Company, Heyn in 1628, with only a handful of men in longboats, captured a Spanish treasure fleet along the coast of Cuba (pages 748-9). The incredible feat saved the Netherlands from *(Continued on page 755)*

PABLO BUSH ROMERO COLLECTION

TIME RAN OUT for Nuestra Señora de los Milagros *on February 22, 1741, when the ship ran aground off the Yucatán coast. Her goods, bound for Spanish colonists, included a gold double-cased English watch. As a shim between the works and the inner casing, its maker used a snippet of newspaper (below)—still legible after 218 years under the sea—advertising a timber auction.*

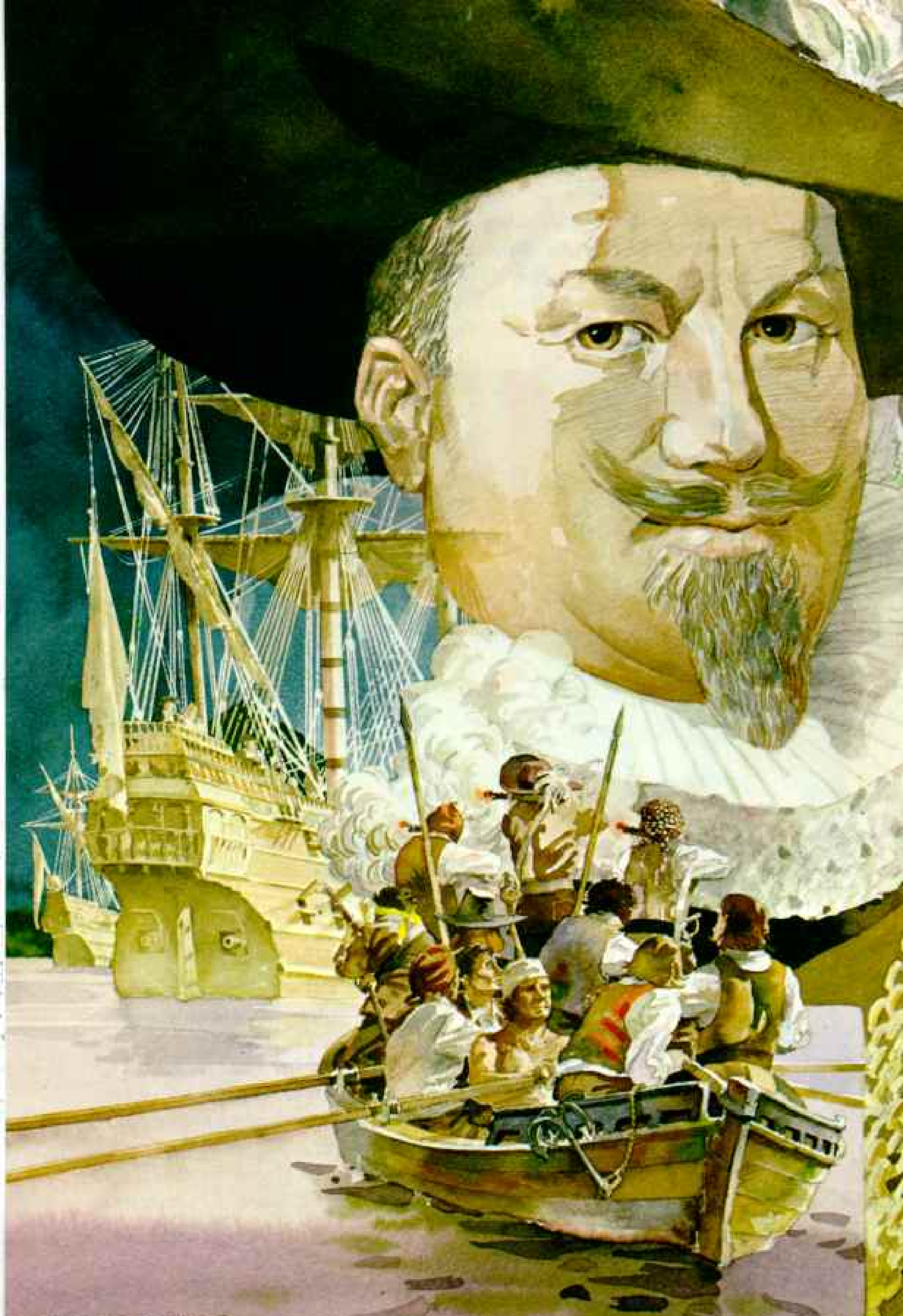


NOT EVEN TODAY'S AIDS to navigation could have saved the Winchester *in 1695. Brass dividers and a portable sundial (**below**) recovered from that English man-of-war rest on a modern chart of the Florida shoals that claimed her a mile and a half south of Carysfort Reef Light. While she sailed in a convoy homebound from Jamaica, scurvy riddled her crew. With death at the helm, she drifted to her doom.*

CAPT. BOB KLEIN COLLECTION

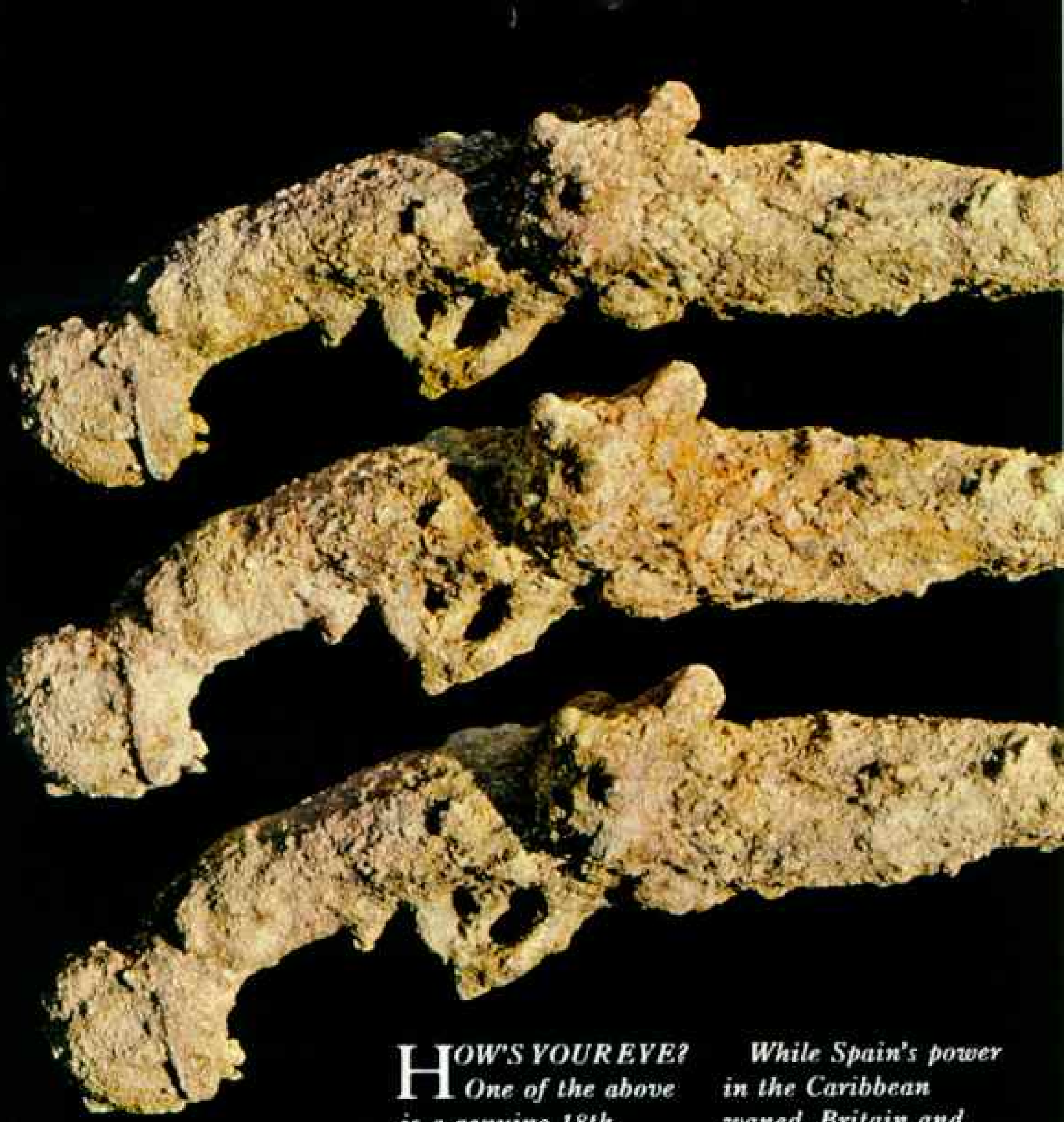
FLORIDA DIVISION OF ARCHIVES, HISTORY, AND RECORDS MANAGEMENT

*ENDLESS HOURS were marked by a pocket-size brass sundial (**left**). The gnomon that created the shadow folded down when not in use. The instrument went to the bottom along with fabulous riches on July 31, 1715, when a hurricane smashed into a Spanish treasure fleet.*


RICHARD SCHLECHT

A daring Dutchman snares a Spanish bonanza

*PIETER PIETERSZOON HEYN. His name brought joy to every heart in the Netherlands when he seized a Spanish treasure fleet in 1628, surprising the convoy off the Cuban coast. In small boats Heyn led his raiders toward the galleons. "We attacked with a musket charge. . . ," he later reported, "calling to them: '¡Buena guerra!' "—a signal that the crew would be spared. Surrendering without a fight, the Spaniards gave up millions of dollars' worth of loot. Thus the Dutch government gained sorely needed capital, Spain lost face, and a Spanish captain general was judged cowardly and negligent, and was executed. To commemorate Heyn's feat, silver medals (**below**) were struck from the captured bullion. But his glory was short-lived. Less than a year later a pirate's cannon cut him in two.*



HOW'S YOUR EYE? *One of the above is a genuine 18th-century flintlock pistol from a Spanish ship, encrusted with sand, coral, and shell. The others are plaster-and-epoxy imitations. The owner had a craftsman make reproductions for fear the real one, middle, would eventually disintegrate as the iron inside oxidized.*

While Spain's power in the Caribbean waned, Britain and France dueled for control of Canada. One casualty: the Machault, *a French supply ship blown up by her own crew in 1760 off the Gaspé Peninsula to avoid capture by a British squadron. A rusted musket barrel (right) holding a triple load bears witness to her futile defenses.*

COMPLETE WITH FLINT, a Spanish pistol lock called a miquelet was salvaged from a 1733 wreck. Its prompt burial beneath the seafloor protected the iron mechanism from corrosion.

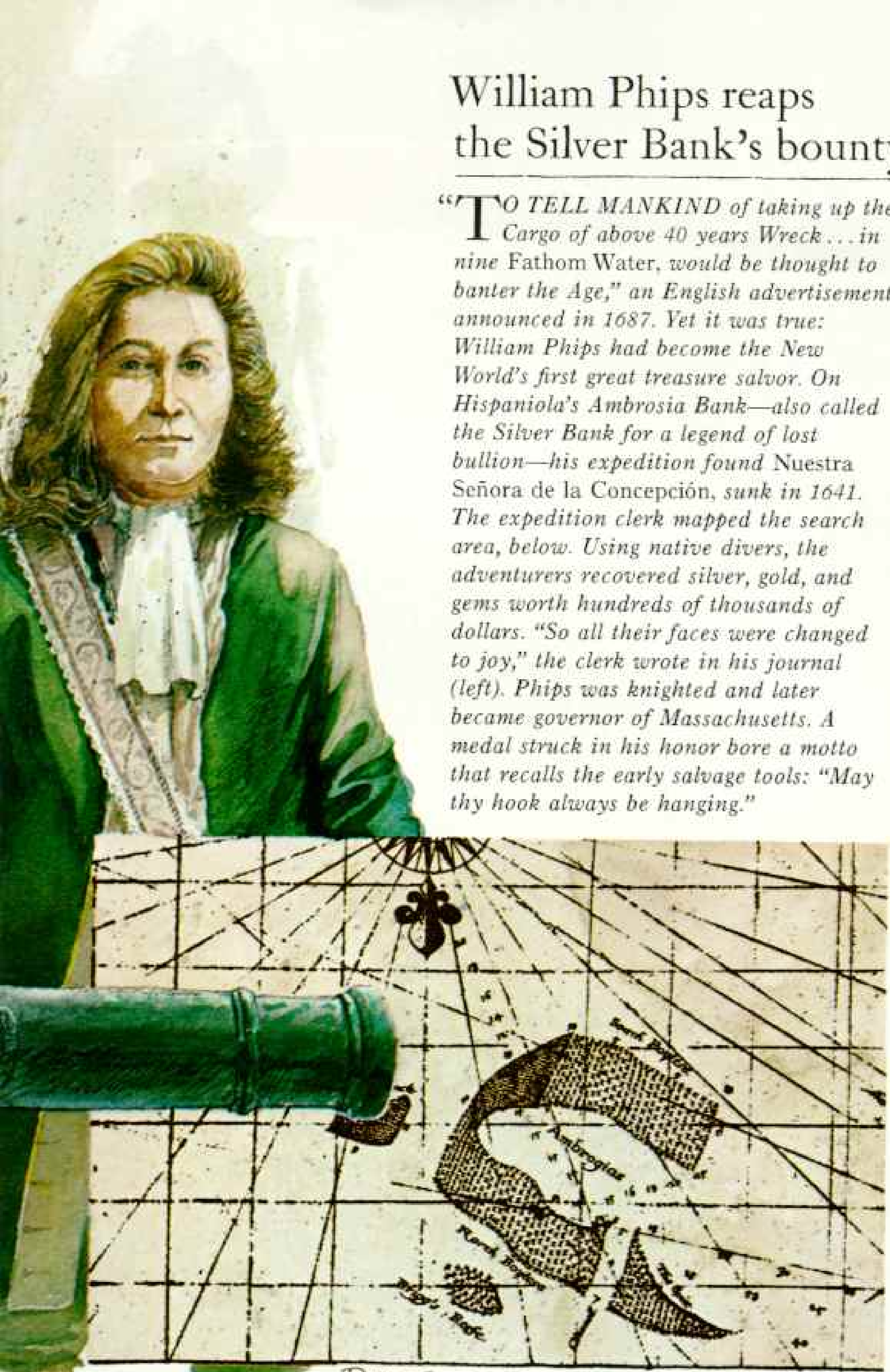
McKEE'S MUSEUM OF SUNKEN TREASURE, PLANTATION KEY, FLORIDA

FLORIDA DIVISION OF ARCHIVES, HISTORY, AND RECORDS MANAGEMENT

INDIAN AND NORTHERN AFFAIRS, PARKS CANADA, OTTAWA, ONTARIO

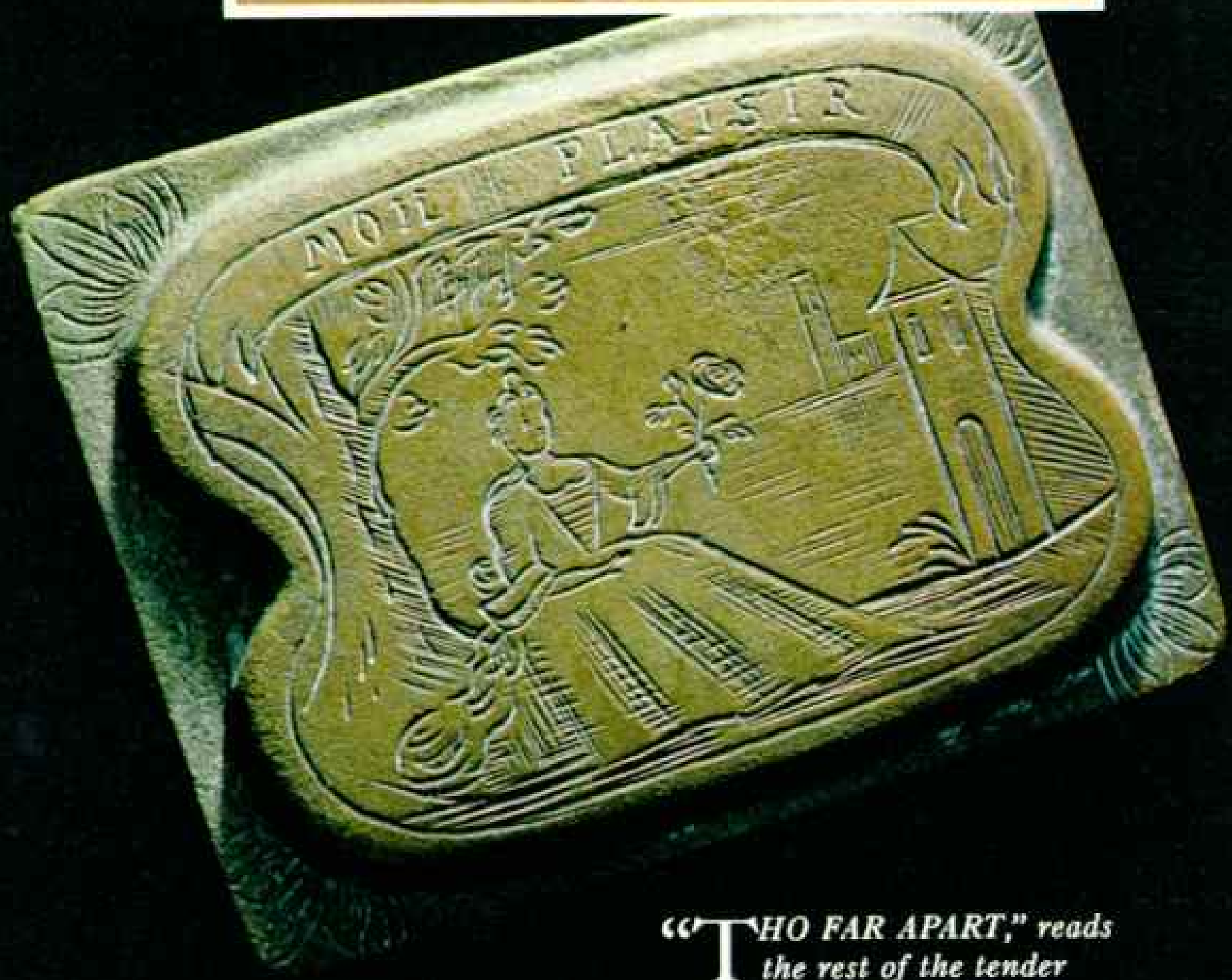
William Phips reaps the Silver Bank's bounty

"TO TELL MANKIND of taking up the Cargo of above 40 years Wreck . . . in nine Fathom Water, *would be thought to banter the Age," an English advertisement announced in 1687. Yet it was true: William Phips had become the New World's first great treasure salvor. On Hispaniola's Ambrosia Bank—also called the Silver Bank for a legend of lost bullion—his expedition found* Nuestra Señora de la Concepción, *sunk in 1641. The expedition clerk mapped the search area, below. Using native divers, the adventurers recovered silver, gold, and gems worth hundreds of thousands of dollars. "So all their faces were changed to joy," the clerk wrote in his journal (left). Phips was knighted and later became governor of Massachusetts. A medal struck in his honor bore a motto that recalls the early salvage tools: "May thy hook always be hanging."*



RICHARD SCHLECHT

RING, CAPT. BOB KLEIN COLLECTION; TOBACCO BOX,
FLORIDA DIVISION OF ARCHIVES, HISTORY, AND RECORDS MANAGEMENT



"THO FAR APART," reads the rest of the tender message inside a gold ring from an English vessel. A brass tobacco box inscribed "my pleasure" in French—perhaps a sailor's souvenir—was found with a Spanish wreck.

(Continued from page 744) financial crisis and endeared Heyn forever to Dutch hearts. So successful were he and his countrymen that in time the term "Hollander" in Spanish came to mean any enemy of Spain.

One of the most dramatic seizures of Spanish treasure took place beneath the sea. In 1641 a galleon, *Nuestra Señora de la Concepción*, sank with a fortune in silver on a reef north of Hispaniola. Unable to salvage the treasure themselves, the Spaniards finally abandoned it. Nearly half a century later a New Englander, William Phips, used native Caribbean divers to recover treasure worth hundreds of thousands of dollars from the wreck (pages 752-3). It was one of the largest troves ever salvaged from the sea until modern times, and it earned Phips a knighthood as well as a personal fortune.

Other enemies of Spain struck her from bases she herself had founded. In 1655 an English expedition under Adm. William Penn and Gen. Robert Venables seized the Spanish island stronghold of Jamaica. While England looked the other way, an assortment of pirates and freebooters—the flotsam of the Caribbean—used Port Royal, Jamaica, as a base from which to harry the forces of Castile.

Port Royal, one might say, abounded in scoundrels, chief among them the legendary buccaneer Henry Morgan. In one notable act of piracy Morgan plundered a Spanish treasure in Panama, then sailed off leaving most of his companions stranded ashore. To the amazement of many, Morgan was later knighted by Charles II and appointed lieutenant governor of Jamaica. In his newfound respectability the former cutthroat turned on his old associates and swept Jamaica clean of pirates, an act that earned him the facetious title "Knight of the Double Cross."

NATURE, not Spain, took vengeance on Port Royal. Shortly before noon on June 7, 1692, a series of violent earthquakes rocked the town and jettisoned much of it into the sea. For two and a half centuries it lay drowned and largely unexplored, until my friend Ed Link, sponsored in part by the National Geographic Society, began to retrieve Port Royal from the depths.

By the end of the 1959 diving season, Ed had recovered hundreds of artifacts, and Bob Marx later retrieved thousands more. The results of the expeditions represent the largest and richest collection of late 17th-century English artifacts ever found.

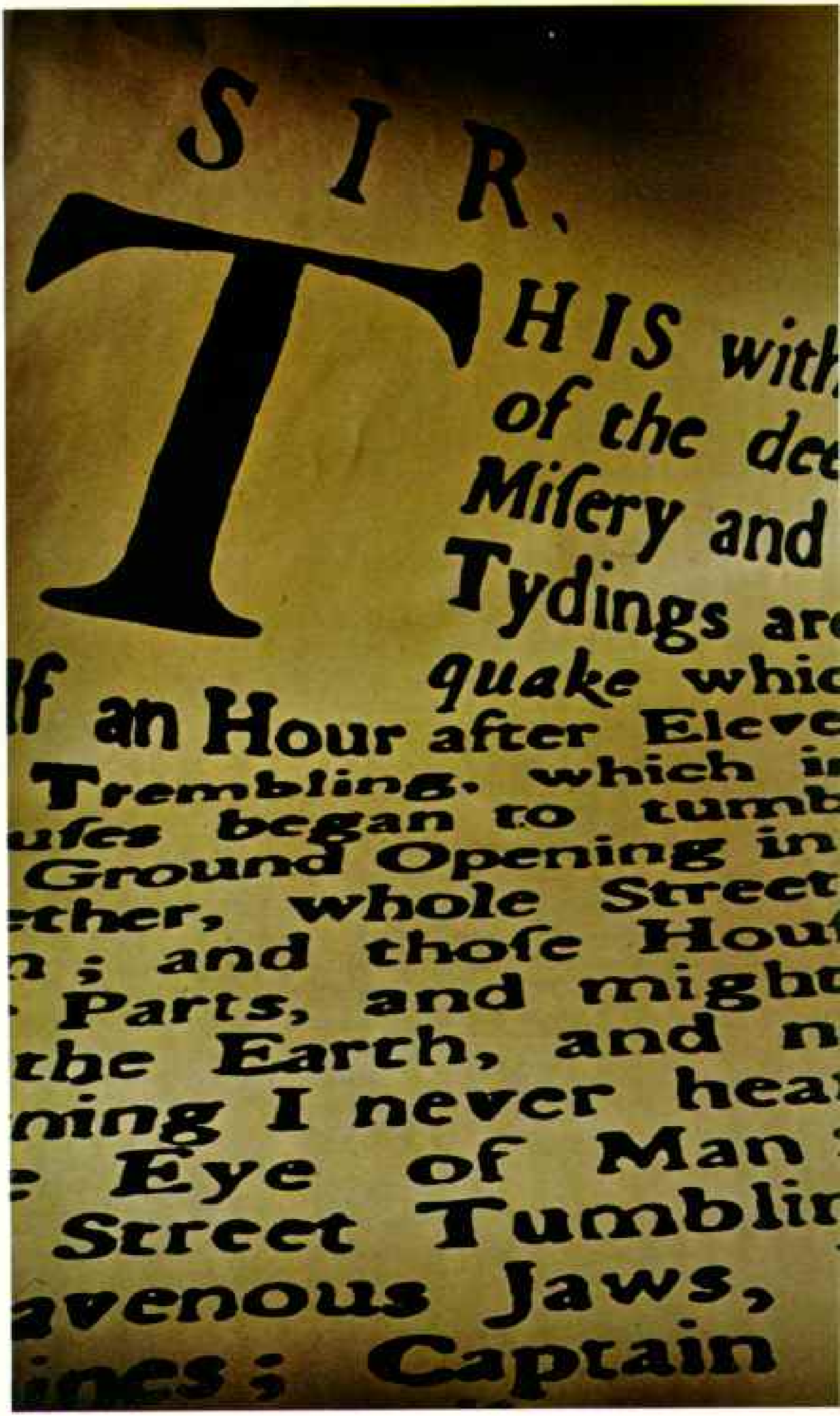
While exploring the murky waters of Port Royal with Ed, I often fancied myself surrounded by sharks. Great numbers of the creatures frequented the nearby harbor of Kingston, where the city dumped garbage. The experience called to mind a chilling memoir from the days when Jamaica was a New World distribution center for African slaves. One day while combing the archives of a Bermuda newspaper, I had come across a reference to Kingston dated 1786 that exposed the full horror of that loathsome trade:

Kingston, Jamaica . . . March 15—It has long been a matter of wonder, in the opinion of the vulgar—why the harbour of Kingston is so much infested with those voracious aquatic animals called sharks. The reason of it, says a correspondent, may be chiefly attributed to the inhuman and invidious practice of masters of Guinea [slave] *ships, from the penury of their natures, throwing overboard the bodies of their slaves who die before they are brought to a market, instead of having them carried on shore and buried.*

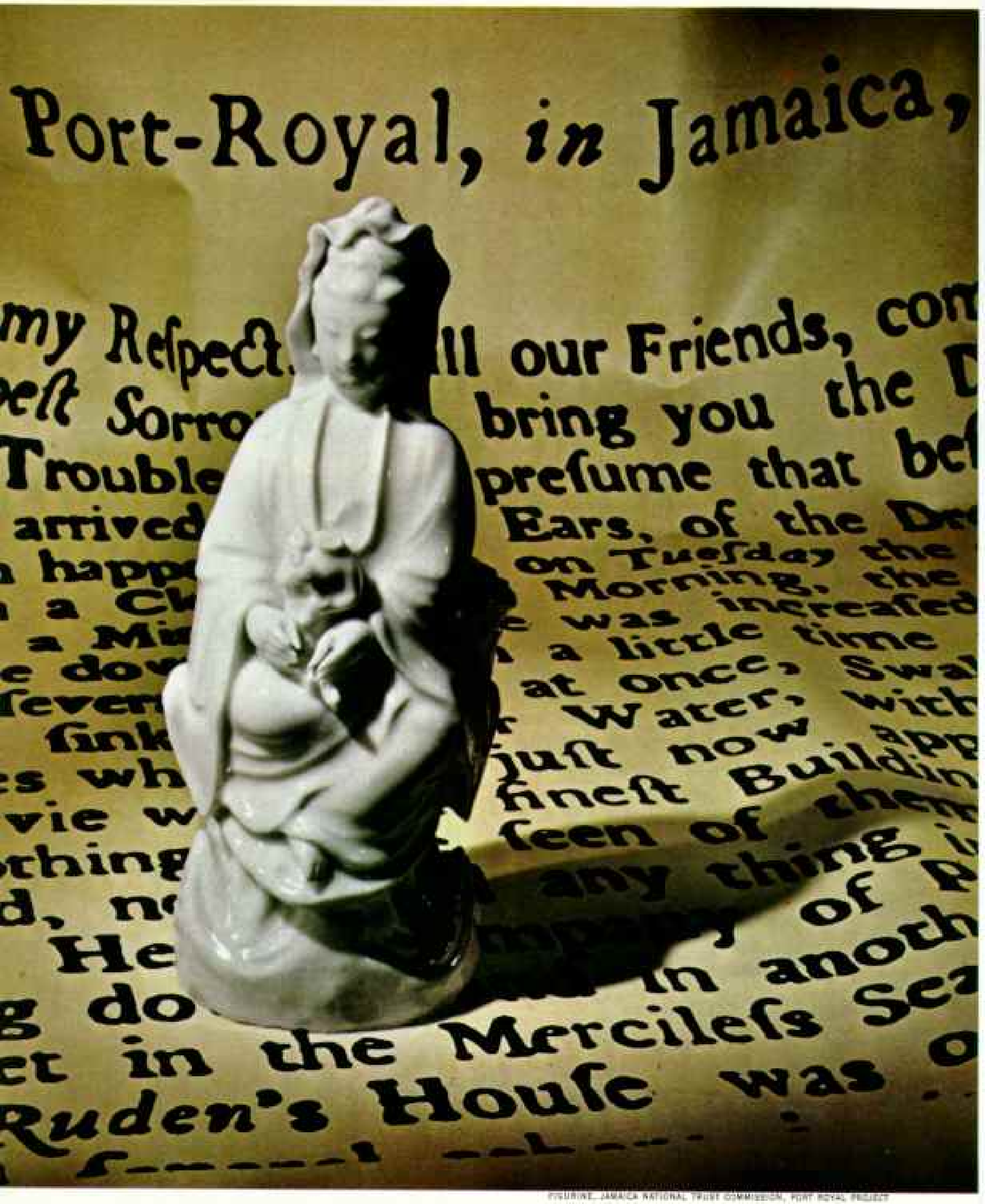
TOWARD the beginning of the 17th century English and French efforts in the New World began to focus more on the establishment of colonies in North America than on injury to Spanish outposts. The result was a series of pioneer settlements such as ill-fated Roanoke, Jamestown, French Quebec, and Plymouth.

Over the next two centuries every major war in Europe inevitably embroiled the New World colonies along national lines. From their isolation in Canada the Québécois enjoyed an occasional reprieve, but England and Spain continued to regard each other as deadly rivals in the New World. In a roundabout way the rivalry cost *Winchester* her life.

An English man-of-war of 60 guns, *Winchester* set out from Jamaica in 1695 as part of a homeward-bound convoy through what were still largely Spanish waters. Off the Florida Keys she struck a reef and went down, to be discovered in 1938 by Charles Brookfield and later salvaged with his friend Art McKee. The recovered items offered a wealth of information about life aboard *Winchester* but nothing about the manner of her death.



GRIM TIDINGS: A letter published in England announces the earthquake of 1692 that devastated Port Royal. Two-



FIGURINE, JAMAICA NATIONAL TRUST COMMISSION, PORT ROYAL PROJECT

thirds of the Jamaican town slid into "the Merciless Sea." A fragile survivor, the religious figurine was made in China and probably freighted from the Philippines to Mexico, then across to Port Royal.

In London some years later, during a study of British Admiralty records from the fateful year 1695, I found the *Winchester*'s log for the day she met her end. As captain and crew struggled to abandon the sinking vessel, the log had been transferred to another ship and ultimately returned to England.

The cause, as Brookfield had rightly deduced from other documents, was as simple as it was dreadful—scurvy. In the captain's shaky hand the pathetic story unfolded of a crew bound by Admiralty orders to continue their voyage, while dying for lack of citrus fruit obtainable ashore. Virtually adrift among shoal waters, *Winchester* struck a reef. The final irony was furnished by an item later retrieved from the wreck—an English Navy lime juicer.

NO MEDICAL EXCUSE exonerated the captain of H.M.S. *Looe*, though I personally feel he has been maligned. Through long research I have come to know Ashby Utting and his crew intimately, as well as the remains of their ship. In point of fact, they lost two ships, though one was a prize. Altogether it was a disastrous voyage.

A British frigate of a type common in 1744, *Looe* was ordered to patrol the Florida coast in search of Spanish shipping. After a time she met with success in the form of a small vessel out of Cuba. The Spaniard was no match for British gunners and knew it. He struck his colors and Utting put a prize crew aboard. Together the two ships set a course for Charleston, South Carolina.

They made it no farther than a Florida reef that today bears *Looe*'s ill-fated name. There Utting lost both his command and his

*FRUIT OF THE VINE flowed freely in Port Royal, as wineglass stems testify (**right**). All but two—third from right, crafted about 1710, and far right, about 1815—may have sunk during the disaster, according to archeologist I. Noël Hume. He jokingly calls the site "a garbage heap of artifacts that date right up to modern times, designed to confuse archeologists."*

*WHO was "the fox" on a Port Royal delftware mug made after the earthquake (**far left**)? No one is sure. Perhaps it was knocked overboard during a shipboard melee. Slipware cups may have been lost during the earthquake, and a bowl some years later (**left**).*

prize to treacherous currents that drove the two vessels aground at night. The British and their prisoners made their way to safety in the ship's longboats.

The third day following the wreck brought still another reversal of fortune. In the salvaged longboats the British managed to capture a passing Spanish sloop and made their way to South Carolina.

"I am extremely sorry," the chagrined Utting wrote his superiors in the Admiralty, "that this should be the messenger of such disagreeable news as the loss of H.M.S. *Looe*. . . ."

An Admiralty board acquitted him on the basis of "some uncommon current," and he was promptly given another command.

Throughout the remainder of his career, however, Utting was plagued by the loss of *Looe*. Prior to the Florida patrol he had been ordered to have her "victualled to four months, and to have two months' French Brandy instead of two months' beer. . . ." At Utting's death one commentator interpreted the long-ago order as evidence of a drinking problem on Utting's part.

I resent such a slur on my friend, who seems to have been a thoroughly able and kindly officer. Brandy, after all, is the drink of a gentleman, and Ashby Utting was plainly that.

BY THE 1750's the reach for the New World had run its course; the rest was consolidation or retreat. Although Spain still clung to her colonies in Florida and the Caribbean, her power was on the wane. Great Britain, the apparent winner, would soon suffer humiliating defeat at the hands of her own colonists after they helped her seize Canada from France. The sea again sheds additional light.

In the summer of 1725 a French payroll ship named *Le Chameau* (The Camel) set out from Rochefort, France, for Quebec City. *Le Chameau* came to grief just short of her goal, on one of Nova Scotia's treacherous offshore rocks. She lay submerged for more than two centuries until a team of three amateur Canadian divers found her and her historic cargo in 1965.

Le Chameau represents one of those rare occasions when a sizable quantity of gold and silver, in this case military pay, came full circle from the New World to the Old and back across the *(Continued on page 767)*

*HODGEPODGE of housewares salvaged from the site of the sunken town lines a Port Royal street (**facing page**): pewter platters, a brass candlestick, tankards, a strainer, wine bottles, a hanging lamp, and other goods. Schoolboys joke beside a stone wall thought to be part of a structure where looters were jailed after the earthquake. An earthenware water jug (**below**) reflects the African heritage of the Port Royal craftsman who made it.*

ALL JAMAICA NATIONAL TRUST COMMISSION

*NOVEL TWIST: Used to stir chocolate, one of the New World's many gifts to the Old, a wooden "frother" (**right**) from a 1733 Spanish ship is worked by veteran treasure diver Art McKee. From the wreck of the* Winchester, *Art plucked a lime juicer (**below**) that could have saved the crew from the scurvy that took their lives—had only Key limes like these been aboard. Medicine vials retrieved from old Port Royal shimmer through protective plastic (**facing page**).*

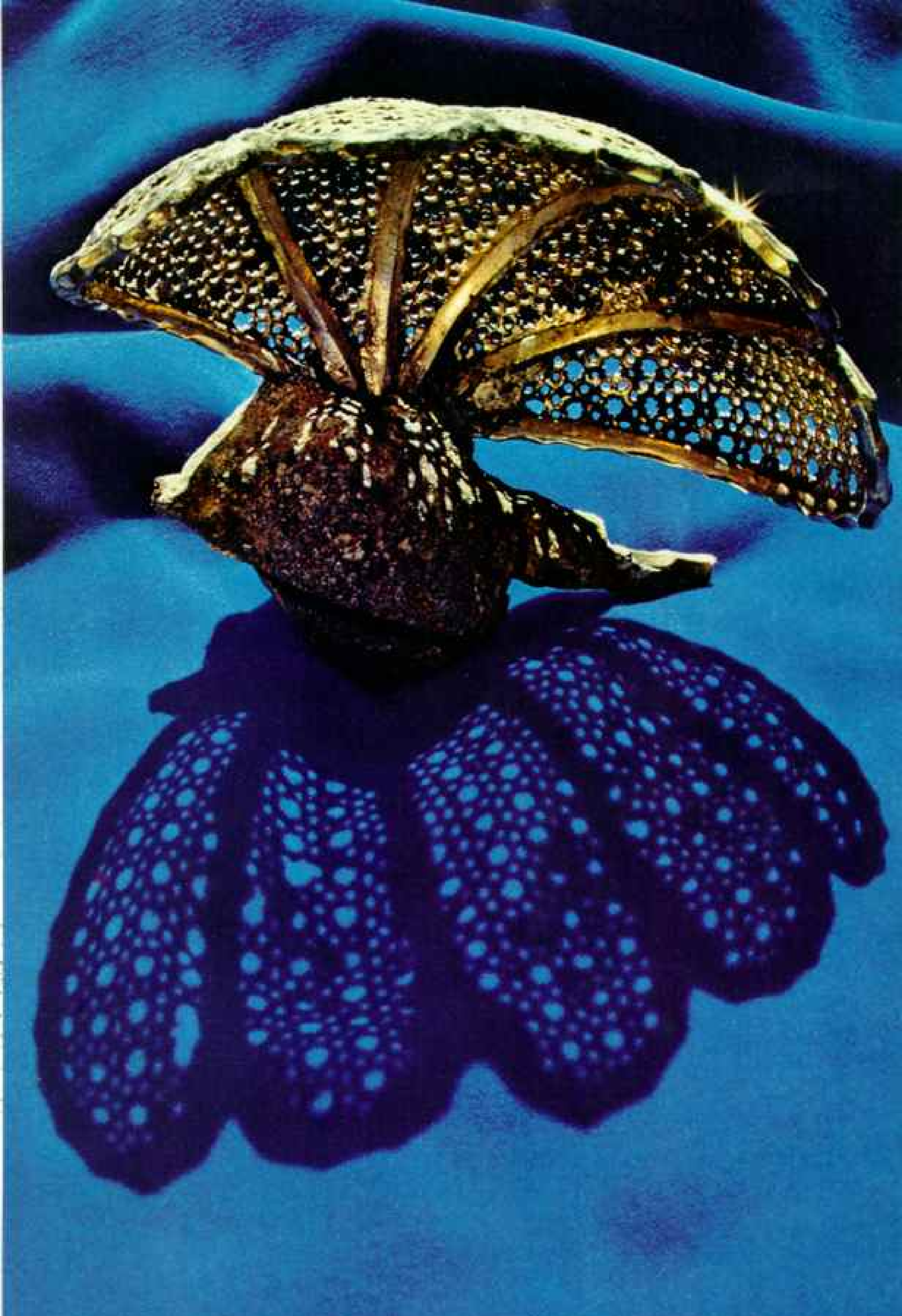
CAPT. BOB VLEIN COLLECTION

JAMAICA NATIONAL TRUST COMMISSION (RIGHT); MCKEE'S MUSEUM OF SUNKEN TREASURE (ABOVE)

CAPT. BOB KLEIN COLLECTION

PIPES (FACING PAGE), COMBS, AND SHOE, PARKS CANADA

*ODDS AND ENDS tell tales aplenty. Pins (above) catalog a trail of wrecks explored by diver Bob Klein and show intriguing craftsmanship: The heads were made of coiled wire crimped onto the shanks. French sailors loved to smoke from clay pipe bowls like these (**right**), which went down with the* Machault *in 1760. Bone and tortoiseshell combs from the ship's cargo, here shown with a modern example at far left, never reached troops in Canada. Some soldiers may have had to fight barefoot, because* Machault *also carried more than 320 pairs of shoes, including this one (**left**) and its mate.*



(Continued from page 761) Atlantic. The need for such shipments is illustrated by another wreck, the French vessel *Machault*, scuttled by her own men off the Gaspé Peninsula in 1760 to avoid capture by a British squadron. *Machault*'s cargo, salvaged by Walter Zacharchuk and his crew, indicates not only the cost but the enormous variety of goods involved in maintaining a New World garrison (pages 764-5). Artifacts recovered from the wreck include military supplies, from musket and cannonballs to shoes and uniform fittings, all necessary items in France's losing campaign against Britain.

Yet even in defeat French elegance asserted itself. Amid the implements of war, *Machault* carried crystal glassware, pewter plate, candlesticks, and great quantities of exquisite Chinese porcelain, all destined for use by colonial officers and government officials. Despite France's declining fortunes in the New World, grace and dignity were upheld to the last.

Drowned cargo of a far different type from that of *Le Chameau* and *Machault* attests to the courage of other Frenchmen in Canada. Along the beds of mainland rivers and streams modern divers have discovered a treasure trove of sunken artifacts from the days of the voyageurs. Driving their heavily loaded freight canoes far into the Canadian wilderness, the rugged trappers and fur traders now and then met disaster in rapids or in sudden ambush by Indians.

Freshwater recovery is as hazardous as that at sea, and often just as rewarding. At the invitation of Walter Kenyon of Toronto's Royal Ontario Museum and Robert C. Wheeler of the Minnesota Historical Society in St. Paul, I inspected fascinating samples of cheap trade goods for which the Indians of North America once bartered away their furs and eventually their lands.

There were nested brass cooking kettles with removable handles for easy stacking, flintlock muskets with ball and bird shot, skinning knives, axheads, wire snares, mirrors—all the paraphernalia without which the Indian had survived over the centuries before Europe reached for his world.

MORE THAN 25 YEARS ago when I set off from the Smithsonian Institution to dive on my first undersea wreck, my chief, for whom I still have great affection, said to me sternly, "Peterson, we don't want this to be a lark."

Well it *has* been a lark, all 25 years of it, for I have become intimate with my country's past—not merely in terms of events but of human lives. In the course of exploring countless undersea wrecks, I have agonized with long-ago captains who surrendered their ships to the fury of storms and have sympathized with Spanish merchants who lost all in a single disaster.

I have shared the grief of many who faced death at sea, either far from their beloved wives and children or in agonizing company with them. I have sensed the arrogance, and sometimes the cruelty, of a ship's master bedecked in jewelry and silver-mounted pistols, witnessing the flogging of a seaman for a real or supposed offense.

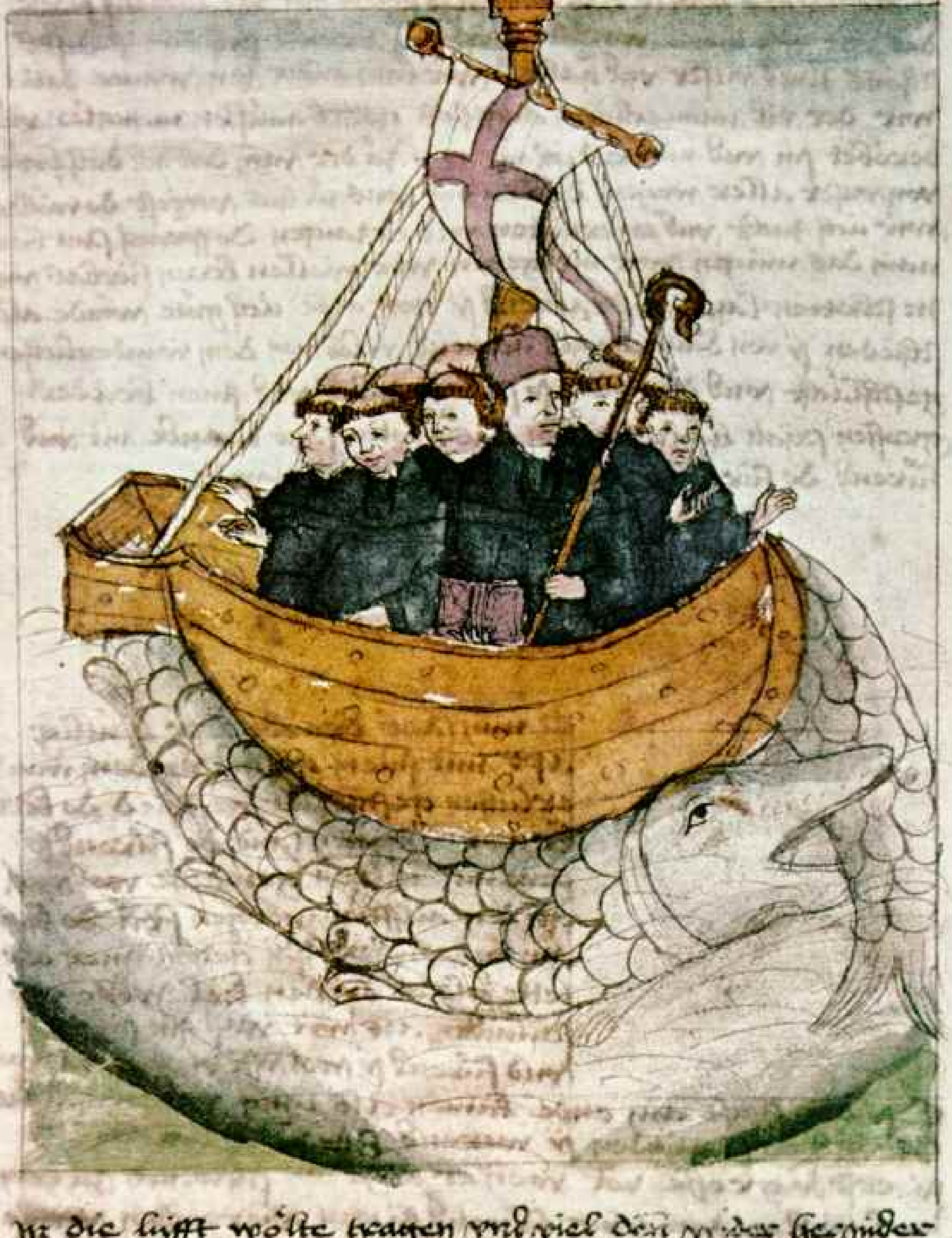
I have rejoiced with a young colonial wife over some memento imported by her husband from the home country to brighten her drab frontier existence. And I have conjured up the horror of a slave-ship hold filled with those who would never see husband, wife, or possibly even land, again.

Of such was the reach for the New World composed—of cruelty, courage, suffering, and joy—much of it dramatically revealed beneath the surface of the sea. No doubt other chapters will be written as man extends his reach deeper to wrecks still unknown across the ocean floor.

Each holds its incalculable treasure. □

ITS DUELING DONE, a sword's magnificent gilded silver handguard endured because the gold plating proved impervious to corrosion after the weapon sank with a Spanish galleon in 1656. The sea claimed its blade, however, proof that the ocean can be a great destroyer. But it can also be a great preserver, holding in its depths a treasury of history, awaiting discovery.

Den schwanz regete d mond der gral von dem mastr als groß
von dem schiff das er den list uff hůb als ob er



yr die lufft wölte tragen vnd viel dick vnder sich
als ob er yr abgrund wölte machen dem selben schiff was
dick vff dem schmalz gemachen holtz vnd gras do wonde d pi alle

Who Discovered America? A New Look At an Old Question

THE NEW WORLD: Who, from the Old, first touched its shore? Historians held for centuries that it was Christopher Columbus. By current consensus, it was Norse voyagers of a thousand years ago. But perhaps it was a group of shadowy, yet very real, Irish seafaring monks who predated even the Vikings by more than four centuries.

In the great pantheon of New World explorers no name is more intriguing, or more clouded in controversy, than that of Ireland's St. Brendan. His legend—today more tantalizing than ever—has persisted through the centuries in the form of a Christian *imram*, an Irish saga: *Navigatio Sancti Brendani Abbatis* —*Voyage of Saint Brendan the Abbot*. With 17 fellow monks, it relates, Brendan sailed to *Terra Repromissionis Sanctorum*, the Land Promised to the Saints, somewhere beyond the far reaches of the western Atlantic.

Was the Promised Land North America? Did St. Brendan actually reach it in the sixth century? Neither history nor archeology offers proof. Yet early mapmakers and explorers gave credence to the legend. Place-names from the *Navigatio* appear on later charts, and early navigators sought vainly for "St. Brendan's Isle." Fact or fantasy, the *Navigatio* had incalculable impact on the great European voyages of discovery—including that of Columbus.

According to the legend, St. Brendan and his fellow monks set sail from Ireland in a leather-hulled curragh; this same type of boat, now covered with tarred canvas, is still used by Irish fishermen. The voyage lasted seven years and introduced the monks to such wonders as demons who hurled fire at them, a floating crystal column, and a sea creature as great as an island. Scholars wonder today: Might they have been volcanic eruptions . . . an iceberg . . . a whale?

Finally, Brendan and his shipmates reached the Promised Land, a huge, lush island divided by a mighty river. Soon afterward they sailed home to Ireland, where Brendan died.

There the legend of St. Brendan ends, to be given new vitality in the 1970's by a real-life sequel. In the following article, British author and explorer Timothy Severin recounts his epic Atlantic crossing aboard a leather boat. In proving that such a long-ago voyage *could* have been made, Tim Severin and his crew have brought one of history's most intriguing tales a giant step closer to the realm of possibility.

—THE EDITOR

Medieval best-seller, the *Voyage of Saint Brendan the Abbot* recounts the saga of the cleric and his Irish monks as they sail into the unknown Atlantic sometime before A.D. 600. Here in a fancifully illustrated manuscript version of the 1400's, their boat rides on a placid whale called Jasconius, shown with fishlike scales. The mammoth creature "picked up the vessel as if he wanted to lift it into the air, then lowered it again as if he might drag it to the bottom of the sea." COURTESY LIBRARY OF THE UNIVERSITY OF EDINBURGH

The Voyage of "Brendan"

By TIMOTHY SEVERIN

Photographs by COTTON COULSON and others

Alive to the sea, *Brendan* fairly breathes with the waves as she nears the coast of Newfoundland. Tiny but tough, the leather boat proved that ancient Irish vessels could have survived the battering of a North Atlantic crossing.

THE SEVENTH WAVE is said to be the worst, the one that does the damage in the turmoil of a gale. Modern oceanographers know this is just a superstition of the sea, but the notion of the seventh deadly wave persists among mariners.

On that savage evening in the North Atlantic the worst waves seemed to be coming at us in a strange new sequence, not every seventh but in random groups of three. As I clung

Passage from myth to reality follows the red-line track of modern *Brendan*, on a map that also depicts incidents from the medieval text of the *Voyage of Saint Brendan*. The logic of prevailing winds and currents dictated a stepping-stone course across the North Atlantic to what may have been the "Land Promised to the Saints," the goal of the Irish abbot and his monks. The re-creation of the saga began at Crosshaven (**1**), where *Brendan* was launched prior to departure May 17, 1976, from Brandon Creek (**2**). Coasting north along Ireland and Scotland, *Brendan* stopped at the Aran Islands (**3**), an outpost of

to the helm of our small open boat, I watched the monstrous swells crest and thunder toward us, each one capable of swamping, capsizing, or destroying our slender craft.

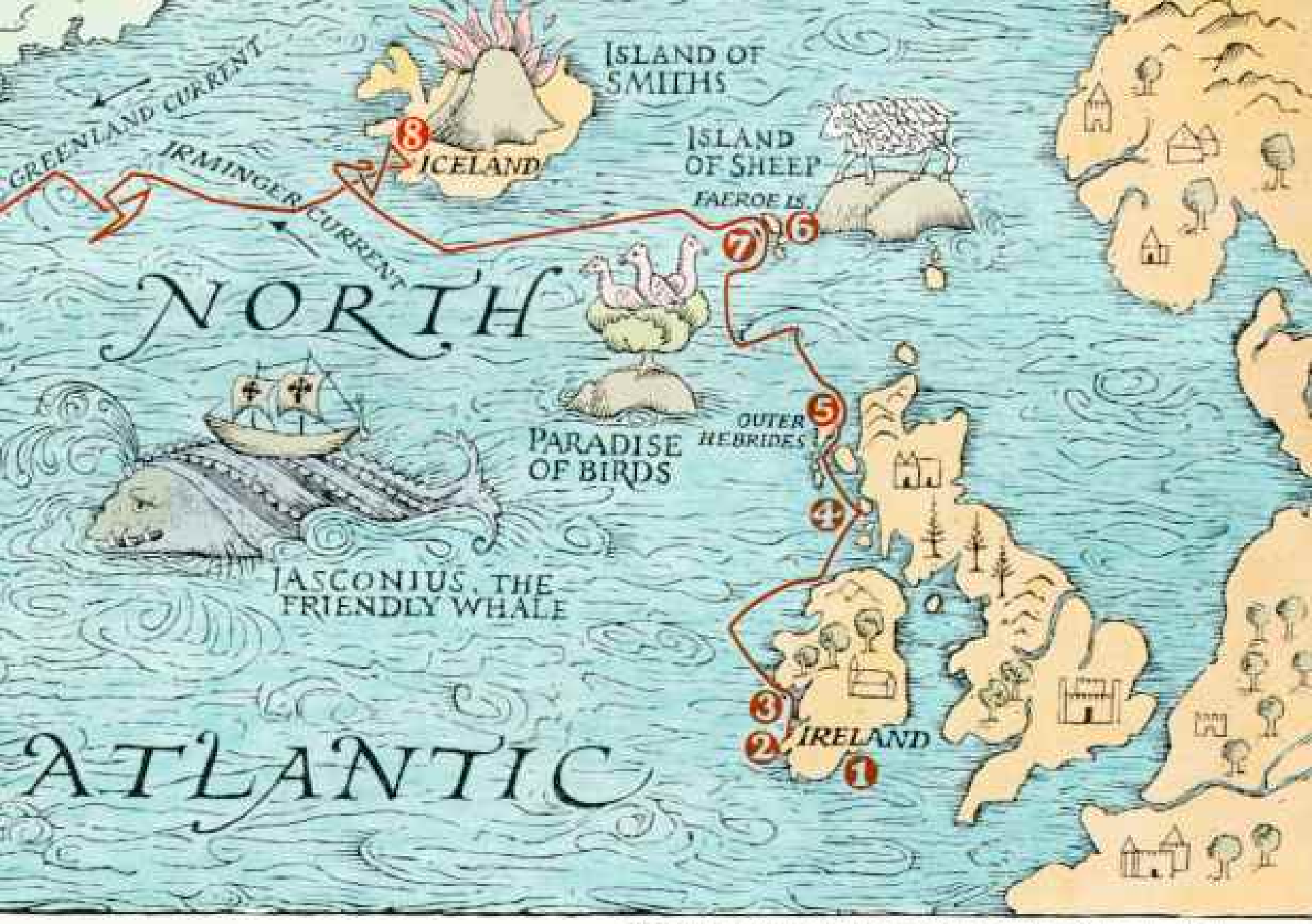
We were a crew of five—George Molony, Arthur Magan, Peter Mullett, Rolf Hansen, and I—all seasoned hands accustomed to rough weather. But our boat was new to storms, and no one knew how best to steer her through a gale. Nothing quite like her had been afloat for perhaps a thousand years, for she was built of leather in the style of medieval Ireland.

What possessed this crew—five seemingly sensible men—to sail such an improbable craft into the teeth of a gale? The answer lay in the name of our boat: She was called *Brendan*, after the great sixth-century Irish monk-explorer St. Brendan, who is credited by legend with having discovered the New World. If we could duplicate Brendan's odyssey in a similar boat, we would strengthen the possibility of truth being buried in that historic legend.

Now, in the midst of the gale, I recalled a bleak warning months before from one of the world's leading authorities on leather. I had explained to him that we proposed to cross the Atlantic in a 36-foot open boat fashioned of wooden frames covered with a leather skin.

"Leather," he observed in his precise university tone, "is high in protein. It resembles a piece of steak, if you like, and it will decompose the same way, either quickly or slowly, depending on various factors."

Author Timothy Severin has written a book about his Atlantic crossing, *The* Brendan *Voyage*, to be published next spring by McGraw-Hill, Inc.



MAP BY PAUL K. BREEDEN, COMPILED BY HUGO AHLENIUS, NATIONAL GEOGRAPHIC ART DIVISION

Irish monasticism, Iona (**4**), and the Isle of Lewis (**5**). In both fauna and geography, Streymoy (**6**) and Mykines (**7**) in the Faeroes resemble the legend's "Island of Sheep" and "Paradise of Birds." The "Island of Smiths," with its rain of flaming rocks, could be Iceland (**8**), where *Brendan* wintered over. On the final leg, the vessel passed an iceberg, recorded in the legend as a "Crystal Column," and sailed into a "Thick White Cloud." On June 26, 1977, parting company with whales like Jasconius of the *Voyage*, *Brendan* lands at Newfoundland (**9**), certainly like a Promised Land to the author and his sea-weary crew.

"What happens when the leather is soaking wet in seawater?" I asked.

"Ah, well," he replied, "of that I'm not sure. We've never been asked to test it. Leather will usually break down more quickly if it's wet, though perhaps the pickling effect of salt water. . . ." He shook his head.

Despite that dire prediction, *Brendan* was holding her own in the gale. Two hours later when George relieved me at the helm, I crawled into my berth beneath our low deck shelter. From there I listened to the waves, separated from my head by a mere quarter inch of oxhide. I noticed how the sides of the hull were pumping in and out like a bellows. The boat was almost a great sea animal, perhaps a whale, within whose rib cage I lay as the creature *breathed* its way through the water. The sensation was strangely reassuring.

Exhausted, I dozed off, to be wakened by a shout from Peter: "My God! Where did *that* come from?" I scrambled out and found him staring aghast at the sinister black hull of a large ocean trawler. She was less than a hundred yards away, all lights blazing, and bearing straight down on us in the darkness.

"Light a flare!" I yelled at Peter, but it was too late; his cold-benumbed fingers could not manage the striking mechanism. With ponderous menace the trawler swept past us so close that we could make out the welding on the steel plates that towered above us. Then she was gone in the night.

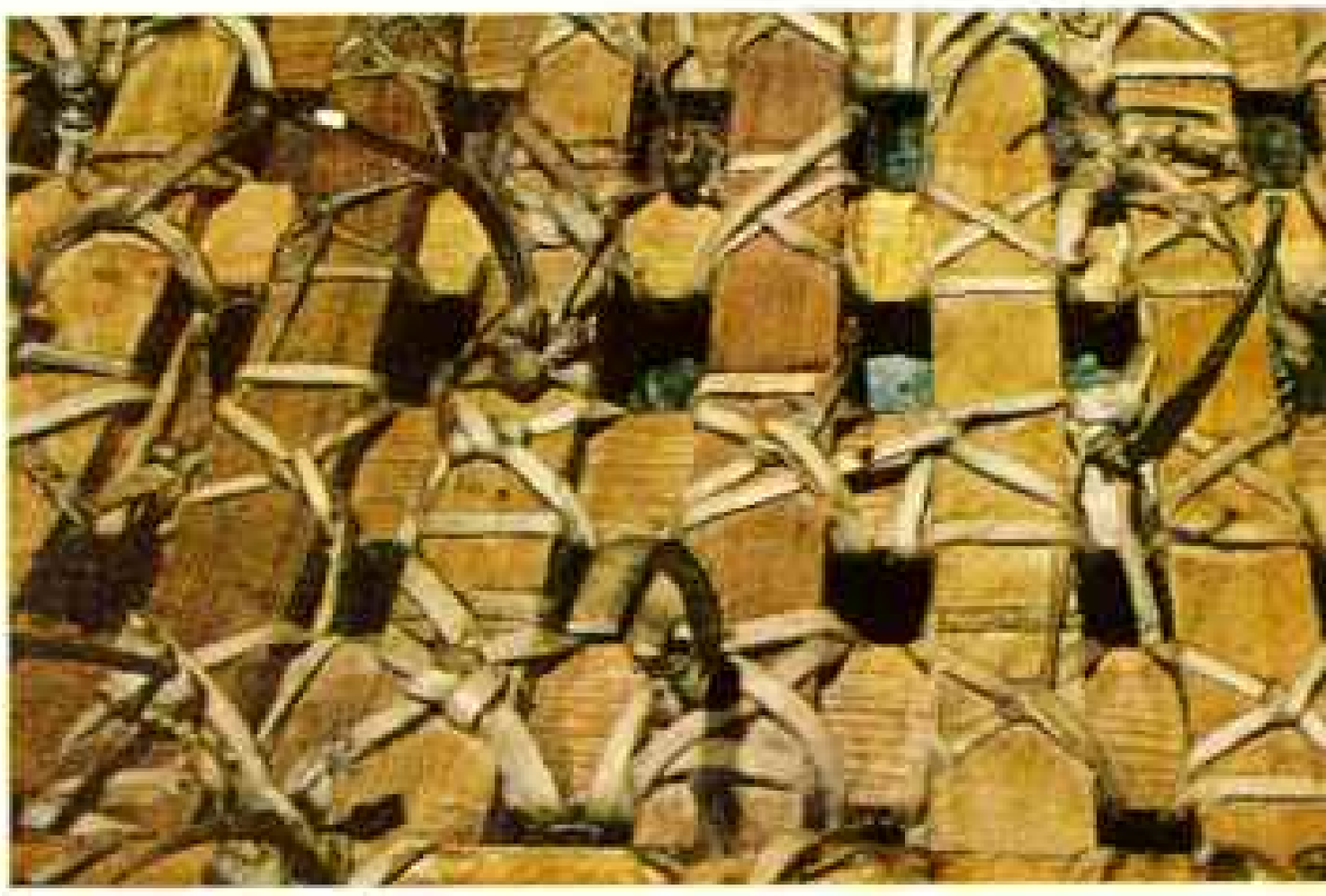
Later, with the near-tragedy well behind us, I had an amusing thought. Supposing a lookout on the trawler had sighted us and reported us to the bridge: a boat from another century, running wildly before the gale under

BOTH BY IAN HUGHARD

Apprentices to a legend, skipper Timothy Severin (**above**, left) and George Molony stitch the hull together with 14-strand flax thread. Following specifications from the earliest surviving Latin text of the *Voyage*, written around the 10th century, they use oxhides tanned in a solution of pungent oak bark.

For the framework (**right**) they bound straight-grained ash laths with two miles of alum-tanned thongs and smeared both wood and leather liberally with wool grease.

Not one lashing, not one stitch, gave way on the transatlantic passage.



a square sail bearing the Celtic cross in crimson and with five desperate-looking men aboard! Surely the hapless lookout would have been accused of drunkenness on watch or put ashore to visit a psychiatrist.

Birth of a Compelling Idea

Our saga had begun three years earlier, when my wife and I were vacationing in western Ireland, St. Brendan's birthplace. As a student of medieval manuscripts, Dorothy was as familiar with the Brendan legend as I was through my own specialty, the history of exploration. Together we had sailed our small sloop, *Prester John*, as far away as Turkey, so we knew something about long voyages in little boats.

One evening over tea at the kitchen table Dorothy remarked, "I don't see why Brendan couldn't have made it."

Nor did I, but that proved nothing. On the other hand, if modern sailors could cross the Atlantic using the same techniques and materials that Brendan had, the legend would gain new significance. At that moment the idea of the *Brendan* voyage was born.

The next three years were a saga in themselves, one of painstaking research, of endless challenge, of frustration, and of what I came to call simply "Brendan luck." Each time I faced a seemingly hopeless problem, one or more experts conveniently popped up with the perfect solution.

There were the fishermen of County Kerry who gave me my first ride in a curragh, the modern version of St. Brendan's craft, now covered with tarred canvas rather than leather. From the Kerry men I learned the handling characteristics of curraghs and the fact that they are true sea boats, not merely inshore skiffs.

There was John Beeby and his generous colleagues at the British Leather Institute, who instantly took to the idea of a leather boat and who tested more than a dozen ways of tanning oxhide for a boat, then sent me to the Croggon family in Cornwall. The Croggons' traditional tannery cured all 49 hides in the way St. Brendan's tanners had, in a solution of oak bark.

There was Colin Mudie, the boldly imaginative naval architect, who personally made the drawings for *Brendan* with medieval-style rigging and who cautioned me on the manner of sailing her: "That knowledge has been long lost. It's up to you to rediscover it."

Gifted craftsmen saw to the construction of *Brendan*'s wooden frame: Paddy Lake, head shipwright for the Crosshaven Boatyard in Ireland's County Cork; and Paddy Glennon, a millowner in County Longford, who hand-picked and felled the ash trees for *Brendan*'s supple ribs. The task of covering the wooden frame with oxhide fell to a cheerful wizard named John O'Connell, formerly a master harness maker at the Royal Warrant Saddlers in London. With a crew of carefully supervised volunteers, John produced a watertight hull held together by some 20,000 stitches of hand-rolled flax thread.

Nearly two and a half years after the *Brendan* voyage idea took shape, Bishop Eamon Casey of Kerry blessed the boat at the Crosshaven yard with a special poem he had written in Irish:

> *Bless this boat, O true Christ,*
> *Convey her freely and safe across the sea. . . .*

Then as if to the boat herself, he added:

> *To go to the land of promise is your right.*
> *You are like a guide of Brendan's time.*

My 4-year-old daughter, Ida, was elected to christen *Brendan*—not with anything as vapid as champagne, but with a bottle of good Irish whiskey! Amid a satisfying shatter of glass and a cloud of glorious fumes, *Brendan* was winched down the slipway.

Departing for the "Promised Land"

Somehow over the next three months the endless details of outfitting the boat, choosing a crew, conducting sea trials, and planning the voyage were seen to. At last on May 17, 1976, we set sail for Brendan's "Land Promised to the Saints" from an appropriate spot—Brandon Creek in southwest Ireland, where St. Brendan is said to have started some 1,400 years before. With a wave to some 200 well-wishers and skeptics alike gathered on shore, we weighed anchor for the New World via Ireland's offshore islands, Scotland, the Faeroes, and later Iceland.

From the first the pliant hull, joined with two miles of leather thongs, flexed to the waves, giving us a disembodied sense of being tuned to the motion of the sea. The feeling was

enhanced by *Brendan*'s low freeboard, a mere 16 inches. Her square-rigged sails allowed her to point up no higher than 90 degrees to the wind, so that we were slaves to every wind shift.

Our first day at sea we spent sorting out a jumble of gear and provisions, setting regular helm watches, and dividing up various shipboard tasks.

My first choice for crew had been George Molony, a 26-year-old friend and longtime sailing companion. Then there was Rolf Hansen, 34, a Norwegian volunteer with wide experience in handling old-style boats. At 23, Arthur Magan, from Dublin, with his tousled good humor, was the baby of the crew. Finally there was Peter Mullett, a 33-year-old former London photographer, who had signed on to film a documentary of the voyage.

As skipper, I was the oldest, at 35. All of us knew about boats, for sailing *Brendan* was too risky for novices. One misstep and you were overboard; there was no way of turning *Brendan* back to pick up a lost man.

Regaled With a Hail of Crabs

Our encounter with the gale and the near-miss by the trawler took place on the night of May 23, after a brief stop at the Aran Islands west of Galway Bay. There, we discovered, word of our voyage had preceded us. As we neared one of the islands, two fishermen hauling pots in a modern curragh called to us.

"Are you the crowd for America? Welcome to the islands."

"Thank you very much."

"Would you like some crab?"

"Yes, please!"

A hail of crabs flew in an arc from the curragh to *Brendan*, and Rolf scrambled about the boat trying to capture them before they scuttled into the bilges. Boiled in seawater, the meal offered welcome relief from our standard fare of tinned meat and beans, dehydrated soup and vegetables, oatmeal, dried fruit, and an occasional chocolate bar.

The storm resulted in several major changes aboard *Brendan*. First was the loss of Peter, who injured his arm and chest in the gale and who, on doctor's orders, reluctantly left us in County Donegal on the northwest tip of Ireland.

Also the storm had shown that our provisions were not well enough protected from rough seas. Many of our "waterproof" plastic bags had leaked, resulting in a nauseating stew of seawater, oatmeal, soggy fruit, and *re*-hydrated vegetables.

Above all, the gale had shown us that sailing *Brendan* was rather like riding a balloon. With too few crew to row effectively, once we cast off we had to sail in the direction wind and weather took us, with little margin for correction. The storm had blown us a hundred unexpected miles off course before it dropped us again on the coast. We began to appreciate the lives of medieval sailors, who had to trust to God, keep patience and faith alive, and risk death by storm, starvation, and thirst.

From County Donegal we set a course for the Scottish island of Iona. There on the waterfront I was approached by a gaunt young man in a ragbag assortment of clothes. With a casual wave at *Brendan* he said he had learned I was short a crew member.

"Y-e-s," I answered cautiously, looking the stranger over. A great beak of a nose dominated his face, and he nervously waved a pair of enormously long arms that gave him the look of some sort of strange, flapping, predatory seabird.

"I'm the captain of a local charter boat," said the stranger. "But my brothers can manage the business if you'll have me aboard *Brendan*. By the way, where are you going?"

Thus we acquired Edan Kenneil, destined to become *Brendan*'s incorrigible jester and live wire. Edan's appetite, it developed, knew no bounds. He would eat virtually anything and everything, and we could guarantee that his darting fork would clean up any leftover morsels. His insatiable hunger and his flailing arms earned him the appropriate nickname "Gannet," in honor of his airborne counterpart—a seabird whose appetite is legend.

Toasts and Bagpipes Take a Toll

One of our final stops before venturing into the open Atlantic was North Uist, an island in the Scottish Hebrides. North Uist is famous both for its hospitality and its bagpipers, and we departed with five splitting headaches, the result of too many liquid farewells and a ferocious dose of the pipes at short range.

On June 17 we left the Scottish islands astern and steered for the Faeroes, some 200

miles north across the Atlantic. Once again we were a crew of four, as personal affairs had called Rolf urgently back to Norway.

The Hebridean fishermen were cautious about our prospects. "I wouldna' want to sail with you" was the parting remark.

During the first 48 hours we made excellent progress. On the second day my noon sun shot put us halfway to the Faeroes. A subtle change occurred as the distance from land increased. Surrounded by thousands of square miles of ocean, we were four men locked in a leather "cell" measuring 36 by 8 feet, less than a third of it sheltered and habitable. In these cramped quarters each of us realized the need for strict self-discipline, if we were to avoid those minor irritations that could erupt into quarrels, even hatreds. By an unspoken rule, each man kept himself to himself and got on with the job. It was an old-fashioned formula, and it worked.

Living conditions were at a medieval level, and no one bothered to wash or shave. It would have been a waste of fresh water, and besides, *Brendan* smelled worse than any of us. Her leather hull, smeared with its waterproof coating of wool grease, gave off a stench no human body could equal.

Modern Materials Fail Many Tests

One lesson became increasingly clear as the voyage progressed: Modern tools and materials were seldom a match for medieval ones. Not only did our plastic containers crack and leak, but expensive metal implements simply rusted away or broke, despite heavy layers of protective oil. Whenever possible we fashioned replacements out of ancient materials such as wood, leather, or flax, with primitive but far more durable results.

The same applied to clothing. As we reached colder latitudes, we abandoned our garments of artificial fiber in favor of old-fashioned woolen clothes with their insulation of natural oils.

As for *Brendan*'s hull, it actually improved in cold water. Daily inspection revealed that although the leather had become saturated with seawater, weeping a continual fine "dew" on its inner surface, the increasing cold made the oxhide stiffer and stronger. Clearly St. Brendan and his crew had chosen the proper route to reach the Promised Land: If they had sailed through tropical waters, the higher temperatures could have melted away the vital wool-grease dressing on the oxhide and speeded up the leather's decomposition.

It all added up to the fact that the sailors of Brendan's day were far better equipped than modern historians acknowledge.

Ship Becomes a Toy of the Elements

The first two days' and 100 miles' progress toward the Faeroes was deceptive; in fact, it took us more than a week to make the other 100. It was a week of wild extremes, in which *Brendan* was becalmed, swept backward by headwinds, and finally lashed by storms and caught in the fierce tidal races surrounding the Faeroes. Toward the end we found ourselves stationary one moment and swept past the cliffs at 20 knots the next.

As we approached the Faeroese island of Mykines, thousands upon thousands of seabirds poured from the 1,000-foot cliffs—fulmars, gannets, skuas, gulls, terns, guillemots, razorbills, and puffins, wheeling overhead in squadrons to fish the teeming waters. The sight called to mind the "Paradise of Birds," which the Brendan saga mentions as being separated by a narrow channel from another island called the "Island of Sheep." Mykines fits the description of the Paradise of Birds very well, and the word Faeroe itself means "Island of Sheep."

At Torshavn in the Faeroes we encountered the man who was to become our fifth crew member, Trondur Patursson. Powerfully built and with a splendid mass of hair, he was sitting one morning on *Brendan*'s gunwale with a beautiful Faeroese girl who turned out to be his interpreter.

"It is said that you have room for a Faeroe islander on your crew," the girl explained. "This man would like to join you."

Good Lord, I thought, surveying the candidate, even a Viking raiding party would think twice before taking this fellow aboard!

"His name is Trondur," the girl continued. "He is an artist, and a fisherman on Faeroe boats off Greenland. He is a serious man."

And a superb sailor, it turned out. A few days later Trondur reported aboard for the voyage to Iceland, or wherever the winds might carry *Brendan*. Trondur brought along a supply of his traditional fare at sea—dried lamb and fish, dried whale meat, and chunks of fresh blubber. Hung from the rigging, the

lamb in particular, with its greenish fur of mold, began to give off a truly medieval smell.

Stepping-stones Across a Stormy Sea

With scarcely two months before autumn storms began sweeping the North Atlantic, we left the Faeroes July 3 on the 400-mile voyage northwestward to Iceland. This was the so-called "stepping-stone route"—a great-circle arc spanning northern Scotland, the Faeroes, Iceland, the tip of Greenland, and Newfoundland—the shortest way between the Old World and the New. It is the route followed today by transatlantic jets, in the past by the Vikings, and almost surely by any Irish monks.

Trondur quickly proved his value at sea by catching more than a dozen cod on a long, heavily weighted handline baited only with bits of colored rubber. As a result we had codfish in every conceivable style—boiled, fried, stewed, made into patties, and even a cod spaghetti that Edan loudly acclaimed. But when Trondur, whose English was gradually improving, offered him a choice after-dinner slice of blubber, Edan recoiled: "No, no, I'll never be *that* hungry!"

Happily for Edan, his revulsion to blubber was strictly dietary. One morning our conversation was interrupted by a massive sigh like a huge gas bag emptying, followed by a rippling sound. "*Hval!*" Trondur exclaimed delightedly, pointing 20 yards abeam at a great glistening mound of black that heaved gently in the water.

It was the first of our many encounters with whales throughout the voyage to Iceland. Our initial visitor surfaced a time or two, then disappeared, but it was only a preliminary. Two hours later as Edan glanced casually over the side, he gave a shout: "Hey, look, a dolphin—no, a whale. *Lots* of whales!"

Peering over the side we made out the shapes of at least 15 whales—pilot whales, according to Trondur—swimming as though in escort a mere six feet beneath *Brendan*'s hull. As the first contingent passed under us, others took their place. We estimated some 140 whales in the herd.

My first reaction was one of concern, for I had been cautioned in London about the habits of certain whales.

"The minke whale," a noted cetologist had told me, "is commonly described as 'curious,' while the fin whale sometimes rubs himself up against small boats."

Just what we need, I'd thought at the time—some itchy whale having a good scratch on *Brendan*'s leather hull! But the herd passed harmlessly beneath us, and never in dozens of later encounters were we touched or in any way endangered by the great creatures.

There was one more curious fact: Our leather boat, because it was whale-shaped or perhaps because it smelled of grease, acted as a magnet for the whales. They would surface beside us, circle us, or even lie gently beneath our hull, so that the water disturbed by their great flukes would eddy up around our little vessel.

Zest Added to a Dull Diet

For a week the weather favored us, driving *Brendan* almost with gale force parallel to Iceland's southern coast. Trondur showed us how to catch fulmars, a type of petrel, with a scoop net or on lines baited with blubber (page 793), and we feasted on the meat, boiled and roasted.

On July 15 an Icelandic Coast Guard patrol plane buzzed us almost at masthead level, and we heard a friendly voice calling us over the radio.

"Hello, *Brendan*. Is all well on board?"

"Yes, everything is very relaxed and the crew is in high spirits. We'll see you in Reykjavik."

On July 17, 1976, we kept the date, gliding into the harbor of Iceland's capital to an enthusiastic welcome. A smiling customs official gave me a form to sign, thus assuring the sovereign state of Iceland that no "rats had been seen on board during the voyage."

Though the *(Continued on page 787)*

Launch day's blustery wind snaps at *Brendan*'s flags and pennants as she stands ready to test Tim Severin's premise. A historian and explorer who has followed Marco Polo's track across Asia and sailed down the Mississippi, Severin became convinced that buried in the mythical baggage of St. Brendan's *Voyage* was a core of seafaring truth. On that theory, he and his crew committed their time, their ideas, and their lives.

HR. TEDMAN

The tribulations of sea trials have the crew scrambling to learn the rudiments of handling square sails (**right**). The finer points were learned en route and in hazard. Later, *Brendan* was more fully covered with tarpaulins to increase seaworthiness. Skipper Severin thinks St. Brendan and his monks may have used spare hides they carried aboard for a like purpose.

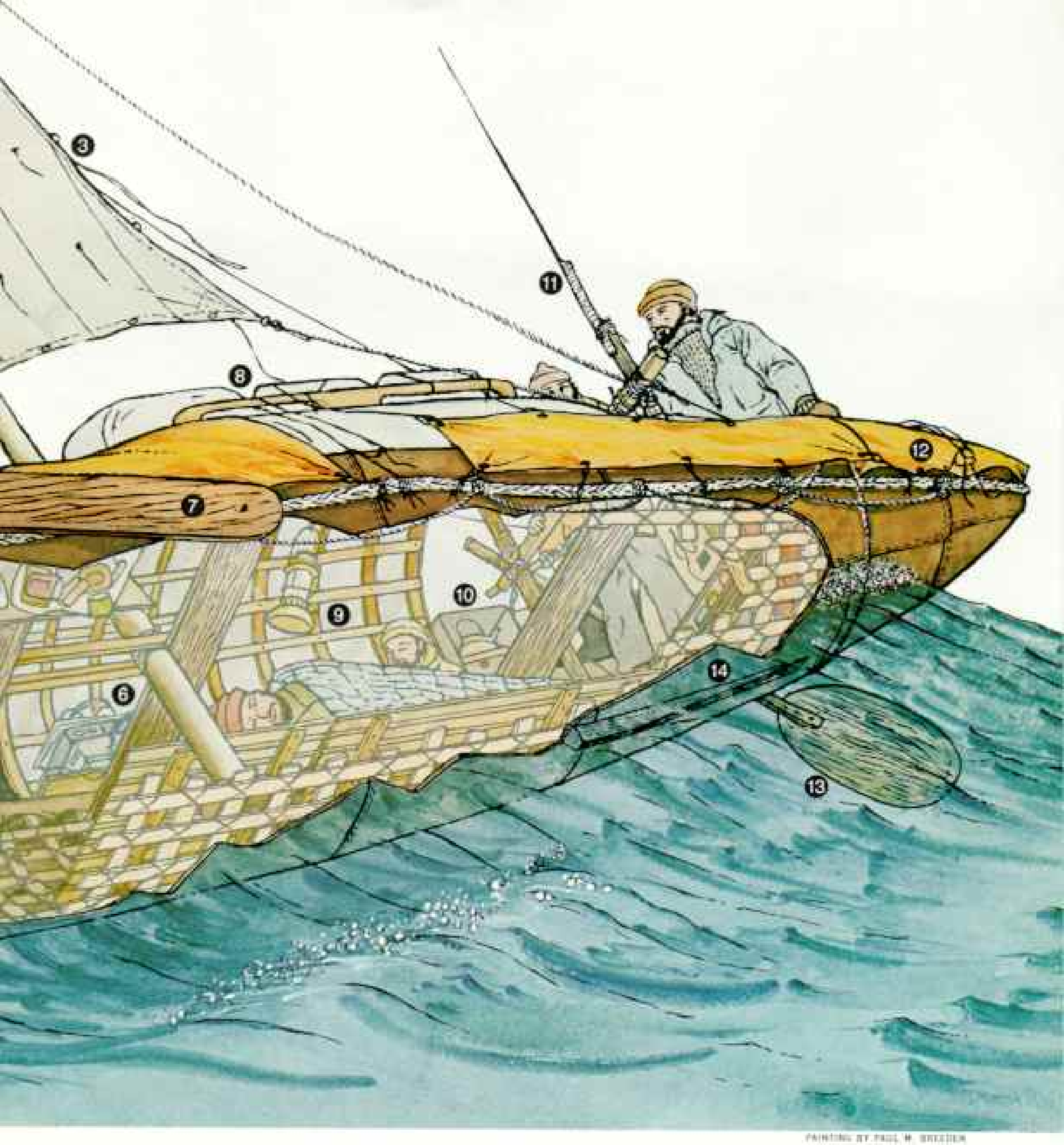
Skeptical Kerry men (**above**) look down on *Brendan*, ashore next to Brandon Creek, by tradition the departure point of the holy men.

"Most of the local people, cautious by nature, thought we were utterly insane," Severin says. One man had more confidence: "Sure they'll make it—but they'll need a miracle."

BOTH BY IAN HEDMANS

Thirty-six feet of leather and wood

DESIGN OBJECTIVES: Be authentic; hold together; stay afloat. Based on the traditional Irish curragh as adapted by naval architect Colin Mudie, *Brendan* did all three extremely well. Although she drew only one foot of water and couldn't beat upwind, her low ballast made her a stable sailer. The vessel's flexible hull and framing absorbed and distributed the strains imposed by high winds and waves. Oak-bark tanning and wool-grease dressing kept the hull watertight and helped prevent deterioration of the leather.



PAINTING BY PAUL K. BRESLIN

1 Hull of 49 oxhides, a quarter-inch thick, reinforced at bow (four layers) and stern (two layers).
2 Tarpaulin, in sections, to keep seas out.
3 Sails of leather became waterlogged, and were replaced by a set woven of Irish flax.
4 Wickerlike skeleton of ash laths, secured by 1,600 lashings. Hull covering is stretched over frame but attached only to oak gunwales.
5 Water and stores, which also served as ballast.
6 Radio gear, charts, miscellaneous equipment.
7 Leeboard, lowered to reduce leeway when sailing on a reach.
8 Framed cabin top supports life raft and solar-cell panels for recharging batteries.
9 Cabin accommodating three, with space for two more in the bow.
10 Cooking box with kerosine stove.
11 Radio antenna.
12 Buoyancy blocks under tarpaulin. Some blocks were jettisoned to add storage; spare oxhides were rigged to protect cockpit in gales.
13 Rudder, or steering oar, leads by stout shaft to a yoke on the starboard quarter.
14 Oak skid for beaching.

An illuminated manuscript of sky seems a benediction as *Brendan* sails from Iceland, the most western outpost of Irish exploration yet proven. Fine weather was not to last. Gales swept *Brendan*, sometimes heading her back toward Europe

COTTON COLLECTION

again. Had her skipper relied only on charts used in the days of Columbus, he might have sought a prominent feature, "St. Brendan's Isle," which was thought to stand somewhere in the Atlantic between Europe and the "Orient."

ARTHUR MAGER

(Continued from page 778) Icelanders were marvelously hospitable, there was one thing they could not do for us: change the weather in our favor. For the next three weeks steady southwest winds swept the island, barring *Brendan*'s progress toward the New World. The autumn gale season was approaching, and there was the pack ice off the east coast of Greenland to consider.

Reluctantly I made the same decision St. Brendan obviously had reached several times: wait for another season. According to legend his voyage had lasted seven years; with luck we would make it in two.

At the invitation of Petur Sigurdsson, director of the Icelandic Coast Guard, we stored *Brendan* in one of his hangars and made for our homes, agreeing to meet in Reykjavik the following May.

Weather's Fury Poses a Crisis

Over the winter I worked on my logs and notes of the voyage. We had sailed more than 1,000 miles and had 1,600 to go—from Iceland to Newfoundland. I knew the second leg would be far tougher. We had not yet faced the notorious Greenland Sea gales, subfreezing temperatures, or the pack ice.

Gathering in early May at Reykjavik, we loaded our stores aboard *Brendan* and set off for the final goal, Newfoundland. At the last moment Edan found he had to return home because of private commitments, so once again we were a crew of four—Trondur, George, Arthur, and I.

In some ways it seemed as if we had never interrupted the voyage. On the second day our old companions, the whales, paid us a visit, though not close enough for Trondur to use a new harpoon he had brought along. I resumed daily navigation fixes and radio contacts, George busied himself with maintenance chores, and Arthur once again took over the still cameras. Life assumed a familiar tempo. It was not to last.

On May 20 the weather began to deteriorate. A sullen swell out of the southwest gave notice of heavy weather to come, and our spirits fell with the barometer.

By midafternoon we were in serious trouble. The great marching hills of water seemed to be trying to engulf *Brendan*. We put on our rubber immersion suits in case we went down, then steadily pumped the bilges amid the rattling crash of wave tops breaking across our low-slung craft. Then the sea found *Brendan*'s weak point: A breaking wave smashed through the open area between helm and living shelter. Water flooded in. The cabin was swamped.

"Pump! Pump!" Arthur yelled as *Brendan* began to settle sluggishly. Scarcely was the bilge water under control when CRASH! Another wave thundered aboard.

We had to close that vulnerable gap, but nothing we had aboard—nylon, canvas, or plastic—was strong enough to withstand the weight of incoming water. Or so it seemed, until suddenly the answer came to me: leather! An old encyclopedia drawing popped into my head, an illustration of an ancient Roman testudo, or tortoise, a defensive canopy of leather shields held overhead by soldiers during a siege to ward off stones and arrows.

In Ireland we had stowed aboard a spare oxhide and some smaller pieces of leather to patch *Brendan*'s hull if she developed a leak or was punctured. In seconds we had the spares out and Trondur was lacing them together with leather thongs. Fifteen minutes later *Brendan* wore a sturdy leather apron between her helm and shelter, and at last the waves rolled harmlessly off. We had survived our first Greenland gale.

Gamble on Brisk Northerlies Pays Off

Nine days later, on May 29, we cleared the southern tip of Greenland. I had gambled on finding northerly winds by running close to the pack ice along Greenland's east coast, and the gamble paid off; on one memorable day we made 115 miles.

Yet the weather continued poor. "Fog, drizzle, cold," were typical entries in my log for

Shooing away a hitchhiker—a water pipit exhausted on its migration from North America to Greenland—Tim Severin tries to get on with his meal. Most ponderous of regular visitors were whales: pilots, fins, sperms, minkes, humpbacks—and killers. What would a grease-smeared hull rich in protein seem to killer whales on the hunt? An easy meal? Only a curiosity, it turned out—to the relief of *Brendan*'s crew.

the period. We had been three weeks at sea, and boredom reduced conversation to a minimum. Like precious dry clothing, we doled out our thoughts and comments little by little, knowing that there were still long stretches of empty time ahead.

On June 14 we encountered our first sea ice. Radio stations I had contacted in Greenland and Labrador reported that the spring ice pack was receding northward through the Labrador Sea, but the reports were inaccurate. Under adverse winds we gradually found ourselves enmeshed in the ice, which stretched westward in a vast, almost unbroken expanse.

Once again Brendan luck favored us. In the space of a single day we encountered a Faeroese fishing boat that towed us free of the ice trap, and a U. S. Navy arctic supply ship that loaded us down with fresh provisions. The latter also gave us an exact position fix via a U. S. satellite. A nice touch, I thought—a medieval leather boat navigating by 20th-century space technology!

Ripping Sound Ends Rest

Our second encounter with ice began four days later and very nearly ended the voyage. In the predawn blackness of June 18, I had just turned over the helm to George and wriggled into my damp sleeping bag when a strange crackling sound, rather like the ripping of fabric, echoed inside the hull.

"Did you hear that? What was it?" I called. George had heard the sound, too, and thought it had come from the hull.

"There's nothing we can do about it in the dark," I said. I was wrong.

I had barely settled back in my berth when the sound came again.

"It's ice!" George shouted from on deck. "I can see lumps of it all around. We're running into masses of it!"

Quickly we dropped the sails to reduce *Brendan*'s speed, then surveyed the scene from the bow with hand torches.

It was a sight to send the adrenaline racing—all around and ahead of us were jagged monsters of ice, not the solid expanse of a few days before, but a nightmare jumble of individual floes with dark patches of open water between. As I watched, the channels ahead yawned wide one moment and snapped shut the next as the floes constantly shifted under the force of the wind.

It was obvious what had happened. A northwest gale that had sped us along over the past two days had ripped into the main pack of sea ice and burst it open, spraying the fragments like shrapnel over the ocean ahead of us. And *Brendan* was about to be fed into them like mincemeat.

My thoughts were interrupted by an awesome sight: a gigantic floe, perhaps the shard of a dying iceberg, heaving directly toward us out of the gloom. Rolling and wallowing like an enormous battering ram, it seemed ready to deliver a massive blow to *Brendan*'s fragile leather skin.

"Hang on!" I shouted to George as a swell lifted *Brendan* up and then flung her down on the huge floe that rose to meet her.

Crack! Thump! *Brendan* shuddered as though she had struck a reef, which indeed she had—a reef of ice. The impact flung George violently backward. He grabbed at a halyard and hung on, actually swinging out like a puppet over the ice and then safely back aboard.

I knew such luck could not last. Without headway we could never steer *Brendan* through the ice. We must gain momentum again, however great the risk, so that we could maneuver among the floes. Taking over the helm, I sent an awakened Trondur and Arthur forward to manage the foresail, while George stood as lookout on the cabin roof.

Threading a Perilous Maze

For the remainder of the night it was a mad scene, an icy toboggan ride in the darkness with little control, virtually no brakes, and a minimum of visibility. From the cabin top George would shout warnings to me: "Big one dead ahead . . . two floes on the port bow . . . one to starboard . . . looks like a gap between them." And I would issue the appropriate commands to Arthur and Trondur: "Up foresail . . . sheet to starboard . . . down, down, bring her down and slow her!"

Dawn came at last, and we were still afloat. "Any water in her yet?" asked George when I made a brief inspection.

"No," I answered, "she came through like a warrior."

Day followed night in much the same pattern. Visibility increased, but it did little to hearten us, for as far as the eye could reach, floe after floe stretched ahead and behind us.

At times *Brendan* seemed caught up in a grim and endless country square dance with giant partners who, as they dipped and curtsied, threatened to crush the life out of her. At length two of them nearly succeeded.

We had worked our way through what seemed the worst of the floes and by dusk that day were within sight of open water. As we eased through a gap between two massive chunks of ice, they swung together, pinching *Brendan*. The boat shuddered strangely, unlike previous collisions. Five minutes later I glanced down and saw water swirling over the floorboards. *Brendan* had been holed and was leaking.

Night Cloaks Extent of Damage

Despite the danger, the leak had to wait. In the gathering darkness we could neither locate nor repair it, and our first priority was still to work free of the ice. "One man on the bilge pump, please," I ordered. "Another at the helm, one forward controlling the headsails, and the fourth at rest."

Our situation was precarious: 200 miles from the nearest land, Labrador; ice floes still around us; a leak of unknown type and size somewhere in the hull; and a sea whose temperature hovered at freezing.

All that night we pumped—2,000 strokes of the bilge pump every hour to empty *Brendan*. Physically we could manage it, but not for long; our fatigue level was already dangerously high. Before dawn I radioed the Canadian Coast Guard station at St. Anthony, Newfoundland, reporting our situation and giving what at best was an estimated position.

"We are not in immediate danger," I added, "but would you please consider the possibility of air-dropping us a small gasoline bilge pump if it becomes necessary?"

"Roger, Roger," replied the St. Anthony operator as if the request were routine. Long afterward I was to learn that the Canadians quickly readied a rescue aircraft at Halifax, Nova Scotia, and alerted one of their icebreakers a day's sailing to the west of us. "But," a Coast Guard officer confided to me, "we rated your chances as nil."

In the end we managed without assistance. During my turn on the pump that night I noticed a curious fact: Occasional flashes of phosphorescence at a certain point on the outer surface of the vessel's hull were matched

BOTH BY GORDON GIBLIN

Plotting a fix, the skipper prepares to make a daily radio report of position to the nearest coastal stations that could dispatch rescue aircraft if necessary. Since *Brendan*'s course could not be predicted, accurate celestial navigation was vital.

Cramped as a monastic cell, *Brendan*'s tiny cabin packed with radio gear and off-watch crew gives minimal comfort. While George Molony tries to sleep, Arthur Magan studies a book on whales. Taking part in a worldwide whale watch, the crew kept a log of all sightings.

simultaneously by flashes inside the pump's plastic intake tube within the flooded hull. The hole, I thought, must be close to the end of the tube.

At dawn I leaned out over the gunwale above where I judged the end of the tube to be, and instantly found the trouble: a dent at the waterline about the size of a grapefruit, with a tear at the center. Under tremendous pressure from a spearhead of ice, our flexible leather hull had finally burst, but only by a length of four inches. Had *Brendan* been built of rigid metal, fiberglass, or wood, she might well have been crushed and destroyed.

Painstakingly we cut a leather patch to size, and George leaned over the gunwale in his immersion suit to apply it (page 793). Working with pliers and an awl, he thrust a heavy needle threaded with flax through the patch and the hull to Trondur, who lay inside and forced the needle back out to George.

It was a bone-chilling three-hour job, and at times George's head vanished in the waves. At last the final stitches went in, the patch was smeared with grease, and *Brendan* was as watertight as the day she was launched.

A Welcome Meeting at Sea

A day or two later we began to see our first signs of land—floating logs, patches of weed, and a marked increase in birdlife. We had been six weeks at sea, and the signs were welcome. Then on June 23 our radio crackled with cheerful news: The Canadian Coast Guard's *John Cabot* would rendezvous with us that same day, roughly 100 miles northeast of Newfoundland's Hamilton Sound.

The meeting was a great boost.

"We were lucky to spot you this morning," said Capt. Leslie K. Eavis, *John Cabot*'s skipper and an old sailing-ship man himself. "The lookout called down and said there was something on the port bow. I said, 'Can't be him, he's supposed to be 38 miles away!'

"But after the second or third look I realized it *had* to be you; I could see the cross on your sails, the red cross."

John Cabot left us with fresh food, extra batteries, and best of all, four pairs of her first officer's dry socks.

Memories of those final three days remain a blur, smudged by our growing anticipation of a landfall. Appropriately, our old friends the whales showed up to help celebrate our victory. A herd of humpbacks surfaced as we entered Hamilton Sound, spouting, breaching, and slapping the water with their great flukes as if in ovation for *Brendan*.

On the evening of June 26, 1977—a year and six weeks after weighing anchor in Ireland—we coasted in to Peckford Island in Hamilton Sound. Dropping anchor astern we paid out the line until *Brendan* rode quietly a few yards from the beach. I turned to George: "Can you take a line ashore?"

As he made ready to jump, *Brendan* crept forward, not with style or speed, but in the same matter-of-fact manner in which she had ranged over three and a half thousand miles of ocean.

George leaped. His feet splashed, then touched ground (pages 796-7). And I thought at last, "We've made it."

Legend Moves Closer to Truth

The site of our final landfall has no particular significance. What matters is that *Brendan*—a leather boat that some predicted would disintegrate in the first ocean gale—had successfully crossed the Atlantic. She may have looked more like a floating bird's nest than an oceangoing vessel, but she had brought us safely through fog, ice, gale, and calm, across some of the world's most unforgiving waters. She had proved beyond doubt that the Irish monks *could* have sailed their leather boats to the New World before the Norsemen, and long before Columbus.

But *Brendan* had done more than that. She had showed that the saga of her namesake was no mere splendid medieval fantasy, but a highly plausible tale. Scholars of epic literature will not be surprised. Their experience shows that some of the most durable legends, from the *Iliad* to the romance of Alexander the Great, are founded upon real events and real people.

In St. Brendan's case those people must have been very special men, even by the exacting standards of their day. The territories they sought were the special lands beyond the horizon, the unknown places, the wondrous realms to be revealed by God. In short, the Promised Lands.

Such was the motive that inspired St. Brendan and those who came after him, including ourselves—man's age-old instinct to explore, to test, to learn.

COTTIE COULSON

A friendly Ahab practices harpooning on a mild day at sea. Trondur Patursson joined the crew in the Faeroe Islands, where whale meat is still regularly eaten.

ALL BY ARTHUR BAGBY

Hulking ice slips by to port as *Brendan* threads open pack off Labrador (**above**), as viewed by a camera whose shutter was jammed by exposure to seawater. Most dangerous were the jagged teeth of smaller floes. One day at dusk two of these scissored the boat, and water spurted in.

It was sew or sink when the puncture was found, and the crew pumped 2,000 strokes an hour through the night to clear the bilges. At dawn George Molony pushed thread through a leather patch (**right**) to seal the leak—stitches just in time. Ice-cold water may have served to preserve the leather hull, which might have rotted on a more southerly crossing.

To catch a fulmar, Trondur Patursson tosses chunks of bait astern to distract birds. Then, with a sweep of the net, he captures a meal (**left**). That day the crew had fresh roasted bird with a taste similar to squab to relieve the monotony of their regular fare.

ARTHUR BRIGAN

Reefed down in a rising wind, sails pull *Brendan* into fog (**left**). Waves slosh at the tarpaulin covers and trickle in at seams and crevices, ensuring a cold, wet cabin. In gales, the reefed foresail kept the boat moving so she would not lose steerageway. It was safer to wander off course under control than to risk turning broadside to the waves, with the possibility of capsizing.

Fighting off tedium, Trondur relaxes on deck in a whaler's hat, foul-weather jacket, and wool trousers (**above**).

"Wool, wool, and more wool. It kept us warm even when wet," says skipper Severin. In general, medieval materials held up best. And traditionally smoked and dried foods gave more sustenance and tasted better than modern dehydrated ones.

Ashore in the New World, perhaps the "Land Promised to the Saints" of St. Brendan's saga, George Molony sets foot on Peckford Island, Newfoundland. Could this same scene have been

CURTIS CONLEON

played out some 1,400 years ago by grateful men in homespun cowls? Archeology may never be able to confirm or deny it. But the possibility can no longer be dismissed. □

The Year the Weather Went Wild

By THOMAS Y. CANBY
SENIOR EDITORIAL STAFF

FROM THE DARK HOLE of his aircraft window high above South Dakota, paper executive Robert Haines looked down perplexed on the nighttime prairie below.

"Those rural roads should have been empty at that hour," he recalls, "but I was picking up headlights—lots of them, on vehicles heading east and south.

"I saw more and more lights as we flew on west. By the time we reached Aberdeen, South Dakota, there was a solid string of them, as far as the eye could see.

"When we landed, I discovered what they were. Cattle trucks—load after load of range cattle, heading for the slaughterhouses. Drought had parched the pasture, and the ranchers were selling out."

Sell out they did. Two-thirds of the cattle in parts of eastern South Dakota were trucked to market and sold at depressed prices as drought more severe than in dust bowl days scorched the northern plains. Wheat farmers who normally harvested 30 bushels an acre got two, or one, or none. Dairymen whose grass and hay gave out fed their cattle thistles and cattails and saw cows bear calves that were sick and blind from malnutrition.

Is Nature on a Rampage?

In hindsight, calamity was building even then, the summer before last. Now it has spread alarmingly. More than six million Californians grimly endure water rationing, and the state's farmers have suffered almost a billion-dollar loss in a year. Much of the West has been hit nearly as badly, and last summer drought seared a broad swath across the Southeast.

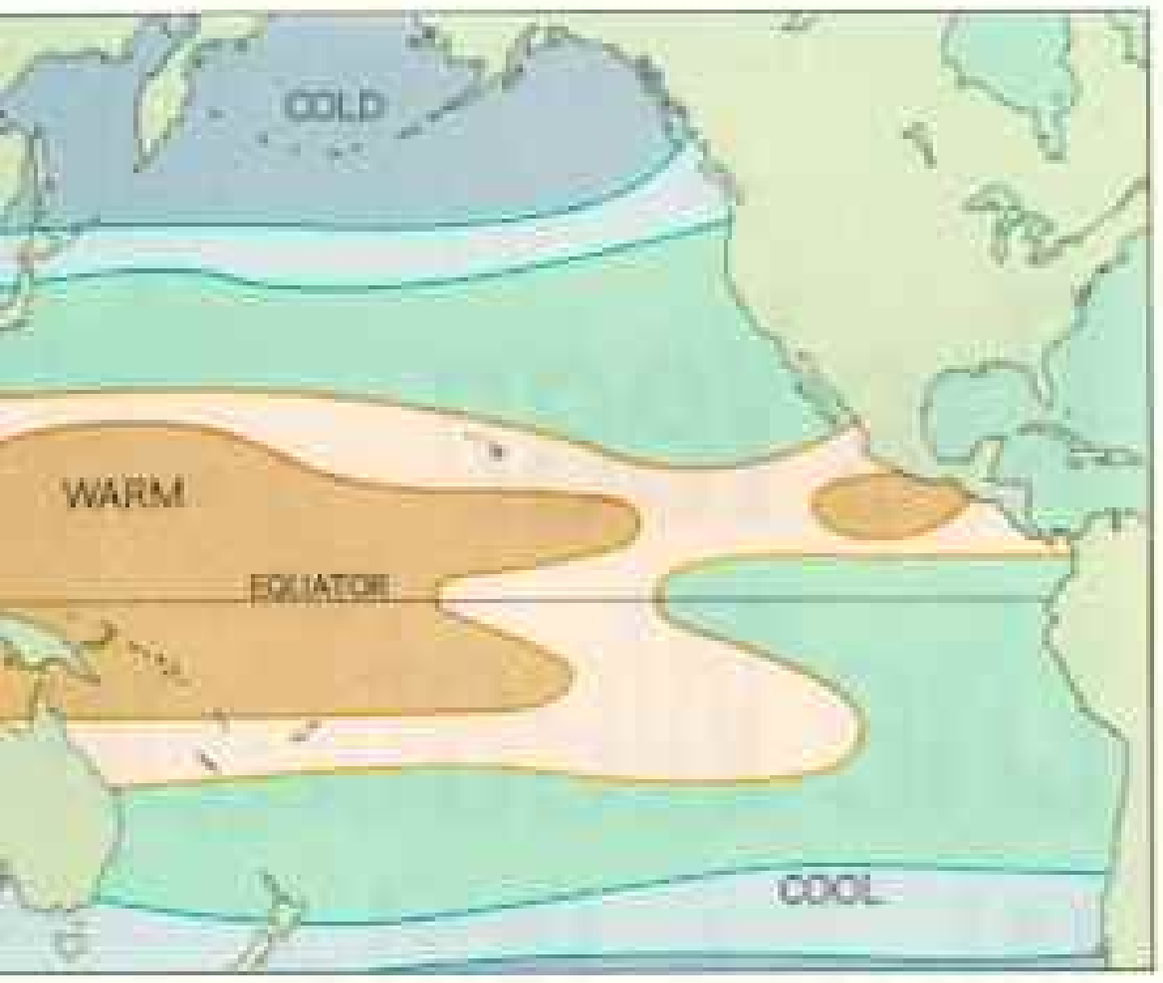
Along with the dry came the cold. No one east of the Rocky Mountains will forget the cruel winter of '77, when record-setting freezes and disastrous fuel shortages brought misery and hardship to millions.

What's happening to the weather? This protracted losing streak—is it merely a chance roll of nature's dice? Or does it fit into a recognizable long-term pattern of adverse climatic behavior?

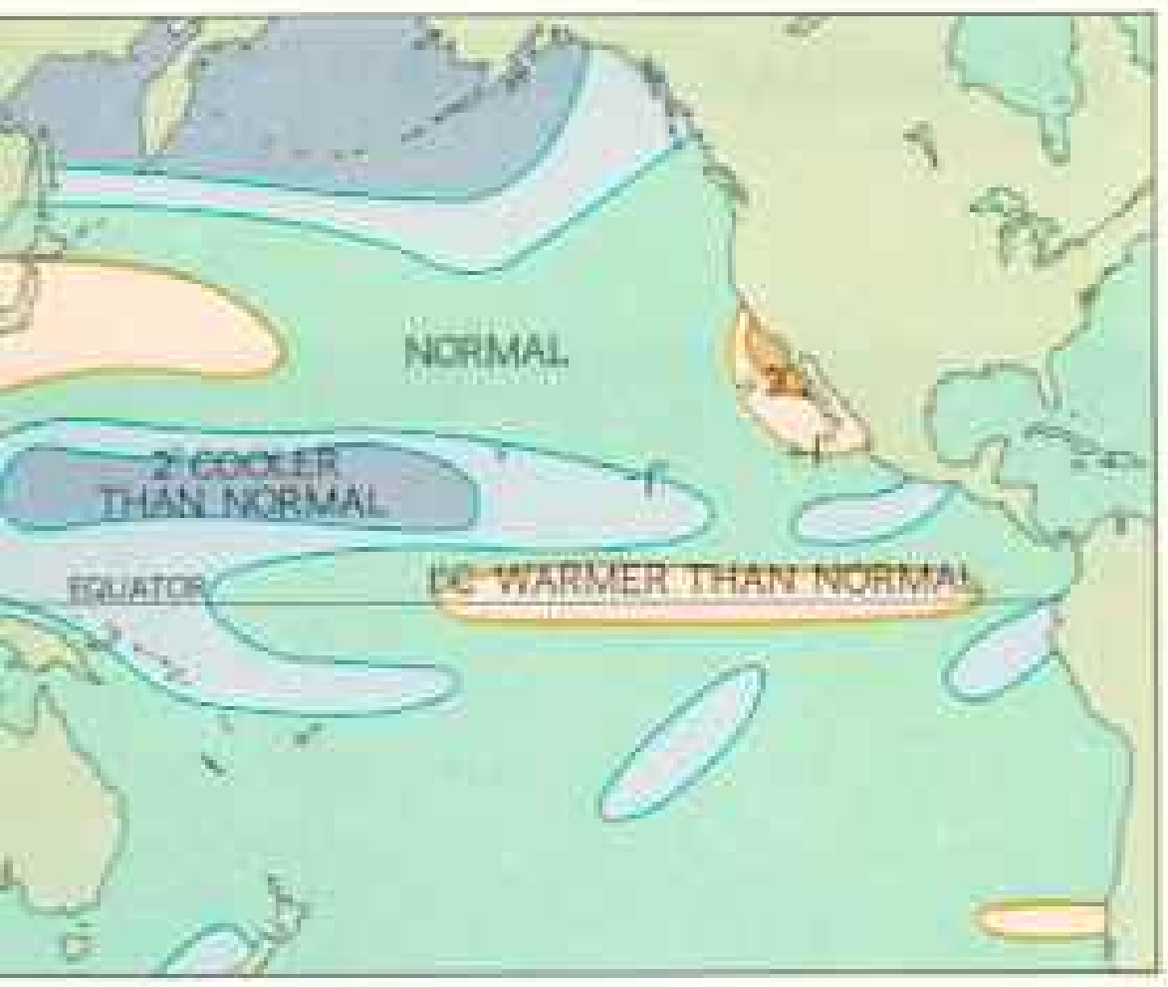
Such questions, I found, are incredibly complex; query a climatologist for hard answers and you are likely to get only hesitant hypotheses. But these scientists *have* dissected the anatomy of the meteorological monster that helped work last *(Continued on page 804)*

BY PENNE CLATTS, NATIONAL GEOGRAPHIC PHOTOGRAPHER GEORGE F. MOBLEY

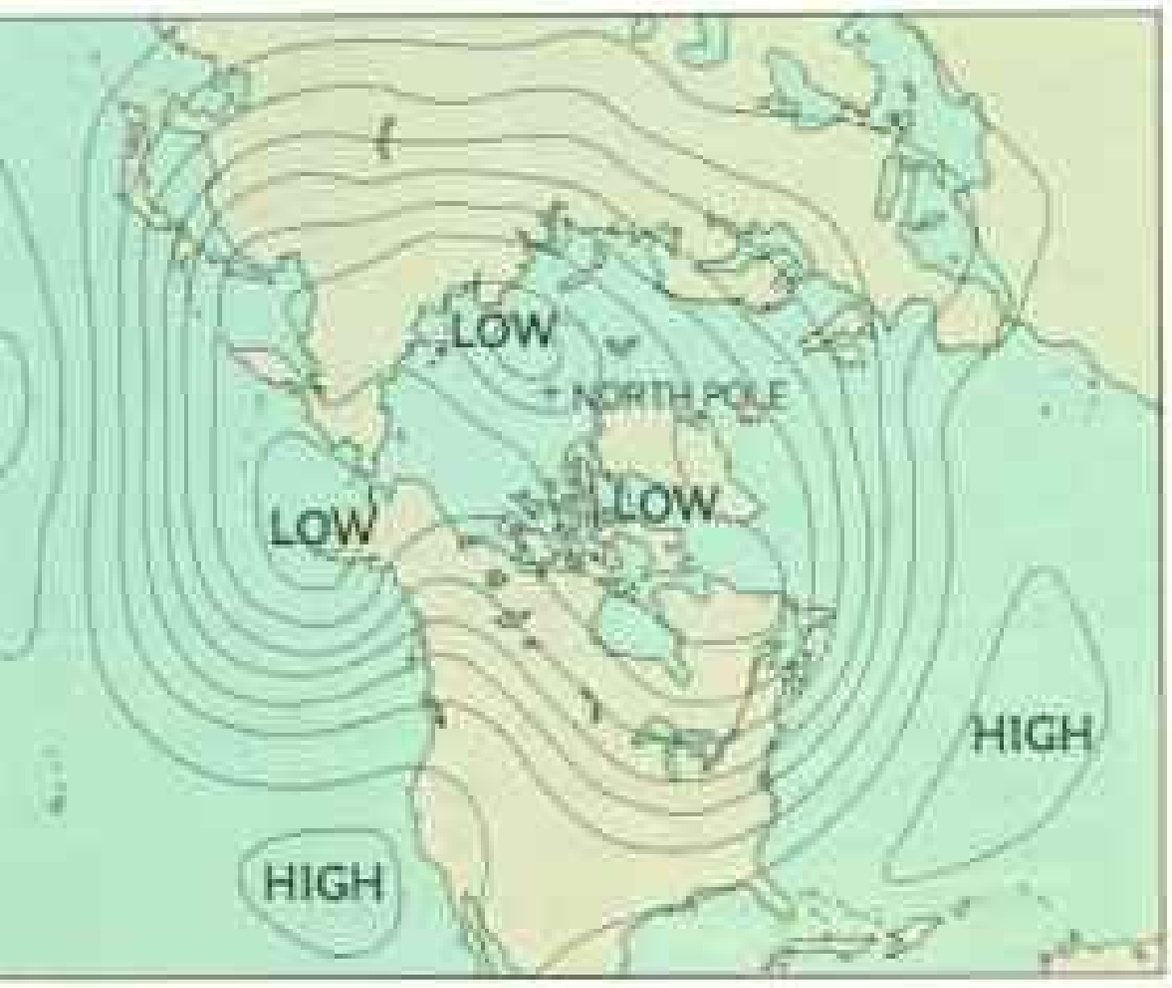
Icicles on Florida oranges, overwhelming snowfalls in the Northeast—thus the U. S. staggered through the winter of 1976-77. By summer a more serious crisis had gathered momentum: Parts of the nation were suffering the worst drought on record.



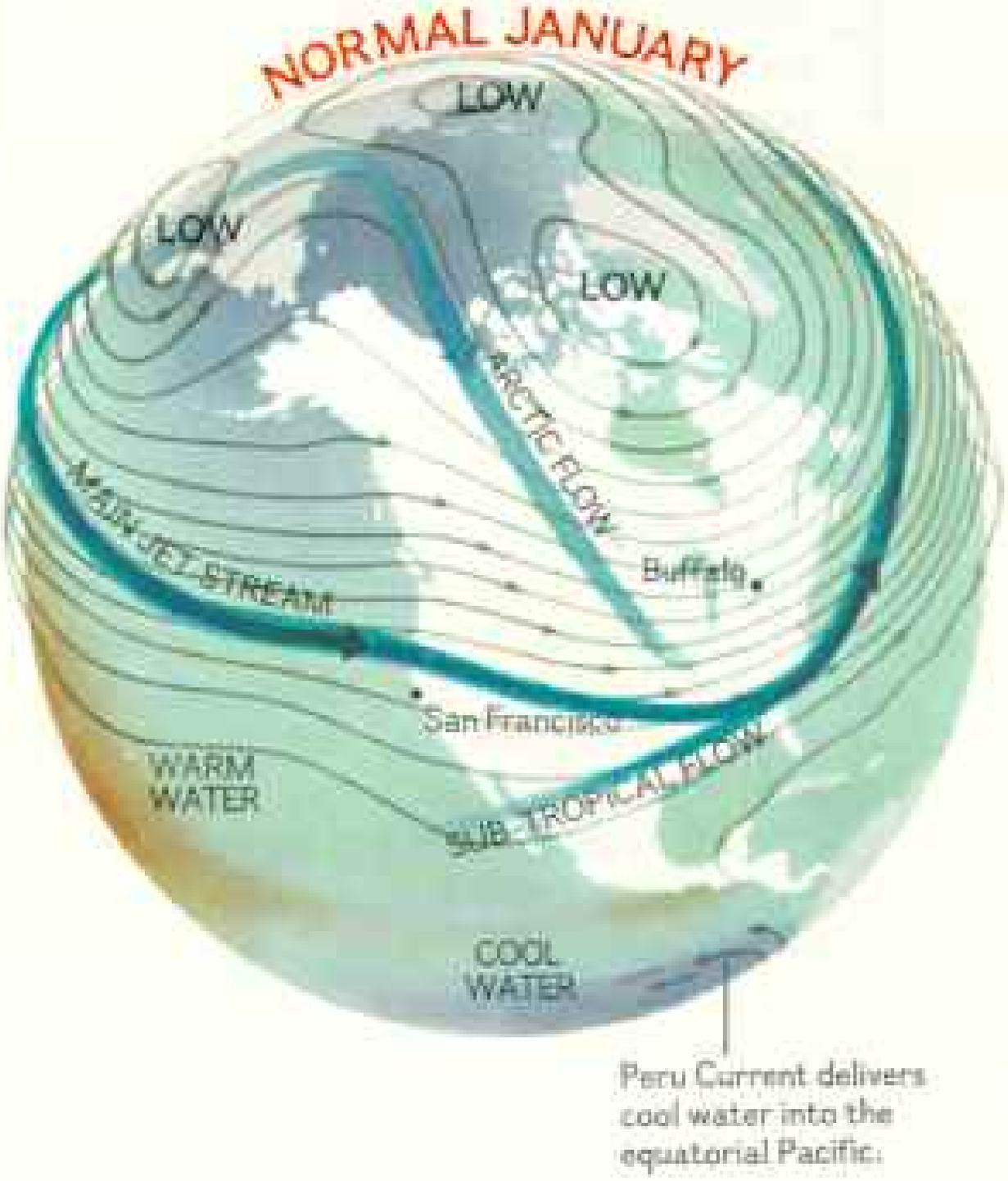
NORMAL NOVEMBER: Warm surface water in the central Pacific and cool water off South America reflect usual conditions for the month.



NOVEMBER 1976: Variations of as little as 2°C in sea-surface temperatures may have intensified unusual pressure systems and the winter that followed.



NOVEMBER 1976: Low pressure in North Pacific and high pressure off North America's west coast strengthen a bulge in the normally circular pattern of air movement.

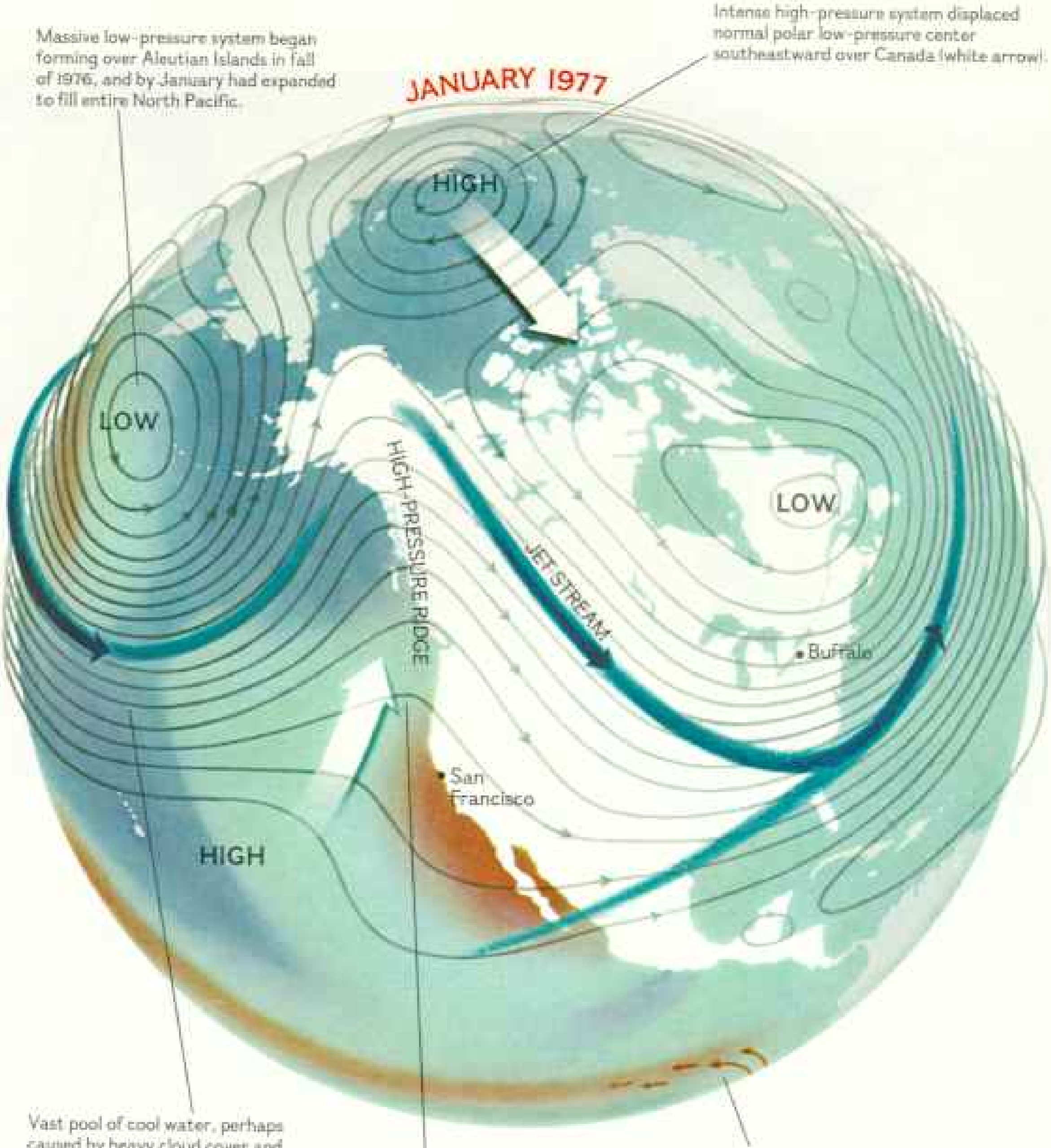


Peru Current delivers cool water into the equatorial Pacific.

Ill winds blow in a bad winter

LOOPING AROUND a huge low-pressure system in the North Pacific (**right**), and deflecting off a high-pressure ridge along North America's west coast, the earth-circling jet stream and its accompanying westerlies were diverted to Alaska in a pattern unbroken for most of the winter of 1976-77. Turning back to the south, and accelerated by a shift of the normal Canadian low to the southeast over Newfoundland, the winds—now bearing a freight of Arctic air—funneled straight out of the northwest into the United States. And the disaster was born.

Some scientists look to the oceans and their vast pools of warm and cold water (**upper left**) for keys to long-range prediction of such radical shifts in wind circulation. Though experts agree that sea-surface temperatures are influenced by the atmosphere, which in return is affected by the more heat-retentive water, they differ on the importance of ocean feedback to continental weather. Changes in the Peru Current, for example, are seen by some as symptoms, not causes, of deviant weather patterns.



PAINTINGS (ABOVE) BY WILLIAM H. BOND AND GUSTAV (LEFT) BY EMILIANA VISTARINI, BOTH NATIONAL GEOGRAPHIC ART DIVISION. BASED ON DATA FROM NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Frozen out of work for much of the winter, oyster tongers of Chesapeake

NATIONAL GEOGRAPHIC PHOTOGRAPHER JOE RAEDLE

Bay labor atop hazardous ice floes during February's first thaw.

(Continued from page 799) winter's havoc. Its lair was North America's Pacific coast.

In normal years, a high-pressure system hovers over the coast throughout each summer and autumn, bringing the clear skies and rainless days that have lured so many millions to the sun belt. Usually, in early winter this high-pressure ridge migrates south. With this barrier removed, the jet stream and accompanying moist Pacific winds sweep eastward, dropping life-giving rain and snow on the West. Interacting with cold fronts from the Arctic, these winds produce our familiar winter pattern of alternating cold snaps and warm spells.

But last winter was different. Some experts think that abnormally warm coastal waters, caused by shifting Pacific currents, prevented the ridge's southward migration. Anchored over the continent's edge, it diverted the jet stream northward to Alaska, and with it the moist storms that water the West. Then the stream looped and howled back to the south at half again its usual speed, bearing the icy Arctic air that numbed the East.

Numbing it was—200,000 people frozen out of jobs when natural-gas shortages closed down offices and plants; five billion dollars up in the smoke of bloated fuel bills.

Snow in Miami, Slush in Alaska

In Miami and Palm Beach, January sun-seekers stared in disbelief at frozen white wafers floating down—snow! A judge in Florida recessed court so all could watch the spectacle. Yet 4,000 miles northwest, bears in Alaska came out of hibernation in the balmy winter, and Anchorage schools had to cancel hockey games because of slush.

A blizzard engulfed Indiana, and 3,500 cars and trucks floundered helplessly on Interstate 65. In neighboring Ohio the snow

BOTH BY FRANK JOHNSTON

An armor of solid ice over most of the Chesapeake and its estuaries (**above**) meant some ten million dollars lost by 7,000 bay watermen.

Battling the ice that beset Deal Island, Maryland, 74-year-old Albert Lee labored for six weeks with pumps and buckets to keep his boat afloat. Here (**right**), he leaves the battle, defeated. Ice loosened caulking between planks, and the boat sank. In 60 years of working the bay, Mr. Lee can't remember a winter "as long, as cold, or as bad."

Buffalo digs out after a siege of snow unrivaled in its annals of bad weather. Striking at noon on January 28, a blizzard kept thousands of workers marooned overnight and forced homebound motorists to abandon their cars and struggle through 60-mph gusts in search of shelter. Five days of snow and high winds left the city paralyzed, as the National Guard and volunteer groups made emergency deliveries of food.

stopped a car, and five men froze to death.

A stillness settled on Chesapeake Bay. Ice eight inches thick closed Baltimore Harbor. Seizing dock pilings, the ice lifted them with each incoming tide until piers collapsed like jackstraws. Tentacles of ice pulled caulking from wooden boats, and vessel after vessel quietly sank (preceding page). Unable to sail to oyster beds, resolute watermen strode out onto the ice, cut holes with chain saws, and tonged a fair day's haul.

And in Buffalo, New York. . . .

"The blizzard hit while I was returning from a trip out of the city," explained cabby Victor Barr, 65 and spry. "Stopped my taxi dead. I started walking with the wind chill at sixty below. The wind knocked me down, then blew me down again. It stung my face until it bled. I made it to a jam-packed pizzeria and stood up all night next to an oven. Next day I reached a firehouse, where I could sleep on the floor. The third day I got home. Thirteen feet of snow so far this winter, and none of it's melted. It's unreal!"

A City Buried and Cut Off

It *was* unreal. So deep was the snow, so quiet the metropolis trapped beneath it, that you almost forgot that the January blizzard had virtually isolated some two million people from the rest of the world.

Milk disappeared from store shelves, while in surrounding Erie County snowbound dairymen had to dump their milk in the drifts. Snowmobile tracks soared right over tractor trailers buried on expressways, and looters preyed on stranded autos.

To the old and infirm, marooned in their homes, the drifts were prison walls. Some needed medicines; all needed food. Their lifeline was the telephone.

Phones jangled at Buffalo's crowded and busy Salvation Army headquarters at Main and High. "We've delivered food and medicine to 23,525 homes already," tabulated Maj. Donald W. Nathan, weary of bone but still martial in manner. "We send out four-wheel-drive vehicles as far as they can go, then transfer to snowmobiles."

Weren't they straining their budget?

"So far we've spent $76,000 of our $5,000 emergency fund," the major said. "We act on faith; the money will come in."

I teamed up with volunteer Jack Migliore,

a printer whose shop was closed down by the snow, and we set forth to make a delivery. We passed a detachment of National Guardsmen struggling to clear the clogged streets. With snow everywhere, there was no place to push it; doggedly they loaded it on trucks to be dumped onto Lake Erie ice.

Scaling a titanic drift on Prospect Street, Jack and I knocked at the address on our grocery bag. The door opened. An elderly couple, shivering bleakly in winter coats, stood amid bags of uncollected garbage. Wordlessly they clutched the food and melted into the dark, frigid home.

Perched at the eastern end of Lake Erie, Buffalo was reeling under the phenomenon known as the "lake effect." Moisture evaporating from the Great Lakes rises, condenses in cold upper air, and descends downwind in a belt of deep snow. Normally, Lake Erie's snow belt lies safely south of the city. But this year the blizzards bore in straight off the lake, burying Buffalo.

At the eastern end of Lake Ontario, Watertown, New York, also felt the lash of the snow belt. Six feet had fallen in five days, and drifts arched 25 feet high. Four barns had collapsed on cattle; another burned, with firemen powerless to reach it. Officials cautioned pedestrians not to walk up drifts and blunder into overhead electric wires.

In the wake of plows I headed south to the worst-hit area. All was activity at the firehouse in snow-smothered Adams. Firemen and U.S. Army troops were readying food and fuel deliveries for families stranded on Tug Hill, hardscrabble country east of town. For nine days Tug Hill's remote farms and tiny hamlets had been cut off from the world by snow 24 feet deep.

Deer Die Amid the Drifts

We clambered aboard a huge Marine Corps helicopter with double rotors and angled up over the bleak plateau. The only life we could see below was an occasional herd of starving deer. "The weak ones will be pulled down by packs of wild dogs and coydogs—half coyote, half dog," yelled Adams fireman Stanton "Duffy" Hamilton over the chopper's roar.

At house after isolated house we settled down in a blizzard of rotor-blown snow. Duffy and a contingent of troops sallied forth on snowshoes to deliver food and kerosine to grateful occupants.

We landed beside the little unpainted home of Margaret Forsmark, a lively but very lonely widow of 80. "Done my shopping, boys?" she asked. Ignoring the groceries, she chatted happily with Duffy Hamilton. As he at last returned to the copter, she turned to me and talked on, her hands unconsciously kneading my arm. When I too had to pull away, she looked guiltily at her hands. "Excuse me for touching you, a stranger," she blurted. She watched from her open doorway as the helicopter lifted away.

Pennsylvania Runs Short of Fuel

An hour's plane hop southwest, in the Pennsylvania mountains, Fayette County was also besieged. Time after time during January and February, when temperatures screamed to 20 and 30 below, Fayette found itself draining its last drops of kerosine and fuel oil, and many homes grew cold.

"It takes 300,000 gallons a day to keep this county something like warm," explained County Commissioner Fred Lebder, bustling about his emergency headquarters in a little brick schoolhouse paneled with knotty pine.

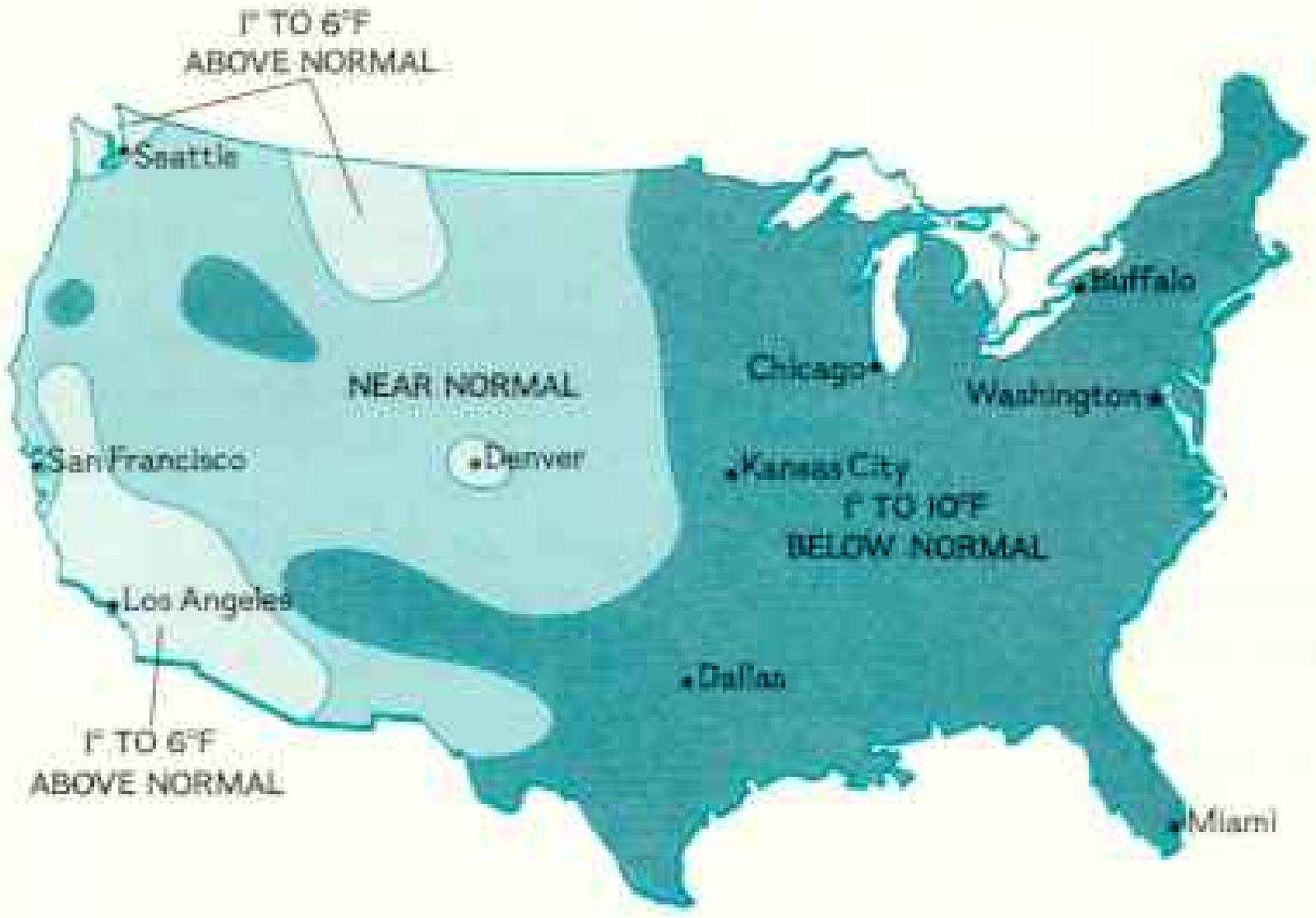
"Why are we short of fuel? Partly allocations and so on, but there are other factors.

"For example, the Monongahela River is frozen over solid, and barges that normally carry coal to the steel mills and electric generating plants are stranded in the ice. So the coal companies have to haul the coal in trucks. I calculate that one coal company with 70 trucks is burning enough fuel to heat 1,820 homes."

The biggest problem, Mr. Lebder said, was supplying the people in the mountains with emergency fuel. The Pennsylvania Department of Transportation was helping.

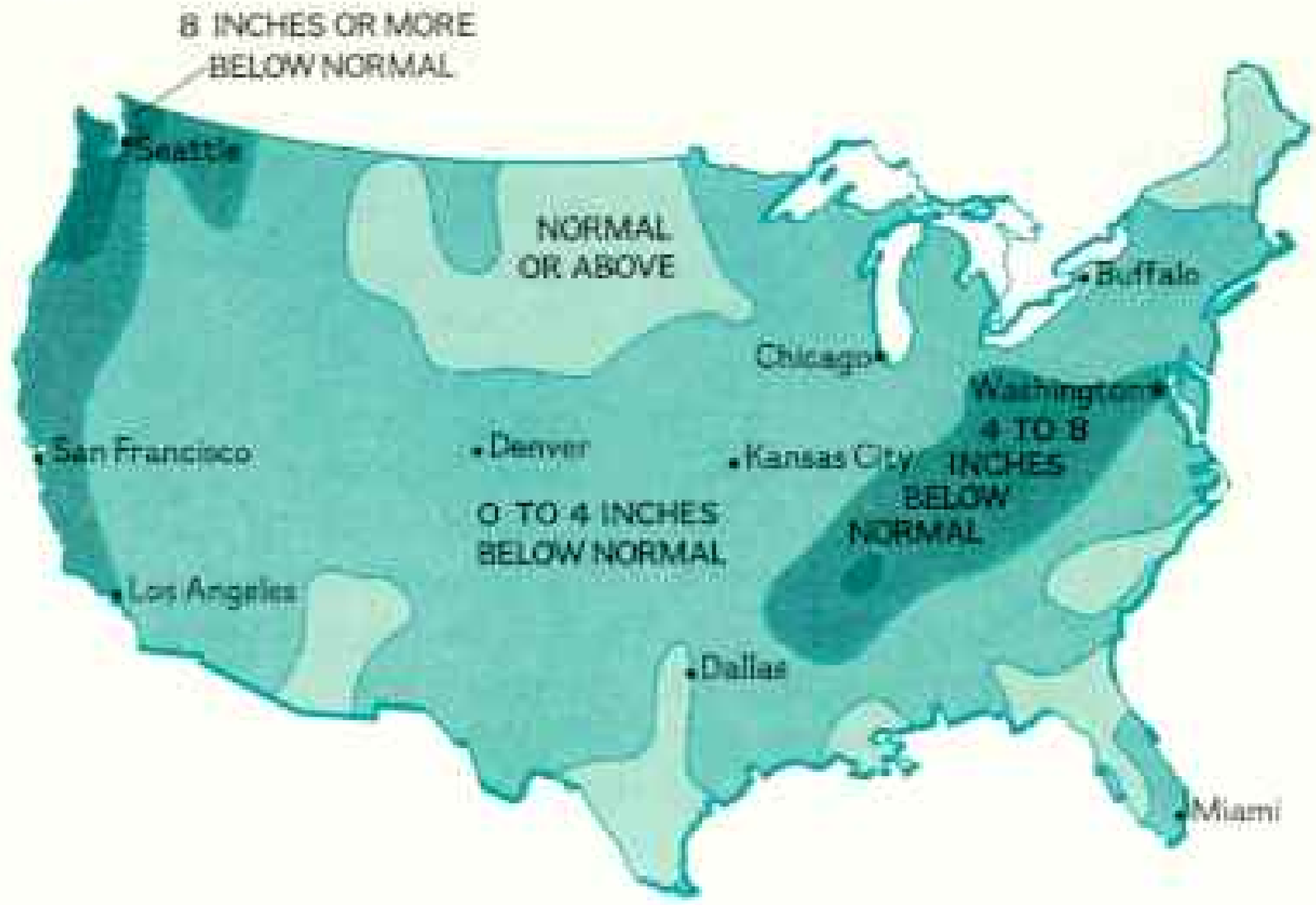
I crept along Route 40 up Chestnut Ridge and stopped at the PennDOT depot known as the Dinner Bell shanty. Here foreman Harry Burd, a robust man in his 50's, dispensed fuel from 55-gallon drums and fought to keep his district's roads passable in the ever blowing snow. "Fast as we clear, it drifts again," said Harry resignedly, "but what else can we do?"

Inside the tiny Dinner Bell shanty, half a dozen ruddy-faced equipment operators took brief respite. In a cloud of cigarette smoke



Numbing cold grips the East...

Viewed as a whole, temperature deviations from normal for the three months beginning December 1 and ending February 28 showed the winter of 1976-77 to be on a par with 1917-18. As in that bitter winter, the West escaped the brunt, while temperatures in the East plunged to historic lows. The Ohio River Basin suffered its coldest weather on record. January was the worst month, with individual readings of 15° to 20°F below normal not uncommon in the East.



and scant winter snow and rain...

For much of the West, last winter sharply worsened drought conditions already well into their second or third year. In the East, precipitation lows—here computed for December through February—went largely unnoticed as frigid air, accumulations of unmelted snow, and fuel shortages captured headlines. By winter's end 22 states—18 west of the Mississippi—were suffering drought problems.

deepen drought across the land

By mid-July nearly two-thirds of the nation's 3,100 counties—or portions of 35 states—had been placed on the federal emergency drought list. Though well-timed rains were promising healthy grain harvests throughout much of the Midwest, reservoirs, rivers, and subsurface waters were drying up at alarming rates. In many areas, the 1977 drought is judged by experts as more severe than that of the 1930's.

DIAGRAMS BY SIDNEY L. JOCKEL, JR.
NATIONAL GEOGRAPHIC ART DIVISION
BASED ON DATA FROM NOAA

they talked about the weather. . . . "The *Old Farmer's Almanac*—*it* predicted this rotten winter. . . . And how about that January night when the mercury plunged to minus 36, turning the diesel fuel to jelly? Even the snowplows were stopped in the drifts. That was the night Harry Burd's ears froze." Three weeks later I could still see the scabs of frostbite.

Factories Close, Out of Gas

I pushed into the Midwest, across the tundra of the Ohio Valley to Dayton. There the thermometer told the tragic story of this winter-wracked metropolis and much of the eastern United States. The average daily temperature in Dayton ran 17 degrees colder than normal. Furnaces burned full time to keep the chill away.

It was the same across the frozen East, placing an unprecedented strain on a limited supply of natural gas. Countless businesses closed down. An epidemic of unemployment spread, hitting hard at Dayton.

In the sub-zero dawn I hailed a taxi and toured nearly deserted streets that should have been clogged with commuters. But I found business booming at the unemployment office. Its cavernous second-floor hall was filled with people signing up for compensation. A steelworker told me his plant had closed eight weeks earlier. In the downstairs lobby, a polite young zealot handed me a limp tabloid denouncing capitalism and extolling socialism. He castigated the Dayton Power and Light Company for running out of natural gas.

Almost everyone seemed to think DP&L was to blame. Not so, responded the beleaguered company. It had taken good care of its customers before this freakish winter struck. Further, DP&L had no storage capacity; it drew directly from a transmission company that bought from gas fields in Texas, Louisiana, and the Gulf of Mexico. *There* lay the trouble. The wells were slowly running out, and low rates imposed by the government discouraged exploration for new gas. And so it went, across much of the shivering country.

In the middle of February the dreadful cold spell suddenly snapped, and spring came early and gloriously to the East. Looking back on the ordeal, was it really the "worst winter" it seemed to be?

If you live in the Ohio River Valley, the answer is an unequivocal "yes." Cincinnati set an all-time record with a brittle minus 25°F. Dayton's 21° below came next, rivaled by minus 19° in Columbus. Pittsburgh recorded a new low of minus 17°; Evansville, Indiana, minus 21°.

From Philadelphia to Peoria, January was the coldest month ever. (In much of Alaska it was the warmest.) Across the South, cities recorded temperatures that bordered on the absurd: minus 1° in Huntsville, Alabama; 10° in Pensacola, Florida; 6° in Jackson, Mississippi.

Snow, too, set records. On January 31 it rested on part of every state of the contiguous 48 for the first time on record (following pages). Never had snow fallen as far south as Miami; never in ten years of satellite observation had it covered so much of the Northern Hemisphere. By winter's end, 200 inches —nearly 17 feet—had fallen on Buffalo.

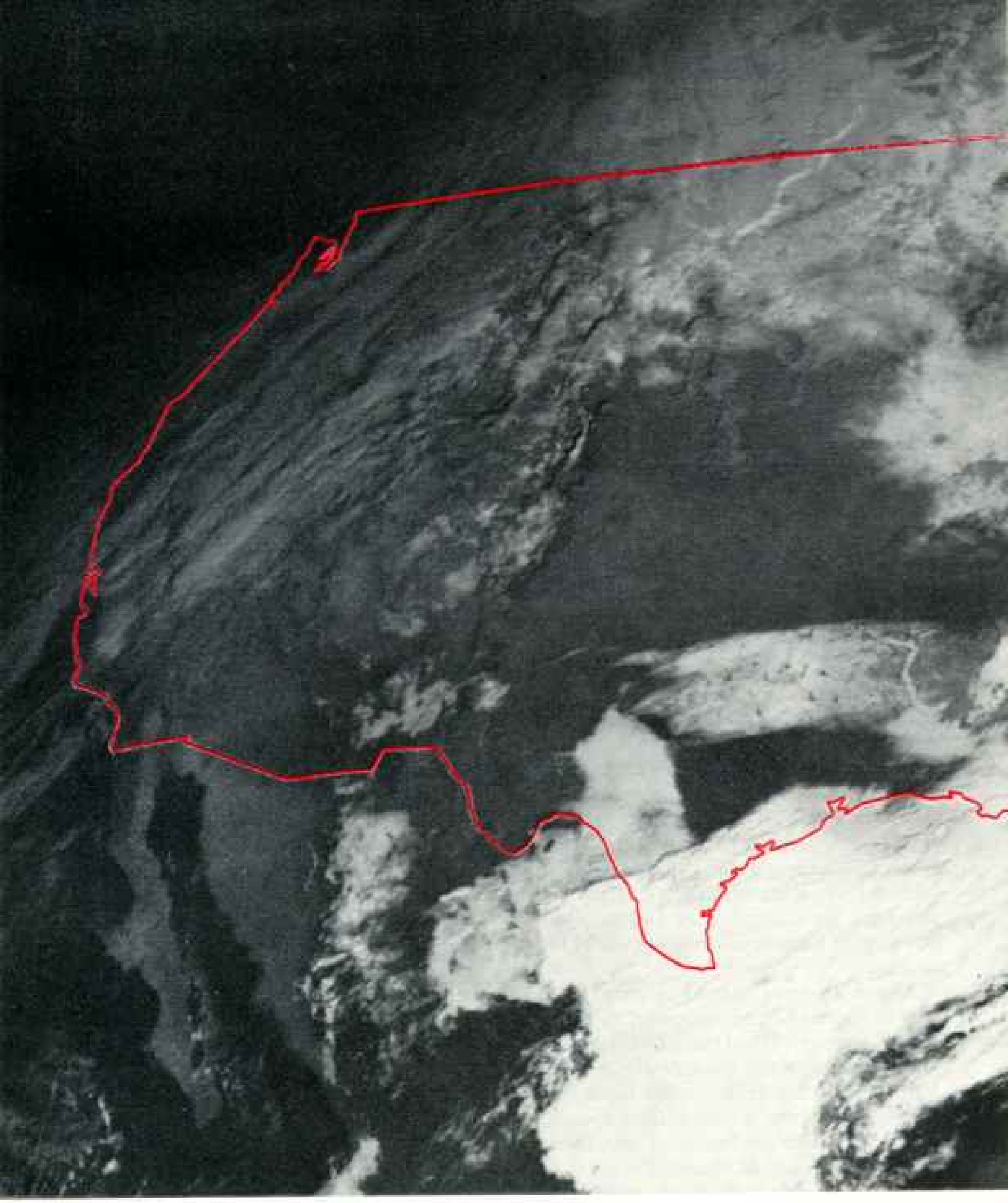
The damage in dollars and cents is difficult to measure. Florida officials feared a potential loss of 900 million dollars in citrus, vegetables, and tourism. Joblessness may have siphoned off another 225 million in Ohio, with New York, Tennessee, and Pennsylvania not far behind. Commerce Department analysts estimate the winter cost the nation a hefty three billion dollars in economic growth, and devoured five billion more in increased fuel.

Rich Topsoil Blows Away

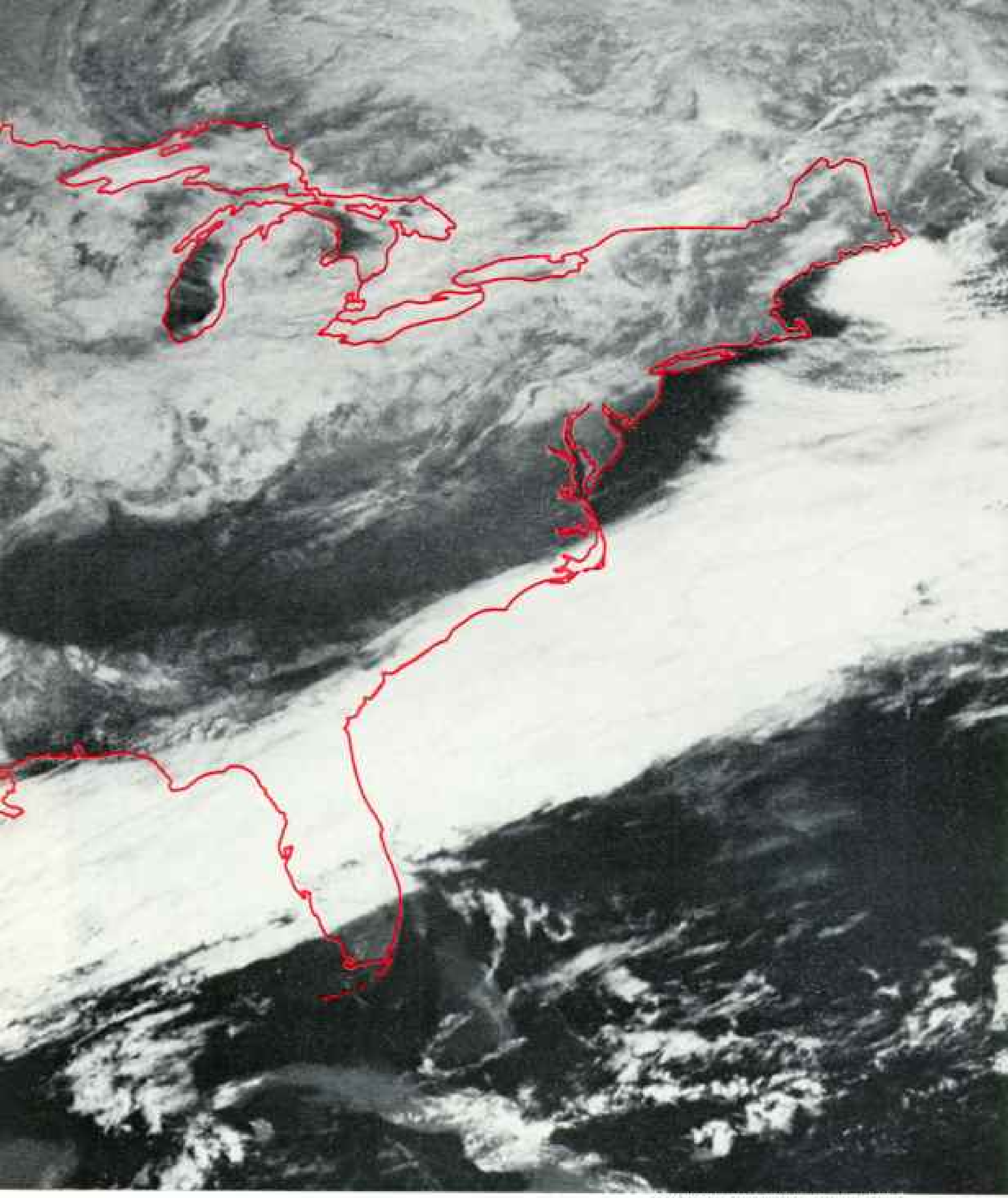
While Easterners shoveled heavy drifts, the National Weather Service announced a seemingly incongruous fact: Much of the nation was caught up in severe drought. Worst off by far were the northern plains and the West.

Already two years of dry weather had plagued the eastern Dakotas and western Minnesota and Iowa. California had endured a year of drought. Suddenly most of the West was stricken.

A major culprit was that high-pressure ridge hovering over the Pacific coast—the same system that was bringing disaster to the East. With moist Pacific storms diverted northward, little snow was falling on the Sierra, Cascades, and Rockies, or on the plains beyond. This meant woefully little spring melt to recharge the rivers and reservoirs of the West (pages 816-17).



Chilling view of the nation was made on the morning of January 31, 1977, when a NOAA satellite transmitted this image from 22,200 miles above the earth. Adding ground data for image areas concealed by clouds, scientists learned that all 48 contiguous states, including Florida, had



NOAA/NATIONAL ENVIRONMENTAL SATELLITE SERVICE

snow on the ground—for the first time in weather records. A belt of snow extending from Texas through Florida and the Carolinas had just been deposited by an eastward-moving storm system, the great swath of clouds here covering most of Florida. In the nation's northeastern quadrant, snow cover reached as much as 400 miles farther south than the normal January snow line. Obscured somewhat by clouds, the Great Lakes were largely ice covered. The snow-starved Sierra Nevada (pages 816-17) lay masked by a cloud deck still in the grayness of dawn.

I ventured westward, to the Great Plains.

"Eastern South Dakota is drier than it was in dust bowl days," I learned from U.S. Representative Larry Pressler as we drove toward his family farm near Humboldt. "Topsoil was two feet deep when this was virgin prairie. Now it's been blown down to five inches in some areas. Trees planted as windbreaks in the thirties are dying off, and few are being replanted."

Little snow had fallen across most of the plains by late February, when the first and worst storm struck. Howling winds scoured clouds of dust from winter wheat fields in Texas, Oklahoma, and eastern Colorado. Aircraft were grounded; three-foot dunes halted trains on their tracks. Blowing dust generated static electricity that dehydrated fragile wheat seedlings. Texans swore the dust was so thick that prairie dogs were digging holes ten feet off the ground. Two days later the dust reached South Carolina.

Scant Snow Menaces More Than Skiers

When I got to the Denver airport, something was wrong. Where were the hordes of skiers? Lack of snow had closed many of Colorado's ski resorts, causing a 78-million-dollar loss and ruining countless vacations.

But even worse: "When snowfall fails in the Colorado Rockies, much of the West is in trouble," warned George Lamb, the state drought coordinator. "Colorado sits at the top of the pile—we export water in every direction: south via the Rio Grande, east through the Arkansas and South Platte, north along the North Platte, and west via the Colorado River. Almost all the Colorado's water comes from our snowmelt; this year we're exporting about 25 percent of normal."

In the Pacific Northwest the mighty Columbia River flowed at its lowest ever, boding ill for a vast region. Thirty-three dams stairstep this exuberant river and its main

Fan of loose ice clogging the entrance to the Chicago River made tough going for boats, which nonetheless managed to plow through during most of the winter. Across Lake Michigan—whose rare ice cover at winter's worst reached 95 percent—a February Landsat view (**right**) shows the eastern shore packed with fractured floes.

NATIONAL GEOGRAPHIC PHOTOGRAPHER STEVE RAYMER (LEFT); NASA

tributaries, generating more hydroelectric power than any other system in the nation. Reservoirs behind those dams irrigate seven million acres, and countless feeder streams nurture valuable fisheries.

Those vital hydroelectric plants—would there be power to the people? "To the people, yes," responded Dick Nyland of the federal Bonneville Power Administration in Portland. "But not enough for industry. The aluminum companies, our biggest customers, already have closed down potlines. We could generate more power, but that wouldn't leave enough water for agriculture and the fisheries."

The fish situation was desperate. Many Pacific coast rivers were so low that salmon and steelheads starting upstream were wedging in solid masses at the river mouths. Later, officials on the Columbia would face another problem: how to float this year's fingerlings down to sea without taking vital water from the utilities and farmers.

The Golden State Dries Up

I went south, to California.

"Dreadful" California, it struck a scornful eastern visitor during the gold rush. "Poorest state in the Union. She has little to recommend her except her fascinating metal."

"Today," rebutted agricultural economist James Youde of the University of California at Davis, "the state provides a quarter of all the food we eat in the nation.

"The key to this enormous productivity lies in control of water. Three out of four acres of California cropland are irrigated—a fifth of the irrigated land in the United States—through the greatest system of reservoirs and aqueducts ever built. Tens of thousands of wells, some more than a thousand feet deep, pump additional billions of gallons a day. In all, Californians use up 28 billion gallons of water a day, one-quarter of the entire amount used in the U. S."

"California's water system," explained Robert Burnash of the Sacramento office of the National Weather Service, "was based on the years 1924-34, believed to have been one of the driest periods in state history. But now tree-ring studies indicate that even drier periods have occurred in the past. Civilization in California is under severe stress, and it could grow worse."

The stress began two years ago when the winter of 1975-76 brought the third driest wet season yet on record in much of the state.

Then came last winter, shattering all records in the northern part of the state. One after another the turquoise reservoirs strung along the state's rivers shrank within cracked mud flats. As the crisis grew, water rationing and scarcity became a way of life.

For six million Californians on rationed water, the nightmare seems to have no end. "It's always on your mind," said Mary King, whose family lives in parched Marin County. "My blood pressure rises every time I hear a flush. We get 57 gallons apiece each day. That may sound like a lot, but a single leisurely shower could finish it.

"The worst thing," she sighed, "is knowing that even with normal rains this winter, we may still have to ration next year."

Water-saving devices lurked everywhere. A plastic valve in the shower head reduced its flow; gravel-filled containers in the toilet tank kept each flush to a minimum. Scoops lay beside shower and sink to salvage "gray water" for flushing and for parched shrubbery (page 829). Buckets under downspouts caught runoff from the roof. Like most rationed Californians, the Kings used less than their allotment.

"Our lifeline," asserted Marin water manager J. Dietrich Stroeh, "is the emergency 24-inch pipe the state laid along a traffic lane on the Richmond-San Rafael Bridge. It brings in nine million gallons a day from the delta—four-fifths of our total consumption.

"We'll survive," said the youngish engineer, pacing off nervous energy as he spoke. "But we Californians are going to have to make permanent adjustments. For example, we can't preserve eastern ideas of lawns and shrubs here in the semiarid West. Our reservoirs are telling us that."

New View of a Mountain Lake

At California's largest reservoir, Shasta Lake, poised where the Sacramento River pours out of northern mountains into the Central Valley, I ambled down a wooded slope to the normal waterline. I plunged in, fully clothed, notebook in hand. Breathing easily, I worked my way down along the steep walls—10 feet, 20 feet, 30. At 60 feet I moved out onto the sloping bottom—a vast tableau of beer cans dropped from fishing boats

overhead. A hundred feet down: an old auto engine and a discarded deck chair. At 150 feet I finally halted. Fully clothed, notebook in hand—and still dry—I had reached the shriveled remnant of water in Shasta's awesome, melancholy basin.

Wells Burrow Deeper and Deeper

All over northern California, recreation was suffering—boating limited or even prohibited, fishing restricted, camp areas closed because of fire hazard. Cattle and sheep ranchers and some dairymen were suffering, too, with their unirrigated grasslands long turned brown and the cost of hay doubled.

Down in the San Joaquin Valley, grapegrower John Valorosi of Madera was shelling out $12,000 for a new 400-foot well and pump (page 828). I found him among his vines with a shovel, coaxing a rivulet of well water from row to row to nurture a 15-acre field of seedless wine grapes.

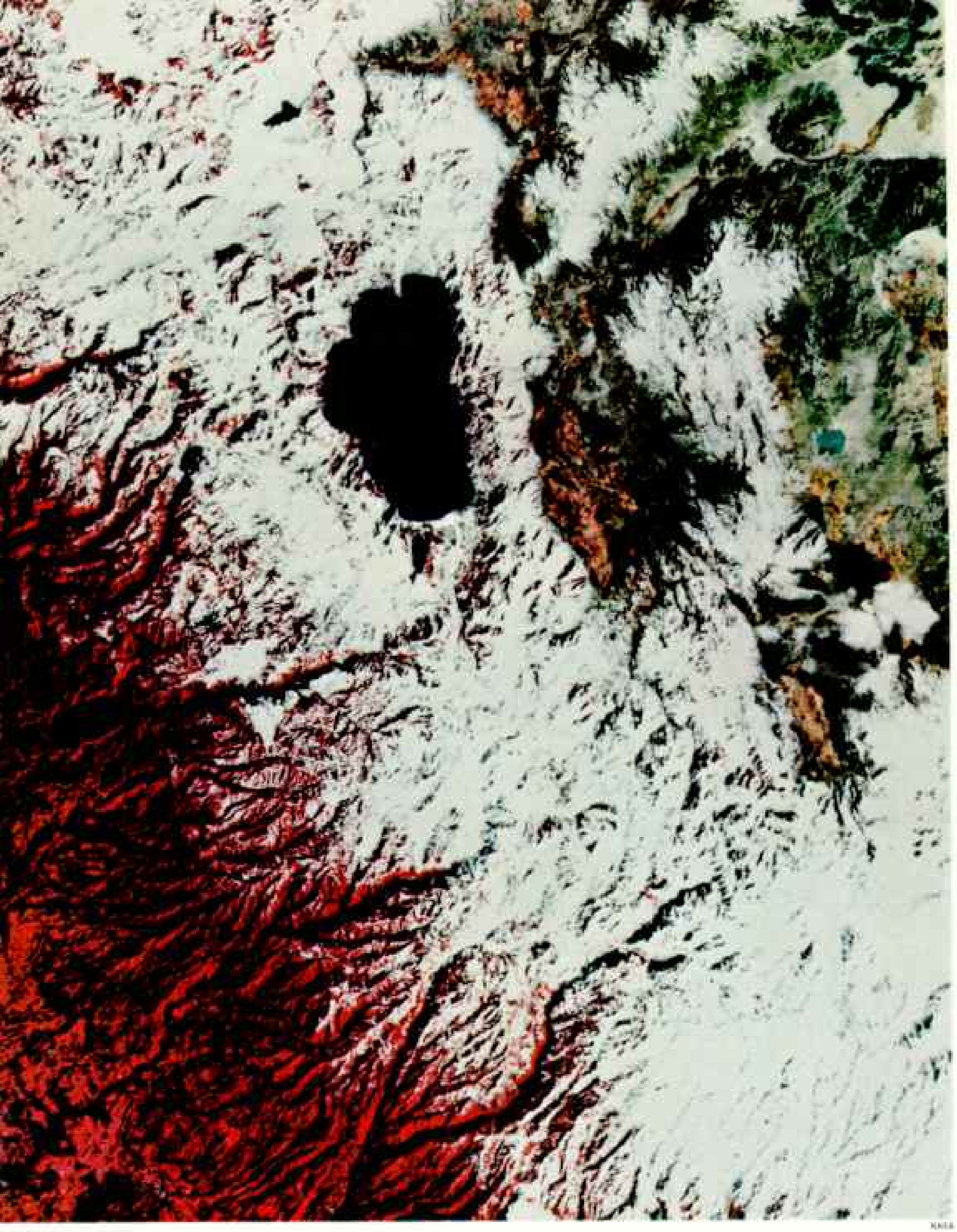
"When ditch water was abundant, I could flood this field in three days," grunted the stocky grower as his shovel guided the flow. "This way it will take three weeks, but I don't lose so much in evaporation and seepage."

Wasn't he afraid his wells would run dry? Huge aquifers underlie the Central Valley, but two years of drought and heavy pumping had dropped the water table alarmingly. In some places even the ground was sinking.

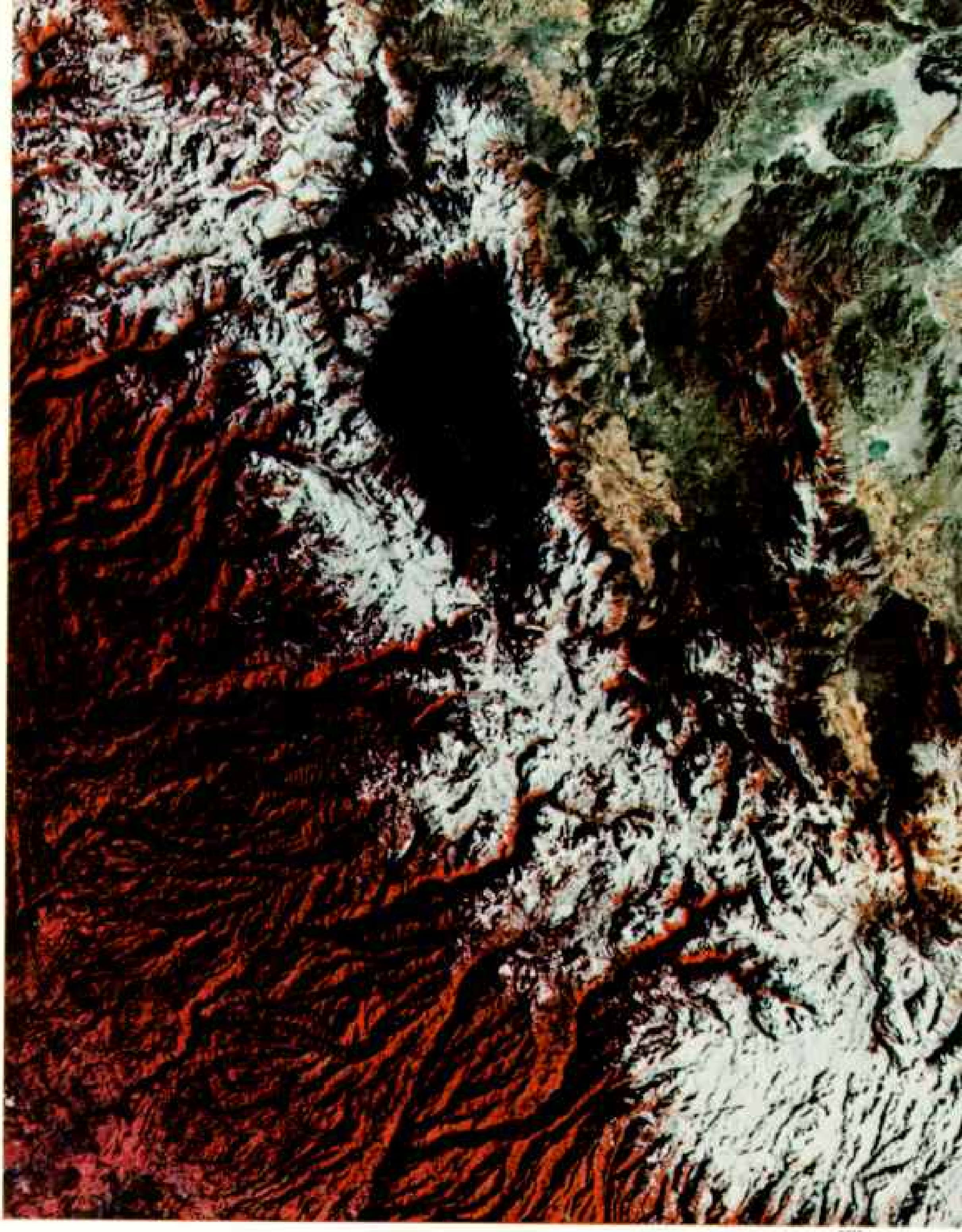
Mr. Valorosi was indeed worried. "When my father came from Italy in 1905, this land was desert, but wherever he dug a posthole, he hit water. Now the table is down to 105 feet and dropping fast." He mounted a motorcycle that normally carried him on rounds

GEORGE F. MOBLEY

Blithe footnote to tribulation, snowdrifts piled so high against zoo fences in Erie, Pennsylvania, that this deer jumped out to brief freedom. Three reindeer similarly escaped from the Buffalo zoo. Thousands of students also enjoyed unexpected vacations when natural-gas shortages closed schools for unprecedented periods of time. More sobering, Americans paid an additional five billion dollars in higher fuel bills, while the U. S. foreign-trade deficit skyrocketed to cover the cost of imported oil.



Winter's gift to the dry West, mountain snowpack is nowhere more vital than in California. This 1975 satellite view of the Sierra Nevada around Lake Tahoe shows a normal February snow line down to approximately 4,500 feet above sea level. In such years spring melt replenishes some 100 major reservoirs in the state. They, in turn, generate as much as a third of north and central California's electric power and supply a significant part of the irrigation water for the state's nine-billion-dollar agricultural industry.



The gift withheld: In February 1977 the Sierra snowpack—a scant quarter of normal—reached down only to 6,500 feet, setting the stage for a summer of massive forest fires. Already low after the previous year's drought, California's reservoirs began to go dry, idling hydroelectric turbines and forcing farmers to drill more irrigation wells. But California was not alone. Virtually the entire West suffered as low snowpack reduced the flow of the Colorado, Columbia, and other critical river systems.

of his irrigation valves, stuck his shovel in a saddle holster, and revved up. "I'll never in my lifetime recover the cost of this well. My children, maybe. . . ."

Returning to Sacramento, I passed through the delta, an inland maze of islands and waterways where the Sacramento and San Joaquin Rivers merge to flow into San Francisco Bay.* Once the delta was a partly saline swampland; in dry times brackish bay water penetrated to present-day Sacramento and Stockton. Today the reclaimed region forms a luxuriant habitat for wildlife, boat enthusiasts, and farmers.

To hold back the salt water, the U. S. Bureau of Reclamation and the state must keep up an adequate flow of fresh water into the delta, creating a hydraulic barrier against the bay. But with river flows reduced, salt water was damaging crops (next page). People on salt-free diets were buying bottled water. The delta was also stirring outrage among water-starved farmers elsewhere. For each square foot of reclaimed land in the western delta, they complained, the bureaucracy was squandering 270 gallons of precious water a year.

Battle to Use Water Wisely

In Sacramento, the state Flood Control Center was a madhouse. *Flood* control?

"We've converted to a Drought Information Center," explained its chief, Don Neudeck. "These guys"—he pointed to four aides trying to cover six telephones—"are answering questions from the public.

"Last winter a lot of calls came from Easterners who wanted to help by shipping us their surplus snow. We declined; transportation would have cost about a thousand times the price of water here. Some callers can't understand why we don't desalinate a little of that huge ocean next door—they don't realize the cost in energy and money.

"Most, of course, want to know how they can conserve water, or what boat ramps and camp areas are still operating. These people we can help."

What, I asked, can Californians really do? I heard a brief rundown from James McDaniel, a veteran water engineer of the California Department of Water Resources.

"The obvious things are drilling more wells, which is going full tilt, and conservation, both at home and in agriculture—drip irrigation, irrigating at night to reduce evaporation, and shifting away from water-intensive crops. We can also shunt water from one area to another, as we're doing from the delta to Marin County."

What if a third dry winter strikes?

"We'll be in bad shape, but we still have some options. We can pump water from two lakes, Berryessa and Clear Lake. There would be more exchanges and sharing, and more

*See "California's Surprising Inland Delta," by Judith and Neil Morgan, GEOGRAPHIC, September 1976.

LOWELL GEORGIA (ABOVE) AND KERBY SMITH

Time runs out for many of California's man-made lakes. The outlet tower at Pardee Reservoir—Oakland's main water source—stands high and dry in June, its normal waterline visible under the catwalk (**above**). Another outlet, on the lake bottom, taps the remaining water. Behind the nation's highest dam, the level of Lake Oroville had dropped 162 feet by March 1977 (**facing page**), moving a marina out some 400 yards.

hauling of water, especially to mountain communities. As a last resort we could get every well in the Sacramento Valley to pump into rivers for distribution in the drier San Joaquin Valley. But for bay area communities, those already rationed, another dry year would be cutting it close—*very* close."

Could Alaska Help Water the West?

The western drought kindles interest in a water project first proposed a decade ago. For sheer magnitude it has few rivals.

Known as the North American Water and Power Alliance, it would tap the rushing Yukon River and other Alaskan and Canadian waterways. A colossal network of dams, canals, and tunnels would channel the water to southern Canada, 33 states, and Mexico. Ships could ply NAWAPA's Brobdingnagian waterways. The original estimated cost: 100 billion dollars.

This gigantic scheme dramatizes the conflict that arises when dependence on water exceeds natural supplies; such projects, some feel, merely push growth further beyond safe limits, preparing the way for a greater crash.

I heard a response from Robert Burnash of the National Weather Service: "California possesses the capacity to provide a bountiful supply of water for a larger population—if we manage properly what we have and collect all that is available. Bear in mind that northern California receives 24 to 45 inches of precipitation a year, yet we catch only a thirtieth of this. If we choose, there is no reason why the state cannot continue to grow as it has in the past.

"Terrible as it is," he added, "a drought like this has its benefits. It makes us pause, take stock of our problems, and react. If this crisis had waited for 25 more years of growth, we might have been more vulnerable and the results cataclysmic."

What are the possibilities of predicting droughts and cold spells, so we can plan in advance and cushion the shock?

So complex is the world weather machine that some climatologists question whether we ever will be able to make reliable long-range forecasts. Even the most optimistic believe the goal lies a decade away. Yet there are those who predicted last winter's harshness, at least in broad outline.

In late November Donald L. Gilman, chief

Bitter harvests threatened farmers in the California Delta east of San Francisco. With river flow and rainfall reduced, soil salinity —a perennial delta problem—grew worse. A color infrared picture of a tomato field (**facing page**) tells the story. Healthy topsoil appears green; dark blotches reveal salt buildup, and young plants, such as this salt-stunted seedling (**above**), show up as faint red lines. Reduced flow also boded ill for young king salmon (**below**, right) hatched far upstream. Those that survived to migrate met anchovies from the Pacific, in hand at left, farther inland than normal.

LOWELL GEORGIA (LEFT AND TOP); KERBY SMITH

both by GEORGE OLSON

When the rains came, they often came with a vengeance. In Kansas City, 25 people died in a September flood spawned by two massive cloudbursts in 24 hours—a freak occurrence described by the National Weather Service as probable only once every thousand years. On search and rescue, a big road grader (**above**) plows past a smoldering service station. Many fires broke out when floodwaters tore gas appliances loose.

In the soggy aftermath, a resident whose street was submerged past ground-floor windowsills sorts out belongings (**left**). In this year of extremes, downpours also struck Minneapolis-St. Paul and Johnstown, Pennsylvania, which was heavily damaged as 75 perished in its third major flood in a hundred years.

of the Weather Service's Long Range Prediction Group, made such a forecast, based in part on the severe cold of that autumn and the likelihood it would persist. A similar prediction came from oceanographer and meteorologist Joseph Chase of Woods Hole, Massachusetts. He based his forecast on atmospheric pressures and a calculation that our winter air would flow in from Siberia.

Simultaneously, climatologists Jerome Namias and his British colleague Robert R. Dickson pored over data that Dr. Namias had amassed at the Scripps Institution of Oceanography in La Jolla, California. Independently they arrived at similar forecasts.

Pacific May Shape U. S. Weather

Dr. Namias, a pioneer of long-range forecasting, believes that North America's weather is shaped largely by surface temperatures of the North Pacific. These temperatures, he contends, strongly influence the air masses above them, and this air eventually flows eastward to become our weather.

Analyzing some 20,000 temperature readings transmitted by ocean vessels each month, Dr. Namias observed the buildup of an immense pool of cool water in the western Pacific. By autumn this surface water was the coldest ever recorded. The ship reports also revealed regions of abnormally warm water off California and Central America.

"Those adjacent areas of cool and warm surface water," the climatologist told me, "formed a pattern that seemed likely to anchor a high-pressure system over the coast. The sharp temperature gradient between the two Pacific pools would tend to accelerate the upper-air winds flowing north toward Alaska, and these in turn would loop south again, bringing Arctic air down to the East. This, in oversimplified terms, set the stage for last winter's weather."

Dr. Namias's forecasts still are experimental, as is far-reaching research at the Weather Service's parent agency, the National Oceanic and Atmospheric Administration, which focuses on numerically simulating the weather in huge computers.*

Clues may exist in the striking similarity of last winter and the vicious one of 1917-18. "Before both winters," notes NOAA meteorologist A. James Wagner, "the distribution of Pacific surface temperatures was much the same. Also, both autumns were abnormally cool east of the Rockies. Even Arctic air patterns seemed to be similar. The weather never repeats itself exactly, but the parallels suggest something to look for."

Another important clue may lie in the amount of early-winter snow cover. Studying 11 years of satellite records, NOAA's Donald R. Wiesnet discovered that heavy snows in December presage more of the same for the entire winter.

Predictable or not, extremes of temperature and precipitation will be with us for a while, contend many meteorologists. They believe that the recent decades of benign weather—a period most of us regard as "normal"—were an era of exceptional mildness.

"The unusual thing," says Dr. J. Murray Mitchell, Jr., a NOAA senior climatologist, "is not the variability we have now, but the lack of it between 1950 and 1970."

Tree Rings Tell of Past Droughts

What is the cause of this increasing variability? Here I found far less agreement. But a large body of experts believe it relates to a gradual cooling of the Northern Hemisphere, particularly in the Arctic, since 1940.

"With cooling," asserts Dr. George Kukla of the Lamont-Doherty Geological Observatory in New York, "the fluctuations of the seasons extend farther south, introducing a new uncertainty into the weather. You also see a greater north-south swing of the jet stream, increasing the likelihood of persistent, loopingweather systems such as last winter's."

From tree rings comes new evidence to support another intriguing theory: that western droughts tie in with the sunspot cycle.

Scientists have long pointed out the synchronization between drought on the Great Plains and the 22-year "double cycle" when sunspots reach their minimum. Now Murray Mitchell of NOAA and Dr. Charles W. Stockton of the University of Arizona claim that tree rings confirm a 22-year drought cycle west of the Mississippi. Another exhaustive analysis of tree rings, by the University of Arizona's Dr. Harold C. Fritts, discloses that weather patterns like the one that plagued the U. S. last winter occurred frequently in

*See "We're Doing Something About the Weather," by Walter Orr Roberts, NATIONAL GEOGRAPHIC, April 1972, and "What's Happening to Our Climate?" by Samuel W. Matthews, November 1976.

ALL BY LOWELL GEORGIA

An unholy alliance of wind and loose earth, aided by three years of deepening drought, time and again last winter walloped eastern Colorado. One dust storm, seen here on March 10 near the Kansas border (**above**), turned overnight into a killer blizzard that claimed more than 40,000 cattle. The snow it delivered —piled up by 85-mph winds against buildings, fences, and dust drifts—was of little use to most of the parched land.

At the southern end of the High Plains drought belt, many areas of northwestern Texas also took their licks. "I've been hailed out one year and sandblown the next," says cotton farmer Don Williams (**left**), displaying the mixture of wind-blown soil and sand that laid waste his fields before he could plant his spring seed. Unable to withstand the second year's losses, he was forced to auction off his 150-acre farm. Farther north, in the panhandle, many wheat farmers edged close to bankruptcy as spring storms left four-foot dust drifts (**right**).

the 1600's, when the world was locked in what climatologists call the Little Ice Age.

As the searing summer of '77 ground on across the land, I touched base with some of the people and places I had visited earlier.

Relief had come to South Dakota, but the three-year siege had taken its toll. "The dreadful thing about drought," said Don Lias, a thoughtful Humboldt dairyman, "is the way society itself withers. Farmers go out of business, and their farms are bought by corporations for tax shelters. Young people go away, and they never come back. The churches are full of old people who slowly die off. The region itself dies."

The West Waits for Respite

Other parts of the Great Plains had been blessed with timely rains and bountiful grain harvests. But on the west side of the Rockies spirits were as low as the reservoirs. The Colorado River flowed at an anemic one-third of normal—starved by the failure of the snowpack. White-water raft trips down the Grand Canyon were running aground on sandbars, and the river's great reservoirs, Lakes Powell and Mead, were shrinking. They could survive another year, but after that their dynamos would falter.

In the Northwest, low water in the Columbia still idled turbines and thousands of aluminum workers. It also threatened the downstream migration of young salmon and steelheads. Officials had responded with Operation Fish Flow: Releasing bursts of water from dam to dam, they flushed millions of fingerlings safely to sea.

In California's San Joaquin Valley, John Valorosi was looking forward to a fair grape harvest, thanks to his wells. But just a day earlier his older one, 135 feet deep, had gone dry because of the falling water table.

"Every couple of days another one dries up around here," he lamented.

Like John Valorosi, most of California's irrigation farmers were getting by; indeed, some would harvest record crops. But for the dryland farmer—the livestock rancher, the unirrigated crop farmer—the drought all too often meant ruin. Of the nearly billion-dollar agricultural loss, perhaps three-quarters has been borne by the dryland farmer.

Nationwide, the summer brought other woes. Extraordinarily long heat waves

Forlornly waiting for a change of weather, Lawrence Pierson of Burlington, Colorado,

FRANK JOHNSTON, WASHINGTON POST

takes a lonely walk over dustbound fences and across the sorry sight that is his farm. Near bankruptcy, he and thousands like him want to stick it out . . . as long as they can.

gripped many areas in the East. Cloudbursts flooded Johnstown, Pennsylvania, Kansas City (page 822), and the Mojave Desert.

In California, the rains fell in the wrong place at the wrong time. The state still worried most about drought.

"If we don't get precipitation this winter," says Jewell Meyer, a soil and water specialist for the University of California at Davis, "the entire northern half of the state will be like Marin County. Remaining reservoir water will have to go to residential and industrial use, and farms will have to get by on wells. This means electricity to pump them, which we might not be able to generate and which could be prohibitively expensive."

Is Another Bad Year Ahead?

What about the East and the winter ahead —would another deep freeze be as devastating? A Federal Power Commission survey finds slightly less natural gas in the nation's interstate pipelines this year than last, but does not take into account measures taken by distributors and users. In Ohio, for example, the state's Energy Resource and Development Agency has spurred utility companies, manufacturers, and even schools to drill for new gas reserves. Businesses and industrial plants in many states have equipped themselves to shift to an alternative fuel such as oil. The new U. S. Department of Energy prepared a crisis plan for another bad winter.

And what weather will this winter bring? As this issue's deadline approached, the pattern of Pacific sea temperatures showed some similarities to last year's—but also significant differences. The National Weather Service tentatively predicted a colder-than-normal winter ahead for the Northeast, but shied from any more detailed prognostications.

This is the gap that science seeks to close, so that we can prepare for the time when the weather again goes wild. □

Ever deeper goes California in its reach for underground water to tide it over the drought. In the San Joaquin Valley, viticulturist John Valorosi is paying $12,000 for a new 400-foot well (**left**), with no guarantee how long it will produce. Marin County residents look to their laundries and showers for "gray water" (**right**)—better than nothing for lawns and gardens.

LOWELL GEORGIA (LEFT) | FRANK JOHNSTON, WASHINGTON POST

Furrowing the morning calm, fishermen

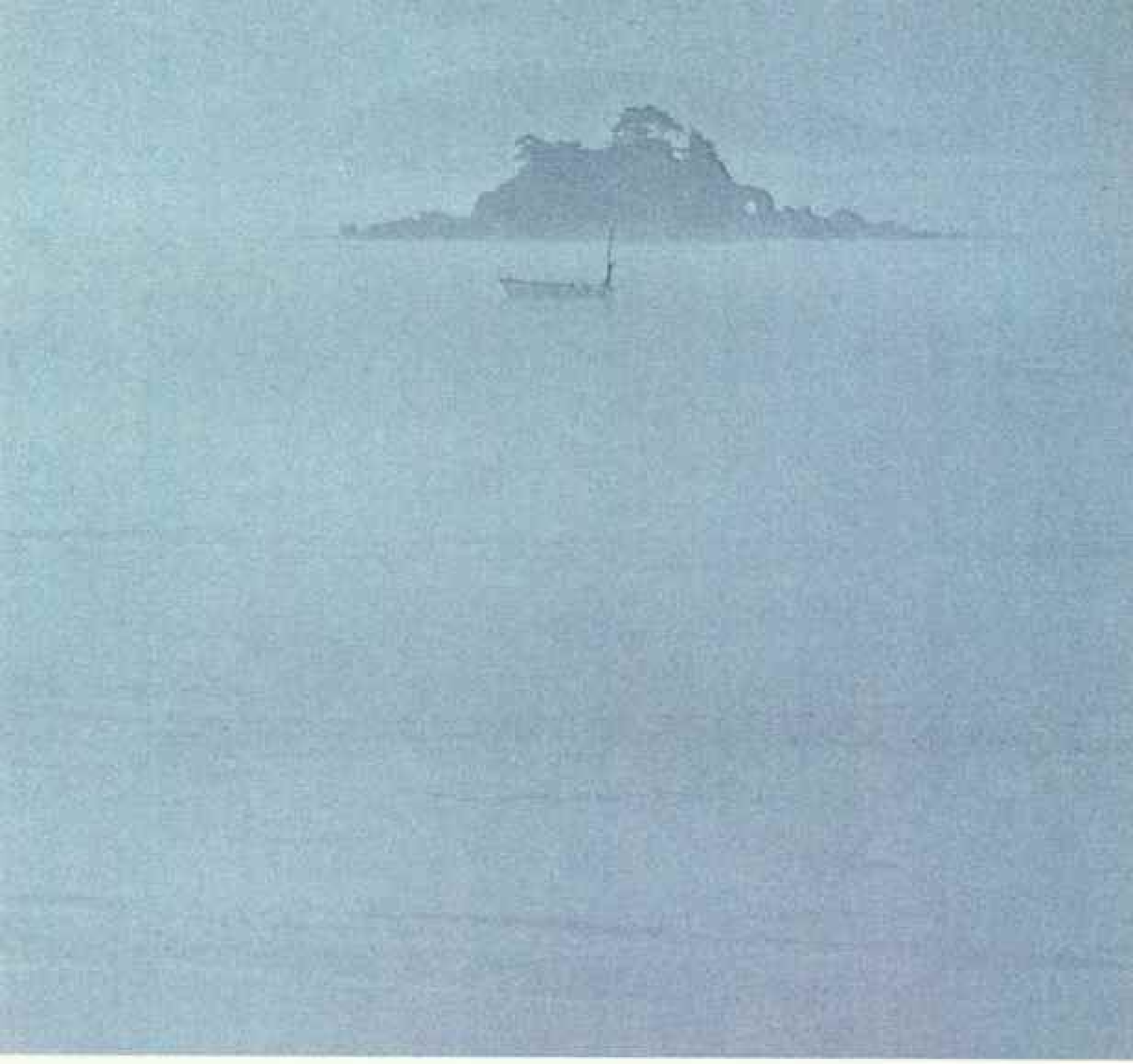
Japan's Amazing

By WILLIAM S. ELLIS

THE MORNING is like sandalwood, with a sweetness to the air under skies grained with the yellow dregs of last night's storm. And we are at sea.

It is not a sea of fathomless depths, or of swells curled in fury. For the most part these are gentle waters, lapping, almost lakelike. Yet large ships sail here, and they sail in long-stilled wakes of voyagers who scribed violent history upon an ancient land.

We are on the Seto Naikai, the Inland Sea of Japan. To the east and north stretches the long arm of Honshu, Japan's major island. Kyushu is to the west, and south of us, where



harvest the riches of Japan's watery, mountain-ringed heartland.

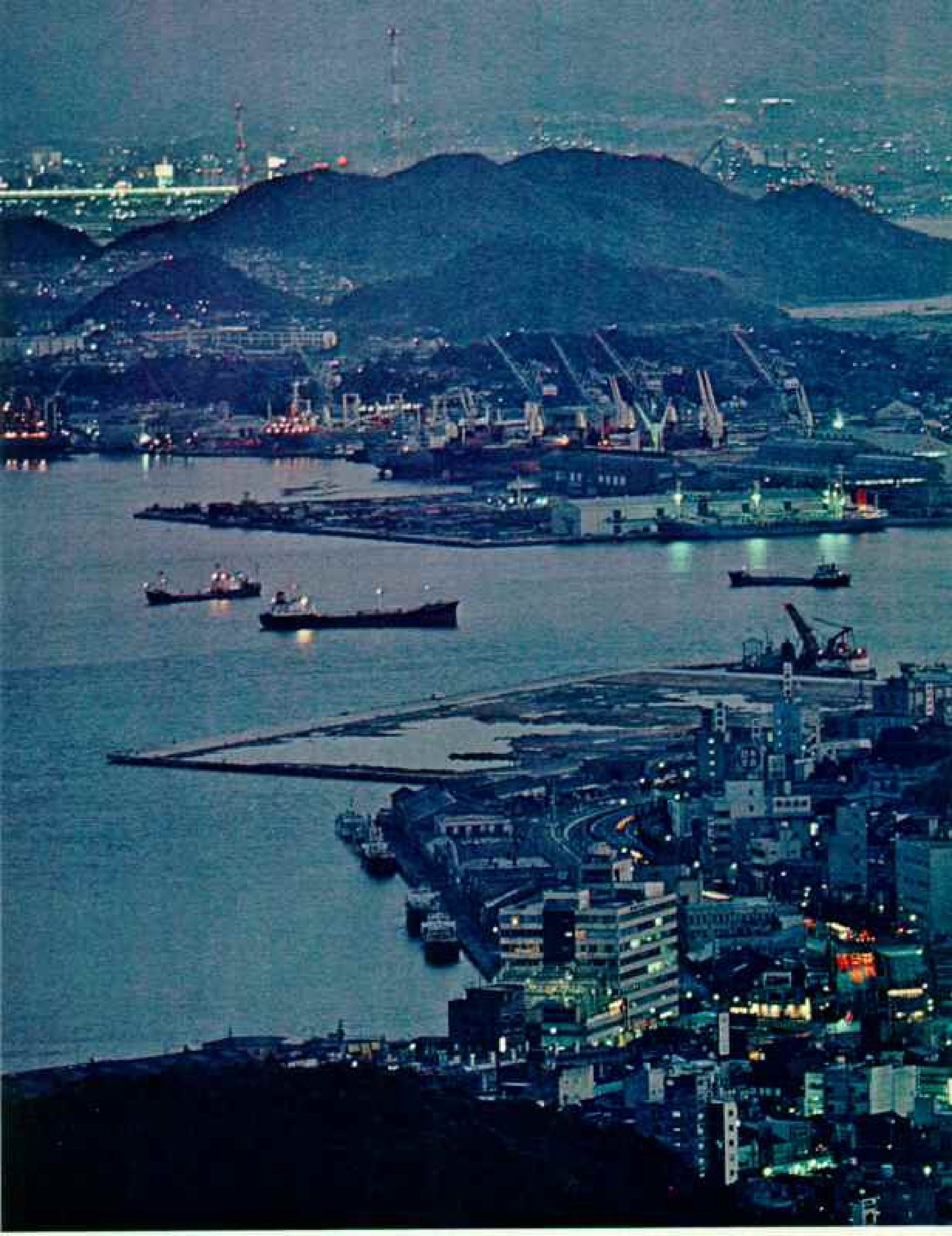
Inland Sea

Photographs by JAMES L. STANFIELD BOTH NATIONAL GEOGRAPHIC STAFF

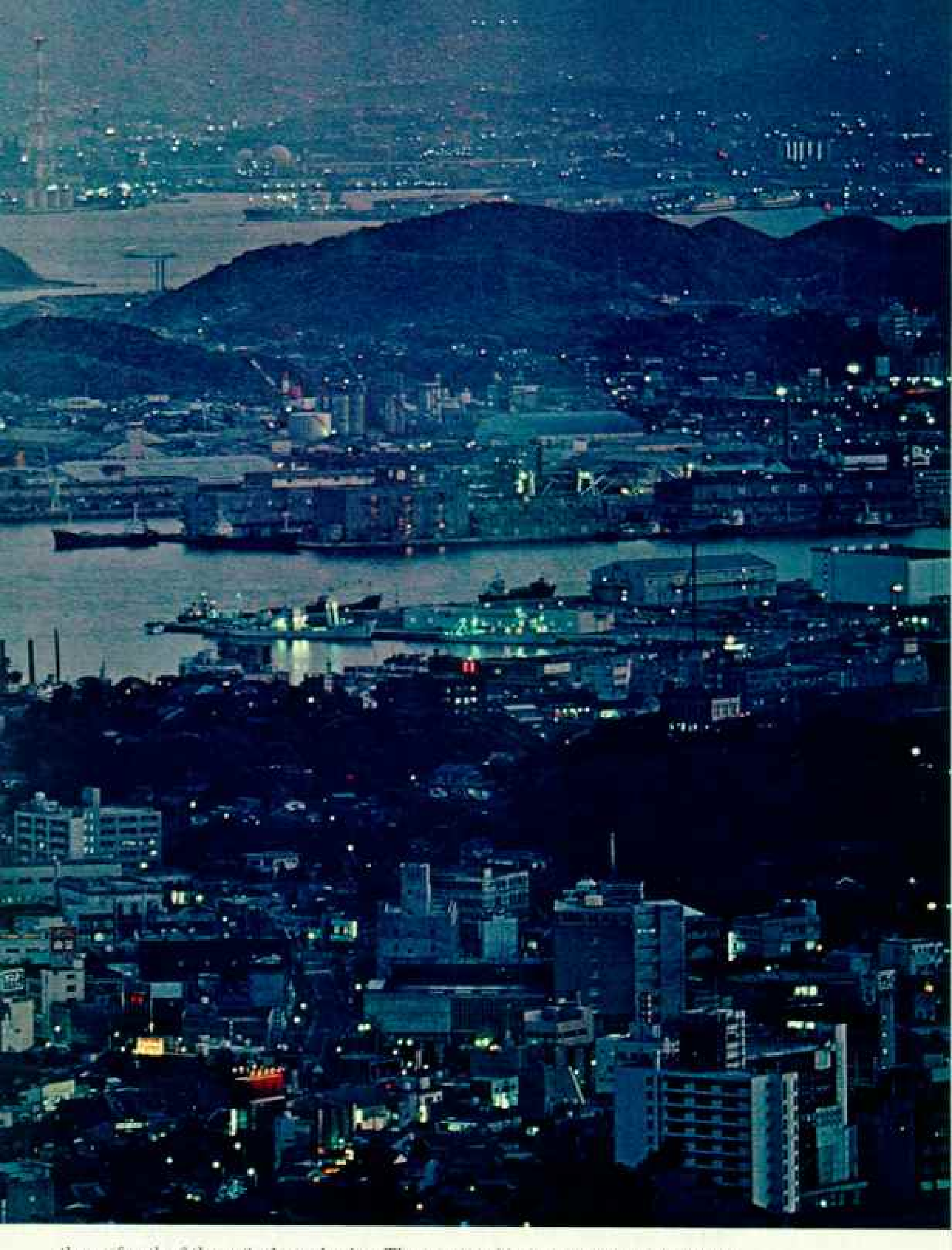
the Inland Sea unites with the Pacific, lies Shikoku (map, pages 836-7).

And on those sheltering islands around the sea one finds the essence of old and new Japan: the Japan of months-long walking pilgrimages to Shinto shrines, and the Japan of travel at 125 miles per hour on the world's most advanced railway. Here the eye falls upon a land of masterfully understated art—the garden with but a single pine and a rock or two—as well as a nation of noisy, neon-lighted *pachinko* parlors.

Nature has lavished smaller islands on this sea. Many wear feathery crowns of bamboo.



Rising tide of industry laps the Inland Sea, from these shipyards and petrochemical plants flanking Shimonoseki Strait at the western entrance all the way to the densely packed megalopolis of Osaka at its eastern end. Unprecedented growth since World War II has meshed the region's industrial centers into a powerhouse that accounts for more



than a fourth of the nation's production. The sea resembles a vast conveyor belt, busy with the ebb and flow of international trade. Through huge ports such as Kobe, iron ore, chemicals, and coal pour into the maw of the area's steel and textile mills, reemerging in countless forms to flow out to worldwide markets.

Fishing villages fill the pockets where island hills slope to the shores, and there are stirrings of life there on this early morning, the first one of May following a pink and perfumed April of cherry blossoms.

FOR NEARLY FOUR HOURS we have waited for the trawler's net to fill. We are fishing for squid. Yoshiaki Tsurumi, the owner and skipper of the boat, is 66 years old, but his strength and stamina are those of a man half that age. He has spent a lifetime on this sea, and from it has drawn his livelihood, in nets like that he has now commanded to be raised.

The hum of the giant winch is like an overture to the parting of the watery curtain. The four members of the crew, mostly family, have taken up positions to receive the catch. Among them is Tsurumi's wife, Kinue, the paradigmatic optimist who is forever smiling (even now the dazzle of the silver in her teeth is cleaving the shadows cast by the hood of her black slicker).

It is a bountiful catch. Pale as paste, and stringy with arms, the squid fill the six holds of the boat—but not before staining the deck with their inky discharge. One crew member, on hose-and-swab detail, is speaking to himself in Japanese, and what he is saying translates, more or less, as, "Cursed be a fish with such messy juices."

By noon most of the squid have been sold directly to brokers, whose boats have pulled alongside. They in turn will sell them, at a profit, in the dockside markets. Tsurumi explained: "I don't have time to take the fish to shore and get the higher price because the season for squid is too short. We can make more money by staying at sea, catching as much as possible, and selling to those who come to us."

For others, too, the Inland Sea is a track for the running of a race against time. Industrialists have packed much of the Honshu shoreline with heavyweight plants—shipyards, refineries, steel and textile mills—to maintain the swift pace of Japan's revving economy.* At the same time, environmentalists are working here to restore health to the ailing waters against the time when, possibly, all the squid are gone, enfolded in a poisonous net of sludge and slime.

"The fishing," Tsurumi is saying as he pins a pickle between chopsticks, "gets worse each year. But I will fish until the day I die." Luncheon has been spread on the afterdeck. There is rice, bean-paste soup, raw squid, pickles, and small plums of puckering tartness. It will soon be time to raise the net again, and to move one catch closer to the end of the brief squid season.

IT IS TIME that I move on, in this the third week of my travels along the Inland Sea. It will take me another month to cover the 300-mile-long waterway from end to end—from Osaka to Shimonoseki. There are islands to be hopped, and steep, temple-topped hills to be climbed. There are paths of history to be followed, and feasts of scenery to be searched out from behind whorls of mist and fog.

There is Seto town to be savored.

In all of the Inland Sea expanse, no place is greener, to my way of thinking, or more in the good graces of nature, than the Sada Misaki. This peninsula is on the western reach of Shikoku island. It is there that Seto town sits, and its approaches exact the caution one grants a watchdog showing gums.

For the peninsula has a spine of mountains, and the main road is wedged much of the way between loose-rock embankments and the lips of piny voids. The descent into Seto town carries through hills banked with orange groves, and where it levels off, there stands the Inland Sea, now gray and sullen under the heavy splash of rain.

I came to a *ryokan*, a Japanese inn, and the proprietress said *(Continued on page 840)*

*See "Those Successful Japanese," by Bart McDowell, NATIONAL GEOGRAPHIC, March 1974.

Spatter-branded by their trade, weary painters call it a day at the Hitachi Zosen shipyard on Inno Shima. One of some fifty major shipbuilding facilities around the Inland Sea, the yard specializes in construction of multipurpose cargo carriers and containerships. Japan today supplies half of the world's new ship tonnage and ranks first in number of nationally owned vessels. Her secret: an enthusiasm for new, more efficient methods, and the energy and willingness of the Japanese worker.

shima, jima.....island misaki .....cape, peninsula

Elevations in meters (black)
feet (red)

KILOMETERS 50
STATUTE MILES 50

DRAWN BY HERBERT BAUMY
COMPILED BY GERARD A. AUSTIN
NATIONAL GEOGRAPHIC ART DIVISION

Sea of Japan

Hamada
Masuda
Oki
+1,339
Hiroshima
Nagato
Shinnanyo
Tokuyama
Iwakuni
Ikuku Shima
Kashiwa Jima
Imabari
Niihama
Hojo
Yanai
Ube
Shimonoseki
Shimonoseki Strait
Yashiro Jima
Matsuyama
+1,981
Kitakyushu
Yukuhashi
Suo Sea
Futami
Iyo
Nakatsu
Iyo Sea
Sada Misaki
Seto
Yawatahama
Kochi
Aki
Kurume
Beppu
Oita
Bungo Strait
Uwajima
Tosa Bay
Okayama
Kurashiki
Fukuyama
Onomichi
Mihara
Takehara
Shimotsui
Tsuyama
Iyo Shima
Kure
Shobara
Marugame
Hiuchi Sea

HONSHU
KYUSHU
SHIKOKU
Inland

Scattered throughout the 3,000 islands and islets of the Inland Sea are protected regions (shown in red) that comprise Seto Naikai National Park, a favorite of sightseers and honeymooners.

Island-bound valley 300 miles long, the Inland Sea, or Seto Naikai—literally "sea within straits"—is Japan's ancient natural highway. Before A.D. 400 the seat of empire shifted from Kyushu to the Yamato Plain, near present-day Osaka. There Buddhism first took root in the sixth century. Some 575 years later the warlord Taira Tadamori, governor of western Japan, purged the sea of pirates. But his clan, the Heike, were later driven from island to island by the rival Genji and finally perished in a sea battle near Shimonoseki. Today vessels (**above**) bound for the world's ports steam out into the open waters of the Sea of Japan.

Home from the sea, a fisherman of Seto town on Shikoku's isolated Sada Peninsula (**above**) is greeted by a local fish vendor, Mrs. Matsue Kato (**right**). Contracting with several fishermen, she purchases enough to supply her customers' needs and delivers to their doorsteps from her well-stocked cart (**facing page**). The bulk of the catch, sold through a co-op, travels to early-morning fish markets in larger cities.

While all the sea's offerings are welcomed in a land that derives half of its nonvegetable protein from fish, esteemed above all is the *tai*, or sea bream, which Mrs. Kato holds. Despite high prices commanded by the much-sought-after swimmer, dwindling catches have led many fishermen to turn to other money-makers. Chief among these is abalone, harvested by divers on the rocky bottom. Raising fish in pens and farming seaweed, along the lines of the oyster cultivation in Hiroshima Bay, may offer some relief for the demands of the future.

(Continued from page 834) yes, there were rooms available—rooms with eyes on the sea, where one could watch it wash against the concrete wall edging the town's main street. Little stirred in Seto town that afternoon, other than the run of rain on the roof tiles of fine old houses crafted with pride and skill. That, and the old man who appeared and ran a streamer in the shape of a carp up a pole. It signified that there was a boy—his grandson—in the house, and spoke the hope that the child would come to be invested with the strength and courage of that noble fish.

Fewer than 5,000 of Japan's 113 million people live in Seto town. Most of those either farm or fish: some do both. In this it is not unlike many hundreds of towns and villages around the Inland Sea.

"Because of the mountains, land transportation in and out of here is not so good," Shigeru Nishitani, the deputy mayor, said. "So it is almost impossible to establish industrial plants. The people fish, they grow oranges, and the young ones go off to the cities where they can make more money."

I walked in the rain along the road bordering the sea, and the fishing boats were starting to come in. Fujio Inai arrived in his 25-foot boat, having spent most of the day snorkeling and diving alone in water deeper than 30 feet while prying abalone from rocks on the bottom. That shellfish is one of the most profitable catches to be made in the Inland Sea, and among the fishermen of Seto town some forty divers go out in search of it.

By sunset most of the fishermen were in. The catches had been transferred to storage facilities at the fishermen's cooperative building. But not before Matsue Kato, an elderly woman of warmth and dignity, had purchased some for her cart (preceding pages). Tomorrow, early, she would be pushing the

The art of eating in Japan demands that what pleasures the palate should first feast the eye. Known as *sushi*, morsels of seafood with vinegared rice include, from top, raw octopus and yellowtail, eel and cucumber in seaweed, squid, shrimp, and tuna. Such delicacies might be served in a villager's home as well as in sushi bars, favorites among Osaka's 35,000 restaurants.

cart through the narrow streets and up and down hillside trails, selling the fish from house to house. It would be a business venture not without a coals-to-Newcastle irony, but one nonetheless successful. They would buy her fish tomorrow, as they did today, and as they have done for many days gone by.

It was still raining in the morning, and the first announcement of the day over the town's public-address system carried sluggishly through the sodden air:

"Attention. The shipment of fertilizer has arrived. Those who placed orders are asked to come and pick them up."

SETO TOWN is not far from Matsuyama in miles, but in tempo and temperament, the two are light-years apart. Both are on Shikoku. Both border the sea. But Matsuyama wears the face of what some call the "octopus-pot culture," meaning the worker is reluctant to leave the place of employment at the end of the day because it is oftentimes more comfortable than home. So it is, too, that the octopus finds comfort—albeit at supreme cost—in the earthenware pot planted in the sea as a trap. Matsuyama, with a population of 370,000, is but one link in a choke collar of big-city busyness around much of the Inland Sea.

Here, bankers are at work, dealing with bundles of yen. Countless clerks in countless offices skate ball-point pens across the pages of ledgers in pursuit of a puck of profit. Whistles summon armies of workers through the gates of plants and factories and usher them out at the end of the shift. Bands play as new vessels with bows dampened by ceremonial champagne slide into the sea. (Last year Japan launched 15.8 million tons—almost half of the world's new ship tonnage—and much of it was built on the Inland Sea.) Furnaces are fired as steel is made, and the acrid breath of petrochemicals wafts on the city air.

One morning, in Matsuyama, I fell in with the march of workers and entered the world of Japanese industrial might. The firm is called Teijin, Ltd.; its primary product is synthetic fibers. The plant is on the site of a World War II naval air base.

"Being located on the Inland Sea offers us many benefits," Kazuhiko Nagasawa, manager of the plant's department of industrial relations, told me. "Most of all, it provides availability of ship transportation, a means for us to bring in raw materials and to ship out finished products."

Nearly 4,000 persons are employed there. The chief product is a synthetic fiber called Tetoron, and enough is produced each day to make 60,000 shirts. No foot-pedal looms are found here. Rather, a complex of sprawling buildings, most of them housing awesome forces—machines that hum and spin and marshal parades of high-stepping pistons, mazes of color-coded pipes, and control panels with flashing lights and the palsied needles of monitoring meters.

Also in the Teijin company complex are houses and dormitories for workers, as well as a hospital, gymnasium, mess halls, and a clubhouse. The workers are Teijin men and Teijin women, all members of the Teijin family and proud of it. They are in the octopus-pot culture, where the comfort and security are all-embracing.

A journey along the Inland Sea is a series of such checkerboard jumps from village to metropolis, from a way of life frozen in time to one driven by the whirlwind forces of advanced technology and a boisterous economy.

ANOTHER WHIRLWIND FORCE descended here and left an enduring mark upon the world. It was 32 years ago, a time when the shadows of American B-29 bombers darkened the waters of the Inland Sea. The bombs fell on Kobe and Kure and Imabari and other cities along the coast. They fell in clusters, tumbling and twisting like wounded waterfowl, and they visited devastation on the land.

But it was the dropping of a single bomb that set the world on a new course. It fell on

Hub of activity, the main street of Kohama serves residents as pier, front yard, and playground. The Mihara suburb's wooden houses and narrow alleys harbor a close-knit fishing community, whose life centers around the canal at left, leading to the sea. But urban sprawl from industrial Mihara flings concrete arms around the enclave, drawing the young toward the womblike security of a company worker's life.

A bell tolls deep within the green recesses of Hiroshima's Peace Memorial Park (**above**, right), rung by each visitor in memory of the past and in covenant with the future. Across the Motoyasu River, a skeletal dome, foreground, marks the point over which an atomic bomb exploded on August 6, 1945. It took 100,000 lives, including those of the husband and three daughters of Mrs. Yuki Sakamura (**right**). She herself was less than a mile from the hypocenter. Yet she has put away anguish, and can say of her life today, "Laughter brings some happiness."

an Inland Sea coastal city called Hiroshima.

The first atomic weapon ever to be used in warfare was delivered over Hiroshima on the morning of August 6, 1945. It was a bomb about ten feet long weighing 9,000 pounds. Released at an altitude of 31,600 feet, it exploded 2,000 feet above the ground. That occurred almost above Hiroshima's domed Industrial Exposition Hall, in the heart of the city (above).

The destruction was awesome. Hiroshima fell in rubble and ashes. The story has been told many times in print and on film—how tens of thousands died, how the heat was intense enough to imprint shadows on concrete, how radioactive "black rain" fell on the waste.

What of Hiroshima today, 32 years after the weapon code-named "Little Boy" used less than an ounce of uranium to set off a force equal to that of 12,500 tons of TNT?

It is, I found, a city thriving in its rebirth. There is little resentment over having been targeted for the debut of atomic warfare; Hiroshima has been too busy. The buildings are back along the streets (new buildings, new streets), and the population is one of the largest among cities along the western Inland Sea.

"At the time of the bombing, we had a population of 400,000. Three months later it was down to 140,000."

Takeshi Araki is the mayor of Hiroshima. We talked in his office in City Hall, not far

from where the iron ribs of the dome of the Industrial Exposition Hall stand as a marker for the hypocenter of the blast.

"Now," he continued, "the population is up to 860,000 and still growing. That number includes 114,500 who were physically affected by the bombing. And I must say that not enough is being spent to help these victims. Each year I must request higher appropriations from the national government."

MAYOR ARAKI was among those who were in the city on that August day when it seemed that the sun had shattered. "At the time," he recalled, "I was at work about five kilometers from the hypocenter. I looked north and saw a flash. A moment later there was the blast. I hid under a desk and escaped injury."

For many of those who were injured, the grim mysteries of the effects of radiation on the human body still haunt their lives—and the lives of their children. Casualties related to the bombing continue to be reported each year.

In Hiroshima today an institution called the Radiation Effects Research Foundation draws financial support from both the Japanese and United States Governments, with participation by the latter being handled under the auspices of the National Academy of Sciences. It is part of a continuing effort begun three weeks after the bombing to study the injuries and their long-term effects.

"In 1955 we began to assemble a file containing the names of 109,000 persons who were exposed," Dr. LeRoy R. Allen, vice-chairman of the foundation, told me in Hiroshima. "Three years later we drew from that a subgroup of 20,000 for detailed study."

Records include the distance each survivor was from the hypocenter, thus, the radiation dosage absorbed by the body. That information can then be related to such manifestations as lesions and abnormal blood counts. For example, it was learned that the rate of incidence of leukemia showed a significant rise in direct proportion to higher dosages.

And the illness does not always die with the primary victim. Many children who had been conceived, but not yet born, at the time of the bombing were found to have heads much smaller than average. "There is also

evidence of mental retardation among that group," Dr. Allen said.

The Radiation Effects Research Foundation facilities sit amid hillside greenery (it was originally predicted that nothing would grow in the scorched earth for 75 years following the bombing), and they overlook an even greener place—the Hiroshima Peace Memorial Park. It is there that the city has deposited its memories of the most devastating episode in the history of warfare. A museum on the grounds houses a collection that tells the story: a wristwatch, broken and burned and stopped at 8:16; the shredded garments of victims; a radiation-scarred stuffed horse.

A museum of horrors, yes. Yet Peace Memorial Park stands as a symbol for what Hiroshima now considers itself: the peace Mecca of the world. The park is a place for thought and contemplation and, for many, prayer.

They pray mostly at the Memorial Cenotaph, where "Books of the Past," containing the names of all known to have been killed by the bomb, are entombed. Inscribed there are the words, "Let all the souls here rest in peace, for we shall not repeat the mistake."

Small reward for their labors—a single boxful of sardines—was all that Capt. Hisao Fukumoto (**above**) and fishermen on three other boats reaped from a day's fishing. Pollution plays a large part in the diminishing catches of several once plentiful species of food fish.

Scientists joined battle in the early 1970's, armed with a government-financed hydraulic model—an 8,970-square-yard scale reproduction of the Inland Sea (**left**). Simulated tidal currents carry red dye through the labyrinth of islands, representing the spread of effluents from industrial and urban areas. Recording results with overhead cameras, researchers seek to understand and restore the sea's ecological balance. Swinging in behind such efforts, public opinion has helped spark cleanups in many industries.

Earth's inner fires surface at Beppu, a city of spas and mineral springs on Kyushu. There heat seekers bake in hot sands (**below**), or resort to the "Blood Pond Hell" (**facing page**), whose red clay is used in the treatment of skin diseases. Geologists believe the basin that forms the Inland Sea was created by faulting, which split a single landmass into the islands of Honshu, Kyushu, and Shikoku.

It is left to the viewer to ponder on the ambiguity of the inscription. "The mistake," meaning the bomb? Or Pearl Harbor?

THE WAR ENDED, of course, soon after the bombing. Japan rebuilt, becoming an industrial giant. Much of the growth occurred around the Inland Sea; 30 percent of the country's output now comes from there. The nine prefectures in that region produce 52,400,000 metric tons of steel a year, along with 1,800,000 tons of the petrochemical ethylene and more than 4,500,000 tons of paper. About 1,870,000 barrels of oil are refined each day. It all adds up to trillions and trillions of yen.

Of course, the prosperity did not come without a price. By 1970 pollution was imposing a heavy burden on the quality of life in Japan, even a threat to life itself, as had been tragically underscored by more than fifty deaths from mercury poisoning at Minamata, on southern Kyushu, in the 1950's.

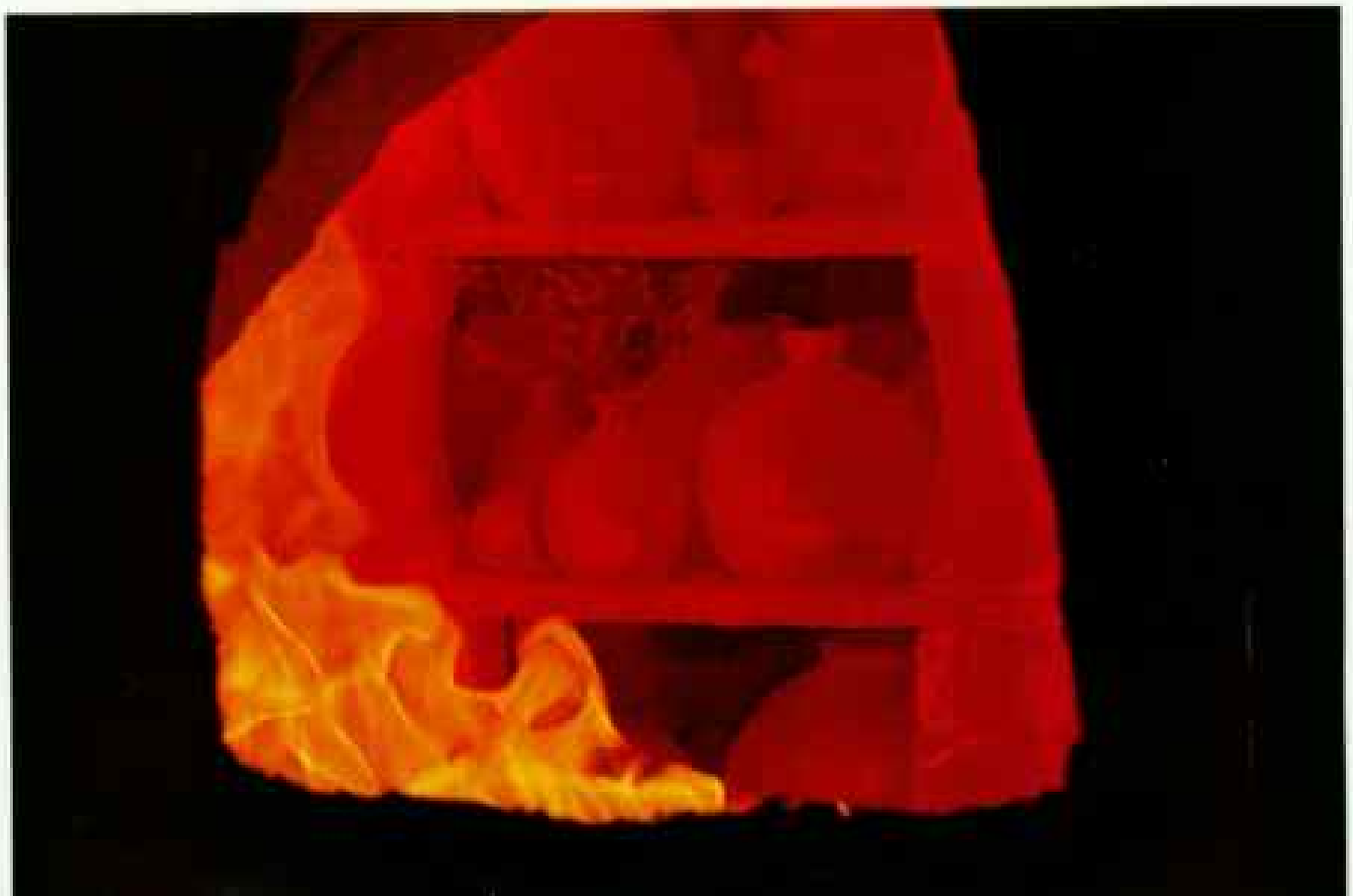
So the country turned to the task of cleaning up. In 1971, the National Industrial Research Institute of Chugoku was established to diagnose pollution ailments of the Inland Sea and to prescribe cures. Its major working tool is a hydraulic model (preceding pages).

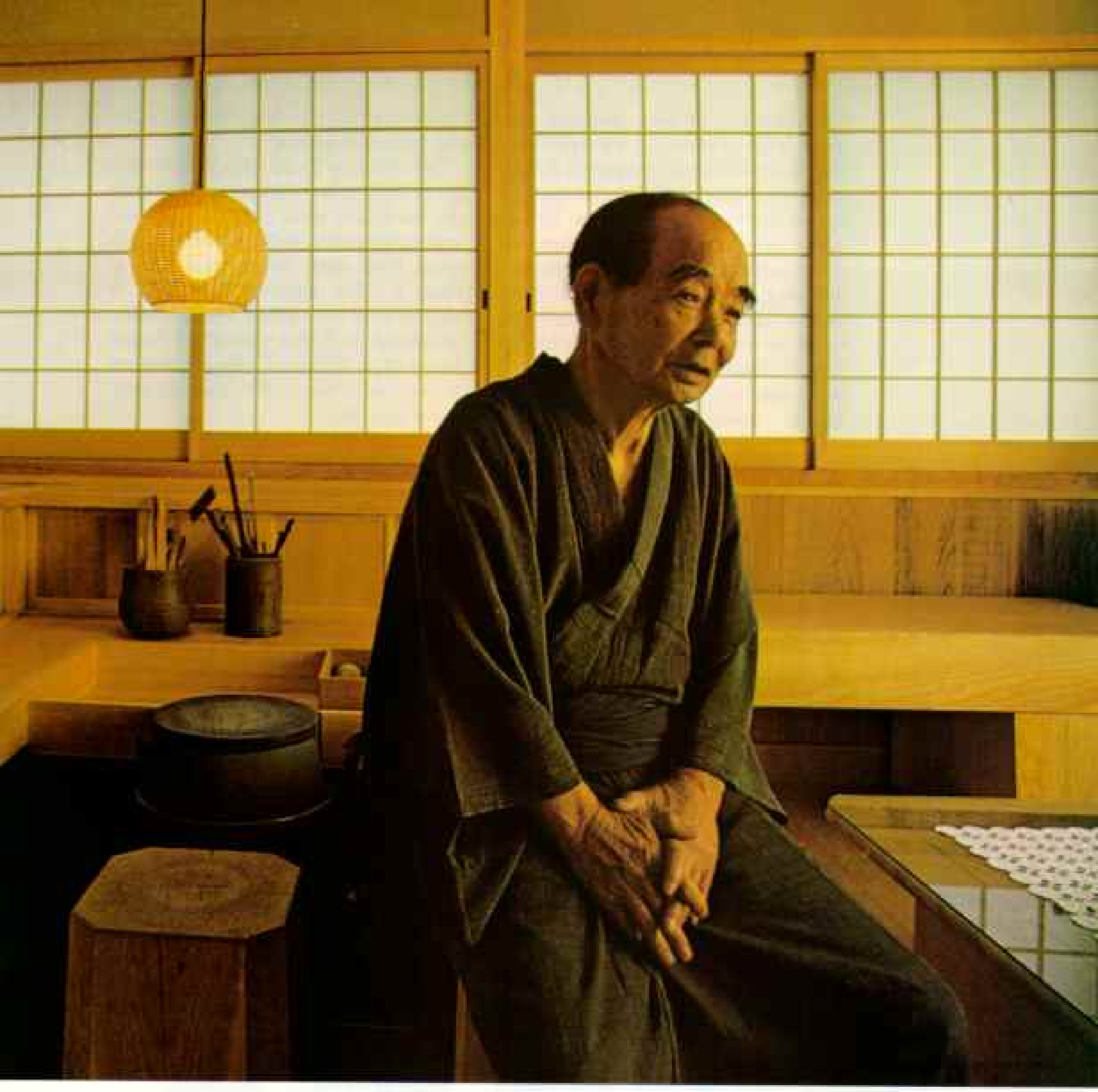
"Using this model, we can predict what will happen with the flow of industrial discharge into the water," Dr. Norio Hayakawa, chief research engineer, said. "After subjecting the model to the tidal patterns of the Inland Sea, we release dyes to simulate pollutants. Then we can study how the pollution is dispersed. This tide simulation reduces one day to nine minutes."

Even at a scale of one to 2,000 the model, fully enclosed, is massive. I surveyed it with Dr. Hayakawa from a catwalk. "I feel that the condition of the Inland Sea is getting better," he said, as we looked down on the island-clogged section of the sea between Imabari and Onomichi. "However, many problems remain. For example, sea bream are scarce in the areas around the industrial parks, and they haven't started to come back. It will take many years for conditions in those areas to get back to normal."

The sea bream, more commonly known in Japan as *tai*, is a favorite food fish, with flesh of a taste to caress the palate. Once, great numbers of tai swam in the Inland Sea. Some

Master of an antique art, potter Kei Fujiwara pursued his craft with such consummate skill that in 1970 he became one of a handful of artists and performers to be honored as "human national treasures." He lives and works at Bizen, famed for its distinctive clay, whose rich tones emerge only upon exposure to great heat. To achieve this, Fujiwara-san stokes his kiln with red pine to a temperature of 1300°C (**bottom**). Falling ash creates a rough finish and additional colors that cannot be anticipated. After the twelfth and final day of firing, even the master may feel an unexpected pleasure in the beauty of his handiwork (**below**).





people blame pollution, others, overfishing; whatever the reason, the stocks diminished.

As a highly prized fish in a country where hardly a day passes without every man, woman, and child eating something from the sea, the scarcity of tai is not a matter taken lightly. Today tai, they say—tomorrow, *saba* (mackerel)? Or *fugu*!

Fugu. Ah, there's a fish to delight the gourmet! It is found in the Inland Sea, and the taking of it is cause for rejoicing, for fugu draws a high price in the market. It is a blowfish, and it can make itself round and as puffy as a soufflé. Parts of the innards are deadly poisonous, and it is decreed by law that only specially licensed chefs may prepare fugu in restaurants. Still, dozens of Japanese die each year of fugu poisoning.

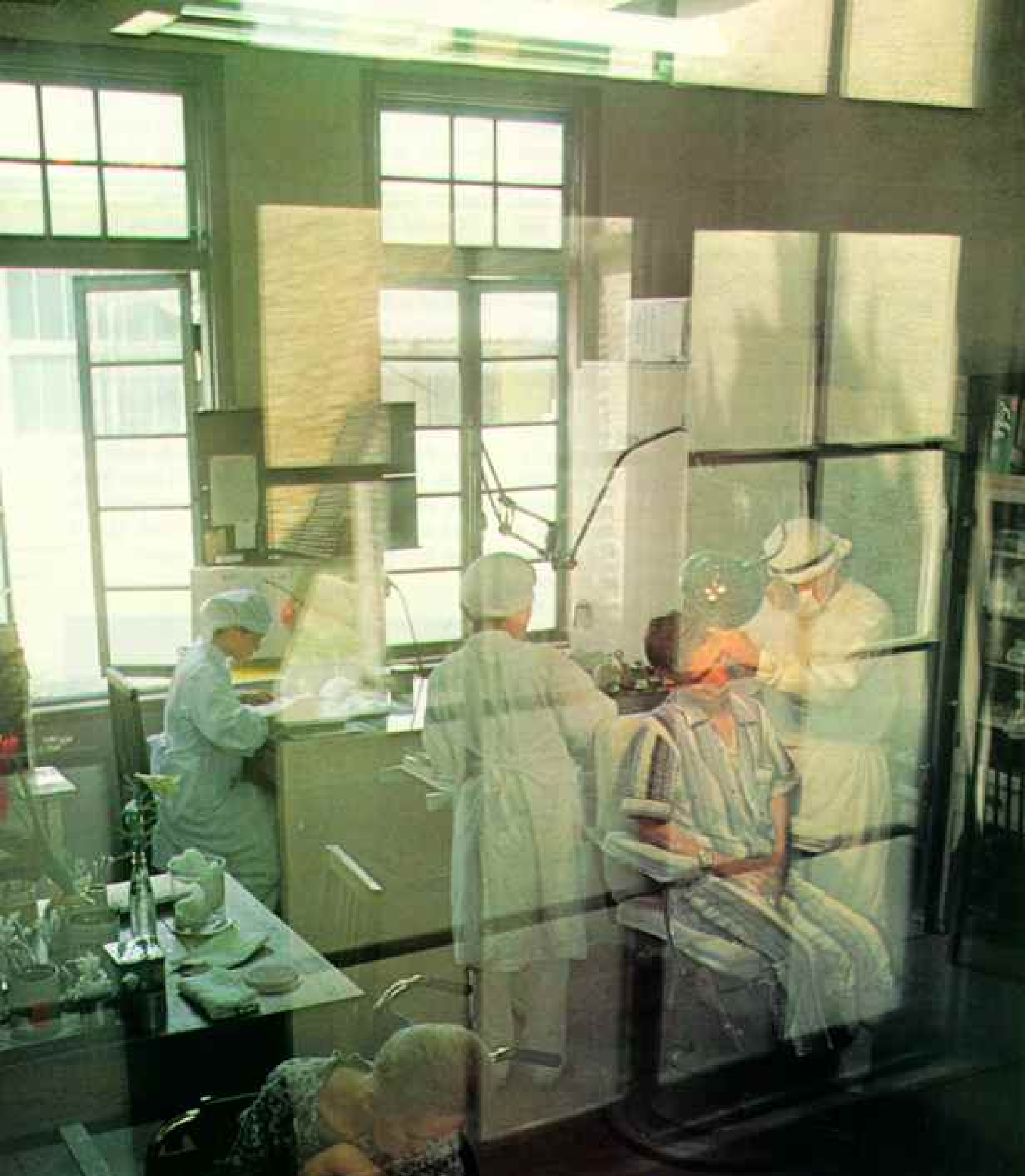
JAPAN HARVESTS the fruits of the seas in staggering quantities—some ten million tons a year, excluding whales.

The wide spectrum of the catches is reflected early each morning in the many fish markets along the Inland Sea—like one at Shimonoseki, for example. The morning I was there it seemed as if the world had been conquered by armies of wildly flopping mackerel.

Wholesale dealers from a wide region had gathered there long before dawn to buy their

Combating a pitiless disease, chief nurse Mrs. Yoshinaka (**center**) helps care for five hundred patients in a world apart: the National Colony for the Curing of Leprosy, on O Shima. Sulfone drugs can usually arrest the illness but cannot undo its damage. Daily therapy, including dipping in hot wax to stimulate circulation (**bottom center**), is necessary to keep limbs from atrophying. Ear checkups at the otology clinic (**facing page**) are part of a program that guards against complications and unwitting injury to skin that the disease has robbed of feeling.

Doctors now know there is little danger of contagion from leprosy. Yet myths die hard, and most patients stay here among those who understand them even when their cases are arrested. One of these is Mrs. Kazuko Toh (**left**). A patient since 1943 and an internationally acclaimed poet, she visited her former home after 20 years' absence but returned rather than suffer society's prejudice and fear.



stocks for the day. The market was dockside, hard by the nodding bows of boats just in from lengthy trips to distant waters. Wooden crates filled the block-long concrete floor, each glistening with the melt of ice. In addition to the live mackerel, there were sardines and flounder, squid, eel, *hamachi* (yellowtail), sea bass and octopus, abalone and scallops, and others. There was tuna, too, as red and as bulky as sides of beef.

Auctioneers moved from consignment to consignment, and the buyers followed. Bids were submitted by a touch of hands under the cover of a long sleeve that hung from the auctioneer's arm. Crates purchased were stabbed with hooks and dragged off to waiting trucks.

It was all done in double time, and by four o'clock that morning the market had closed. All that remained on the floor were half a dozen or so sardines. And, tossed and flipped like pearly knives in a game of mumblety-peg, they were soon driven back to the sea by the wash-down water from hoses.

When the market in Shimonoseki closes, it is good to climb to the heights of that city and look out to where the western reach of the Inland Sea gives itself up to the Sea of Japan.

I couldn't see that far, but I knew that not too many miles away the Mongol forces of Kublai Khan landed on Kyushu. They came in hundreds of ships, in the year 1274. The twin forces of a ship-wrecking typhoon and the savagery of the samurai's sword put the invaders to rout. Seven years later they tried again, and met the same fate. The Japanese gave a name to such typhoons—*kamikaze*, "divine wind."

Looking the other way, I could see the waters of the Inland Sea leading off to where pirates ruled, as far back as the 10th century, and where feuding dynasties grappled in combat. Then, as now, the sea was Japan's central artery of culture and commerce.

MUCH of the Inland Sea region is set aside as a national park, one of two such sea parks in Japan. It preserves gleaming beaches of white sand, sand that spills over into shady groves of black pine. There are miles of jagged coastline, and where the sea flows through the Naruto Strait to the Pacific, there are whirlpools and other frothy ravings of ebb and flow.

Most of all, the Inland Sea has islands and islets, perhaps as many as 3,000 of them. Some are fair-size, but most are small. Some were born of volcanic spewings, but most are bedded in granite, rising from the shallow depths of the sea's prehistoric mold, for the Inland Sea is a vast geological fault.

One of the islands is called Kashiwa Jima. It covers less than forty acres, and most of that lies humped in a steep hill. Half the island is banked with a granite seawall. The other half is open to the surf, which laps up on beaches strewn with driftwood and abandoned racks of bamboo used in the cultivation of oysters.

The population of Kashiwa Jima is one.

"I am here alone, and I love it." As he talked, Junji Fukuzawa sucked in his cheeks until the bones strained against the skin. "I have been here since 1949, and my wife was with me until seven years ago when she died. Has it been lonely without her? No, it hasn't."

Stepping out of housebound roles, Japanese women play an ever greater part in offices and factories, slowly shrugging off traditional strictures.

Fukuzawa is an 85-year-old Shinto priest (pages 860-61). Among his pastoral duties is the blessing of fishing boats, a service he conducts with great dignity while dressed in a magnificent robe of purple and green. There are four shrines on the island, the largest of which was reconstructed this past summer.

"Only once before have Americans come here," he told me through an interpreter as we walked around the island. "That was the American occupation force. They came to this island after the war to put up a communications station. I've only spoken English once in my life. I was on a train, and the sun coming through the window was bothering a passenger. So I turned to the man sitting next to the window—he was speaking to someone in English—and I somehow found the words. I said, 'Pull the shade.' "

We had reached the far side of the island, away from his house, constructed many years ago. He was walking slowly, not out of exhaustion, I think, but to savor the peace that pressed gently down from the hill and up from the surf and through the leaves of the towering bamboo.

"I have no television here," he said, "but I do listen to the radio, especially if there is a baseball game. I am usually in bed by seven o'clock at night."

He stopped and sat on a log by some abandoned buildings once used by a company that cultivated pearls nearby. And he told me he had once wanted to become a doctor.

"I failed the high-school entrance examination, but then I took it again and passed. Only that time I failed my physical examination. They told me there was something wrong with my chest. But it wasn't serious enough to keep me out of the army in World War II. Afterward, because of business problems, I couldn't sleep well at night. So I came to this island to recover."

In the casual manner of entry into the Shinto priesthood at the time, Junji Fukuzawa assumed his clerical role simply by virtue of taking care of the island and the largest shrine there. "It's different now," he said. "You have to take an examination before you can become a priest."

It isn't that the priest lives in total isolation. There is much boating activity in the nearby waters. Also, once a year there is a Shinto festival on the island, to which thousands of Japanese faithful are attracted.

Shinto is an ancient faith, the oldest surviving religion in Japan. The word means "the way of the gods," and the divinities number in the millions. They are called *kami*, and they pervade all of nature, giving basic force to mountain and rock and river and tree.

The religion is represented throughout Japan by the presence of more than 80,000 shrines, and it is observed by more than sixty million Japanese. But it is a faith of diminished force. In Shinto mythology the sun-goddess was ancestral to Japan's imperial family, and one of its basic tenets—emperor worship—dissolved with defeat in World War II.

I left the aging priest to his books, and the company of birds, and the serenity of an island setting that filled his soul with happiness.

THERE IS ANOTHER ISLAND in the Inland Sea where the sense of isolation is strong, but different, and strangely troubling. That's because on this island, one of the many in the Inland Sea named O Shima, there are leprosy patients.

About 500 of them live on the island. For most, their affliction has been arrested. They stay here because they are not easily accepted back into society. Those who still need treatment receive it at a government hospital that has been here since 1909 (pages 852-3).

"Former patients are free to stay as long as they like," a doctor told me. "Some have married here. We allow marriages, but couples must not have children because a child of parents who have leprosy can contract the disease. In most cases the men choose to be sterilized rather than risk conception."

It is a lovely island with thick stands of trees and many flower gardens. Even those who have lost their sight to the disease enjoy walking along the paths. There is a long, well-constructed dock, but not many boats come to O Shima.

As I walked around the island with a member of the hospital staff, the story was told to me of a patient who arrived in 1947. When his family learned that he had leprosy, the social stigma was more than they could bear. His brother-in-law divorced his sister. She in turn took her own life. Finally, just two years ago, the man, who had been on the island for almost thirty years, and who was by that

time nearly blind, surrendered to lingering sadness over his sister's death. He too committed suicide. No member of his family attended the funeral. Outsiders rarely do.

O Shima is one of the few inhabited islands in the Inland Sea without ferry service, partly because of the unfounded fears and misunderstanding of the disease.

Elsewhere, ferryboats chug from island to island, like ants at work in a field of crumbs. They call at the cities and at the fishing villages. They haul trucks and buses and cars and carts. And tourists to the salubrious spas at Beppu, and Buddhist pilgrims to the shrines on Shodo Shima.

I didn't ask Tasuo Mashimo and his wife, Yoshie, how they got to Shodo from their home in Osaka, but they were there, about to set off on a walk to the last of the island's 88 sacred sites. They had been walking for six days. "It has been tiring," Mashimo said, "but we feel very happy, as we always do when we come here on a pilgrimage. This is our fourth visit to all the 88 places."

The Mashimos were following in the footsteps of those who journeyed from temple to

temple on Shodo as far back as the 17th century. Like the early pilgrims, they carried walking sticks made of cedar, and wore the conical hat called the *sugegasa*, and carried a purse of white cloth. At each temple they presented a book to an attendant who stamped it to verify the visit.

IT WAS SOMETHING other than shrines that drew me to Shodo. I came for the soy sauce. In contrast to its sparing use in Western countries (functions there a household in the United *(Continued on page 862)*

A chord of nostalgia for an older Japan sounds along the willow-draped paths of Kurashiki. These dark-tiled, white-walled buildings were homes and warehouses in centuries past, when tribute flowed into the shoguns' tax-collection center for western Japan. Now restored as museum pieces, they hold collections of another kind: folkcraft, toys of many countries, and privately owned masterpieces of Western art.

Osaka after hours: Office workers enjoy nightlife in a beer garden atop the

Kirin Building in the Minami district of Japan's second largest city.

A love affair with his island home is daily renewed for Junji Fukuzawa, sole inhabitant of tiny Kashiwa Jima, as he eats an early breakfast (**below**). Isolation suits him well, and he pauses to breathe in a peace (**right**) shared only with birds and an occasional fisherman. The quiet tempo of his life is altered but once a year, when he opens his house to visitors and dons festival robes in his role as a Shinto priest (**bottom**). For two days he recites prayers and propitiates the Shinto spirits on behalf of thousands who flock to Kashiwa Jima's shrines. At the close of the festival, a procession of boats carries a miniature shrine around the island. The vessels then return to the dock for the last of the pilgrims before leaving the priest once again alone on his shore.

(Continued from page 857) States without a bottle of soy sauce in residence on some back shelf for at least a year?), this seasoning is vital to the Japanese palate. It is the salt of the empire. Only rice is more important to a successful meal.

And for more than three centuries Shodo has been a fountainhead of soy sauce.

"We make 50,000 kiloliters annually here," Shigenobu Kasai, an official of the Marukin Shoyu Co., Ltd., told me. For seventy years the Marukin plant has stood beside the Inland Sea on Shodo. Until World War II, most beans were imported from China, but now the United States is the chief supplier. There is the distinct odor of a brewery about the place, for soy sauce has an alcoholic content.

"We steam the soybeans and mix them with baked wheat and yeast and let the mixture ferment six to ten months," Mr. Kasai explained. "Then we press the mash to get the sauce. Of course, it goes through many refining processes before it is ready for the table."

TALK OF FOOD and dining in Japan is likely to lead to mention of Osaka, the largest city along the Inland Sea and the country's second largest, after Tokyo. There are 35,000 restaurants in this city of 2,800,000 people, and the first-time visitor would believe twice that number.

Some high-rise buildings are given over entirely to restaurants—one to a floor. There are restaurants that serve only fugu, and others with menus limited to tempura. There are *sashimi* (sliced raw fish) restaurants and restaurants featuring lotus roots and *sushi* (pages 840–41). There are also vending machines on the streets dispensing noodles, rice crackers, soda, and dried seaweed.

Osaka is indeed a culinary festival. It is also a city with a heartbeat of thumping vitality, for it is, after Tokyo, the second largest financial center in Japan. Osakans are known for zeal in their efforts to turn a profit. Here the traditional greeting among merchants is not "Hello" but, "Are you making money?"

Since Commodore Matthew Perry ended Japan's isolation from the world less than 125 years ago, Osaka's international port has functioned as the bedrock on which the city has risen to commercial eminence. Along the Inland Sea, only Kobe surpasses Osaka in the volume of port trade handled.

Pressed for living space, Osaka in recent years has started to go underground. Today there are six giant commercial complexes honeycombing the basement of the city. They are pleasant places, with fountains and controlled climates. They are refuges to which thousands flee to escape the traffic and the thick, foul air. It is possible to eat there, work there, and nap there. Indeed, it is believed that there are persons who never emerge from those subterranean cities.

One of the underground complexes is called, of all things, "Rainbow Town." I descended a stairway to it from a department store (or was it from a bank?) and immediately felt the cool, clean grip of conditioned air. The artificial light fell softly on the streets.

Completed in 1971, Rainbow Town is 30 or 40 feet below the heart of Osaka. It is devoted mostly to small retail shops, including a hundred restaurants. I spent most of a day there, eating, shopping, and wrestling with a nagging question: If the city is underground, what happens to the sewage? Later I found the answer; it is pumped up.

THE SUN was clouded over when I went topside to travel to Kure. It was a short cab ride to the train station, where I caught the Shinkansen bullet train. It shot away on the split second of its scheduled departure, past Kobe and Himeji and Kurashiki and Fukuyama and Onomichi. Past all those places and more.

When I arrived in Kure, I boarded a ferry, not knowing—not caring—where it was headed. It would be an island with an inn, I knew, and a good meal and a freshly laundered *yukata* to wear after the bath. It would be somewhere in this lovely sea, and I would walk along the dock in the early morning to wish the fishermen good luck. □

Guardian gateway, the torii entrance to Itsuku Shima Shrine shelters a sacred corner of Hiroshima Bay from the lights of change that multiply along the shore. Much of Japan wears a new face, but in many villages and island byways of the Inland Sea, the grace and traditions of the past stubbornly linger on.

THE SATIN BOWERBIRD

Australia's Feathered Playboy

ARTICLE AND PHOTOGRAPHS BY
PHILIP GREEN

A RAUCOUS MEDLEY echoes from the forest floor as one of nature's most ingenious Romeos entices a female to his love nest. Yet a nest it is not. For the intricate structure (**left**) built by the satin bowerbird will never hold an egg or harbor a fledgling. It is simply the hub of his territory and the site of his wooing.

Of the 18 species of bowerbirds, which are native only to the region of Australia and New Guinea, the satin is the best known, inhabiting forested areas along Australia's east coast. Here in midwinter (July in the Southern Hemisphere) the bluejay-size male begins what is one of the strangest and most elaborate courtship rituals in all the bird world.

With meticulous care he selects sticks to construct the foot-high walls of a bower, enclosing a four-to-five-inch-wide avenue. The architect almost invariably orients this structure in a north-south direction. Ornithologist A. J. Marshall once shifted a bird's bower, only to have the male return the walls to the original position. Into this haven the male bowerbird entices several olive green females each season.

His promiscuity, long suspected, was confirmed by Australian ornithologist Reta Vellenga. Through observation of birds she had banded, she learned that one male mated with five females and initiated ten other unsuccessful courtships.

On the platform of the display area, usually on the north, he assembles a curious collection of objects. They may be natural—feathers of other birds, blossoms, empty shells of land snails. Or the items may come from nearby human settlements—pieces of crockery, bits of rag, or, in the case of this proud thief, clothespins from my home, 200 yards away.

The most startling aspect of the collection is the male's decided preference for blue, although greenish yellow, brown, or gray items—more common in nature—also are usually present. One expert theorized that the color preference may reflect a preoccupation with rivals and their bluish-yellow beaks and usually blue eyes. For throughout the courtship and mating season—July into January—he must be constantly alert lest another male invade his arena to destroy his bower or purloin his prized display objects.

FIVE YEARS and 700 hours in a blind (**below**) have rewarded me with one of the most detailed photographic records yet compiled of satin bowerbirds, including this picture of a male carefully inserting a twig in his bower wall (**facing page**). Male satin birds constantly paint the inside walls (**upper left**) by mixing their saliva with charcoal or with berries, dirt, or rotted wood. Prize display object, stolen from a house half a mile away, a blue marble is carefully brought to the bower (**middle left**). Objects I selected from various bowers reveal the diversity of collected treasures (**bottom left**). I have counted more than three hundred natural and man-made items in a single bower.

HOLDING A BOUQUET in his beak, a mature male pays court to a female in the bower (**left**). The sleek suitor tolerates the watchful presence of an immature male, at rear, who resembles the female in coloration.

As the time for mating draws nearer, the wooer's display becomes more frenetic. Picking up an object, he utters a rhythmic whirring noise, fans his tail, and hops from side to side. His flashing wings almost cover his head (**above**), and refracted light reveals highlights of startling blue in his plumage. After perhaps a thirty-minute performance, mating takes place (**right**).

SURE SIGN of excitement, lavender floods the normally blue eye of a male satin agitated at being held in a human hand. Mulberries, a favorite of this species, ripen on the tree behind him.

Two young males (**below**) prepare for adulthood by practicing their courtship display. These would-be suitors construct rudimentary platforms and collect some display objects—which are often stolen by adults. Although bower building, painting, and displaying are probably inherited behavior, the young males undoubtedly perfect their performance by watching other males. They do not totally attain the bluish coloration until their seventh year, although they do become sexually active before that time. While watching an adult male courting a female, I witnessed a younger, green male furtively invade the bower and attempt to mate with the female. The female fled the bower as the older male viciously attacked the intruder with open beak and foot (**right**), behavior never before photographed. In the brief melee the right wall was partially knocked over.

ON HER OWN, a female satin bowerbird constructs her simple, leaf-lined nest in an orange grove only a few hundred yards from the bower of the male. While he continues to tend his bower, and to display and mate with other females, she cares for her nest by herself. Sometime between September and January the female lays two mottled eggs, occasionally one or three. When they hatch (**above**), the mother is also sole provider, bringing to her offspring flying insects that swarm at this time of year.

As yet unable to fly, a 19-day-old chick explores around its nest (**left**). Some time later, the youngsters will join the flocks of satin bowerbirds that pass through the region, to the dismay of Australian fruit growers. Then next midwinter the nomadic flocks will disperse, and adult males among them will return to their territories to refurbish their bowers once again. □

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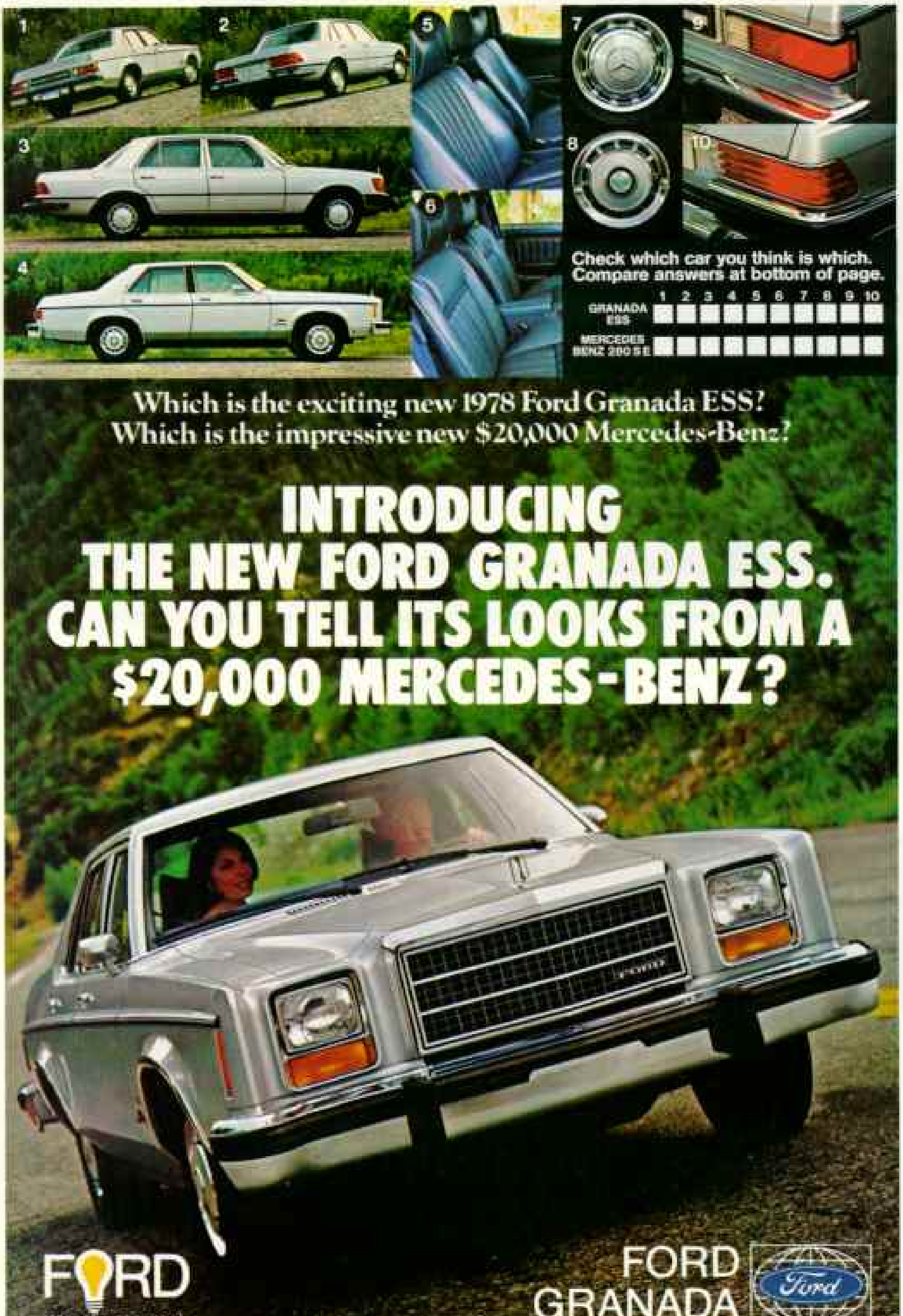

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The National Audubon Society and Fleetwood proudly announce the Official Collection of

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A superb Limited Edition of philatelic covers. Each a finely-detailed original work of art by America's premier wildlife artist: Arthur Singer.

From sea to shining sea, America is blessed with an abundance of stunning birds and flowers. A glorious, spirited patchwork of sound, color and fragrance.

In every state, nature's beauty abounds. Americans know it, and are proud of it. And with each new song a bird sings, and each new flower that blossoms, that pride is renewed and strengthened.

To forever affirm this pride and respect for the natural environment, each of the fifty states has chosen an official state bird and flower as a lasting acknowledgement of nature's bounty. Seen together, as they are in this collection, *The Birds and Flowers of the 50 States* capture the total richness of the great American outdoors, and prove that nature, in all her glory, is an everlasting part of America the Beautiful.

It is appropriate, therefore, at a time when Americans are dedicating themselves to preserving and protecting the natural environment, that America's foremost conservation group — the National Audubon Society — has appointed Fleetwood to issue the *first* philatelic collection honoring these living symbols of the United States.

Fifty original works of art by America's greatest wildlife artist

Each of the commemorative covers in *The Birds and Flowers of the 50 States* is a triumph of craftsmanship and design by a man who is often called America's greatest living wildlife artist: Arthur Singer. For nearly two years, Arthur Singer has labored to achieve the perfection and absolute fidelity to nature that a collection of this importance deserves. As a result, collectors who acquire these fifty covers will own what is surely the most comprehensive, most authentic tribute of its kind ever issued.

Singer's paintings capture each bird in its true colors and shadings. The flame-red plumage of Ohio's Cardinal. The startling brightness of New York's Bluebird. The dramatic orange and black contrast of Maryland's Baltimore Oriole. The head, the feathers, the beak and the tail of each bird is shown in exquisite, and accurate, detail.

A rainbow of floral colors

The state flowers, from the delicate blossoms to the graceful leaves, are just as real. And the colors! The bright orange of the California Poppy. Breathtaking Texas Bluebonnets. Soft pink, sweetly-scented Mayflowers from Massachusetts. Here is a collection which forms a rainbow of floral colors, textures and shapes — a dream garden filled with America's most beautiful flowers.

Arthur Singer has created *fifty* perfectly-colored, perfectly-detailed masterpieces for *The Birds and Flowers of the 50 States*, making this a landmark collection that will be praised by collectors and nature lovers for years to come.

Historic postmarks

Significantly, each of the fifty covers will be issued in the appropriate state capital on *the precise anniversary of statehood*. There, each will be officially postmarked by the United States Postal Service. The covers honoring the thirteen original states will be issued on the anniversaries of their ratification of the Constitution. Thus, the collection is not only a worthy tribute to the official state birds and flowers, but, as the postmarks certify, a collection which can never again be duplicated.

Surprisingly modest cost

Normally, a collection of this scope, by an artist with the international reputation of Arthur Singer, would be beyond the reach of most collectors. Therefore it is significant that the original issue price for *The Birds and Flowers of the 50 States* is a very modest $2.50 per Commemorative Cover. This price is guaranteed for the entire collection, and a deluxe collector's album is included at no additional cost.

Subscribers will receive issues at the convenient rate of four per month for twelve months. The twelfth shipment will include six issues. *No advance payment is required.* Subscribers will automatically be billed for each shipment of covers as it is made.

Deadline for application: January 31, 1978

This magnificent tribute will be issued only in 1978, and is available to you only by advance subscription. The edition is forever limited to the exact number of valid applications postmarked by January 31, 1978.

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Covers shown reduced from actual size of 7½ by 3⅝ inches.

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The Baltimore Oriole and the Black-Eyed Susan

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UTAH
The Sea Gull and the Sego Lily

MICHIGAN
The Robin and the Apple Blossom

NATIONAL GEOGRAPHIC

Blue crab: main cog in an "immense protein factory"

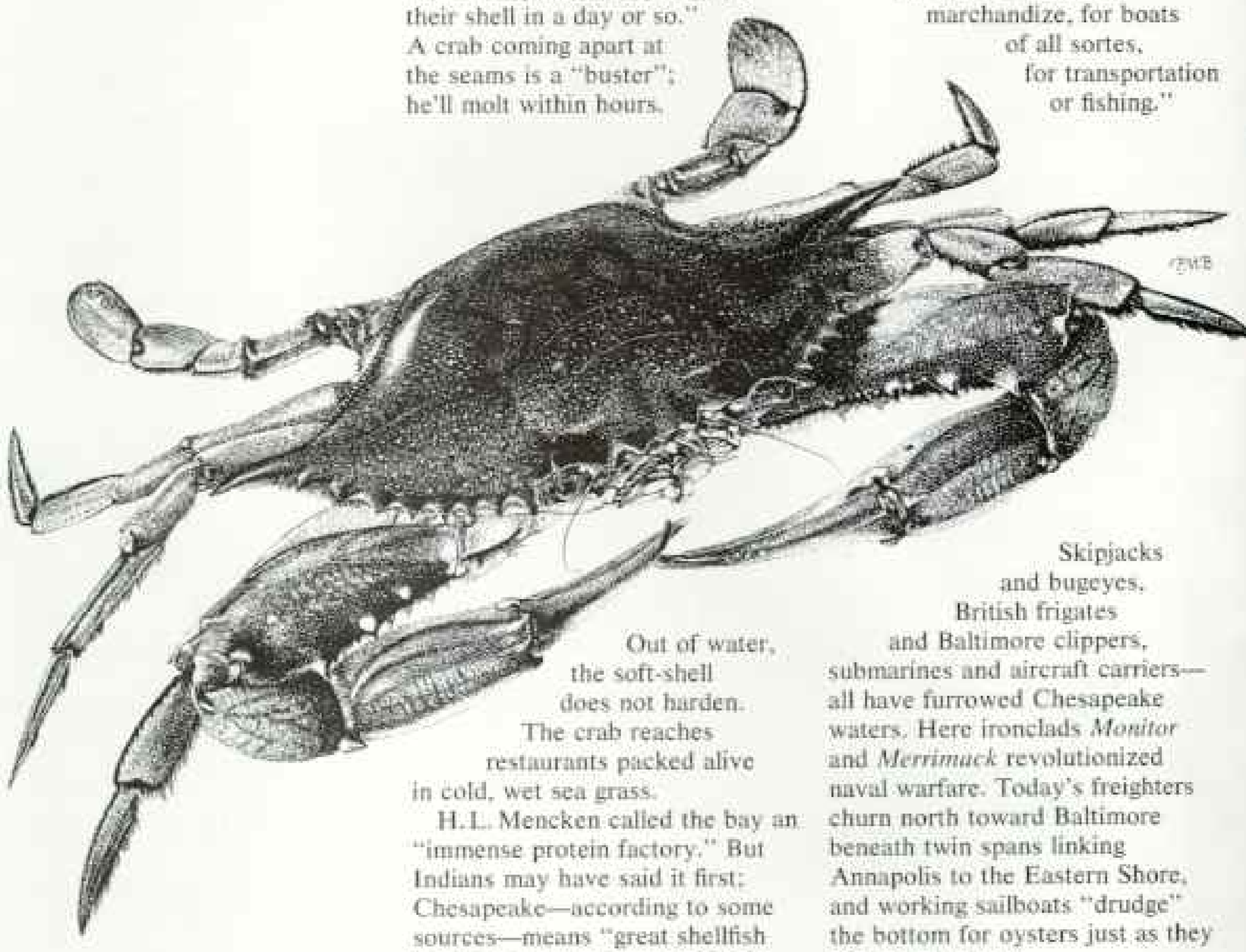
Chesapeake Bay watermen annually harvest millions of pounds of the blue crab *(Callinectes sapidus)*. The succulent crustaceans will be steamed, stuffed, deviled, shredded into salads, patted into crab cakes, and, in their soft-shell state, eaten whole.

Baymen keep a sharp eye out for crabs about to shed their exoskeletons. A Tangier Island packer can spot a peeler by its paddlelike backfin: "Crab with a white edge to his paddle, he's got about a week to go. Pink rim, he'll shed in three days. When they gets red in the paddle, they'll shuck their shell in a day or so." A crab coming apart at the seams is a "buster"; he'll molt within hours.

Clams and crabs abound. To hear a waterman talk, it's a good thing only two or three crabs survive from the million or more eggs a female carries. Otherwise, "the world'd be et up by crabs."

Some 150 rivers, branches, creeks, and sloughs bearing names such as Crab Alley, Ape Hole, and Bullbegger flow into Chesapeake Bay. From the mouth of the Susquehanna to the Virginia capes, the bay washes more than five thousand miles of shoreline.

Capt. John Smith observed in 1612, "the waters, Isles, and shoales, are full of safe harbours for ships of warre or marchandize, for boats of all sortes, for transportation or fishing."



Out of water, the soft-shell does not harden. The crab reaches restaurants packed alive in cold, wet sea grass.

H.L. Mencken called the bay an "immense protein factory." But Indians may have said it first; Chesapeake—according to some sources—means "great shellfish bay," and it is that yet. Despite the overfishing that depleted the world's finest natural spawning beds, the bay still leads the country in oyster production.

Skipjacks and bugeyes, British frigates and Baltimore clippers, submarines and aircraft carriers—all have furrowed Chesapeake waters. Here ironclads *Monitor* and *Merrimack* revolutionized naval warfare. Today's freighters churn north toward Baltimore beneath twin spans linking Annapolis to the Eastern Shore, and working sailboats "drudge" the bottom for oysters just as they did a century ago.

The Chesapeake Bay waterman is but one of the unique people readers meet in the wide-ranging pages of NATIONAL GEOGRAPHIC.

Could tomorrow's energy come from the sea: Some think so. Others believe the sea too vast, too inhospitable to harness on a major scale. Who's right?

The ocean's energy is enormous. Tides rise and fall twice daily, sometimes 50 feet. Swift currents flow around the world. Temperature differences between surface and deeps run as much as 23°. Massive waves roll endlessly. Converting these forces to useful work tantalizes energy experts. They visualize offshore generators powering coastal cities. They dream of ocean-generated hydrogen gas replacing today's fossil fuels. The potential seems boundless.

Yet except for a few tidal dams, no ocean harnessing system exists. True, the technology is fairly well advanced. We can build generating plants, skyscraper-tall, far out to sea. We know how to make hydrogen from water. We can transmit power under water. But, the investment to apply this technology would be enormous. And there are unanswered questions of ownership, security, maintenance of mid ocean facilities.

Today's main energy sources, oil and natural gas, will run low. Then what? Ocean power? Not for decades, if ever. Oceans *should* be investigated, along with all other energy possibilities. But attention must go to each prospect in order of practicality.

We need a national energy policy to establish best use for existing resources and to set developmental priorities for everything from readily available coal to more futuristic sources. That policy should be a blueprint of the rights and responsibilities for consumers, producers and government.

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THE WINGS OF MAN

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1. IT COOKS FAST BY TIME.

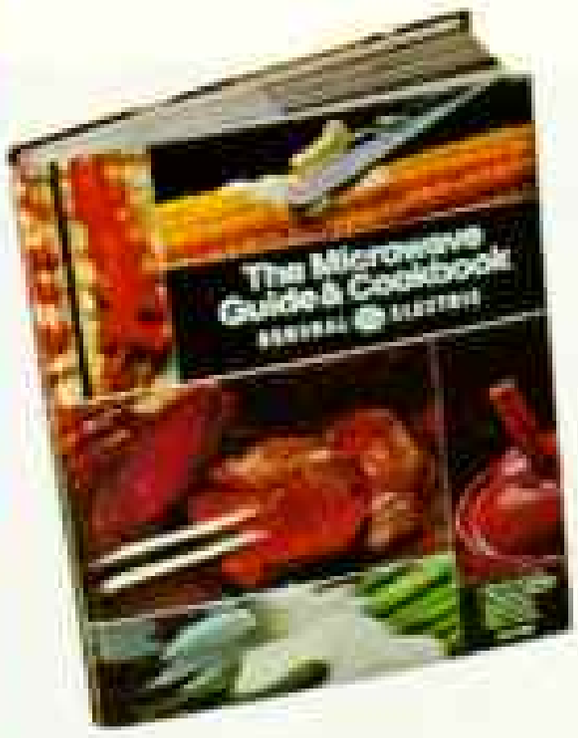
The touch controls let you select the time you want. With computer precision, you can cook tasty chicken, casseroles, hamburgers, vegetables, many other dishes, quickly and deliciously.

2. IT COOKS FAST BY TEMPERATURE.

Just insert GE's Micro-Thermometer™ control in meats, soups, sauces, and many other foods. The oven shuts off automatically when they're cooked to your selected temperature.

3. IT SLOW-COOKS ALL DAY.

Now you can create tender, succulent pot roasts, stews, and many other old-fashioned dishes in a microwave. It's simple to do with General Electric's Simmer 'n Cook setting and the Simmer 'n Cook Stoneware Casserole that comes with this oven.



AND IT COMES WITH GE'S EASY-TO-UNDERSTAND "MICROWAVE GUIDE AND COOKBOOK."

It's much more than a recipe book. General Electric's complete how-to guide takes the mystery out of microwave cooking. In a series of simple, step-by-step lessons and recipes, illustrated with over 450 color photographs, GE gives you the help you need to become a great microwave cook.

THE APPLIANCES AMERICA COMES HOME TO.

GENERAL ELECTRIC

GIVE YOUR HAND A PROMOTION.

Your fingers will appreciate the comfort
and sure grip of a smooth-writing Parker ball pen.
It's the pen every hand hopes to hold someday. Expect up to
80,000 words from a cartridge, a full year of writing.
Refills in a variety of ink colors and line widths.
Matching pencils, of course.
The substantial Parker 75 in solid sterling silver, $22.50.
Slim Parker Classic in 22K gold electroplate, $13.50.
Either makes a flattering gift.

There are pens. Then there is Parker.

PARKER

World's most wanted pens

TWA's widebody 1011. It's built for comfort.

The unusual comfort you get on our big widebody 1011 starts with one of the most important parts of any flight. The seat.

Every Coach seat on our widebody 1011 is extra wide. In fact, you can't get a wider seat on any plane.

And most have narrower seats. Our seats even have special thick cushioning and bigger armrests.

But that's just the beginning of the 1011 comfort story.

Next, so you can really relax and enjoy your flight, we serve you a big hearty steak in Coach on most long meal flights. Not just any steak, mind you—filet mignon.

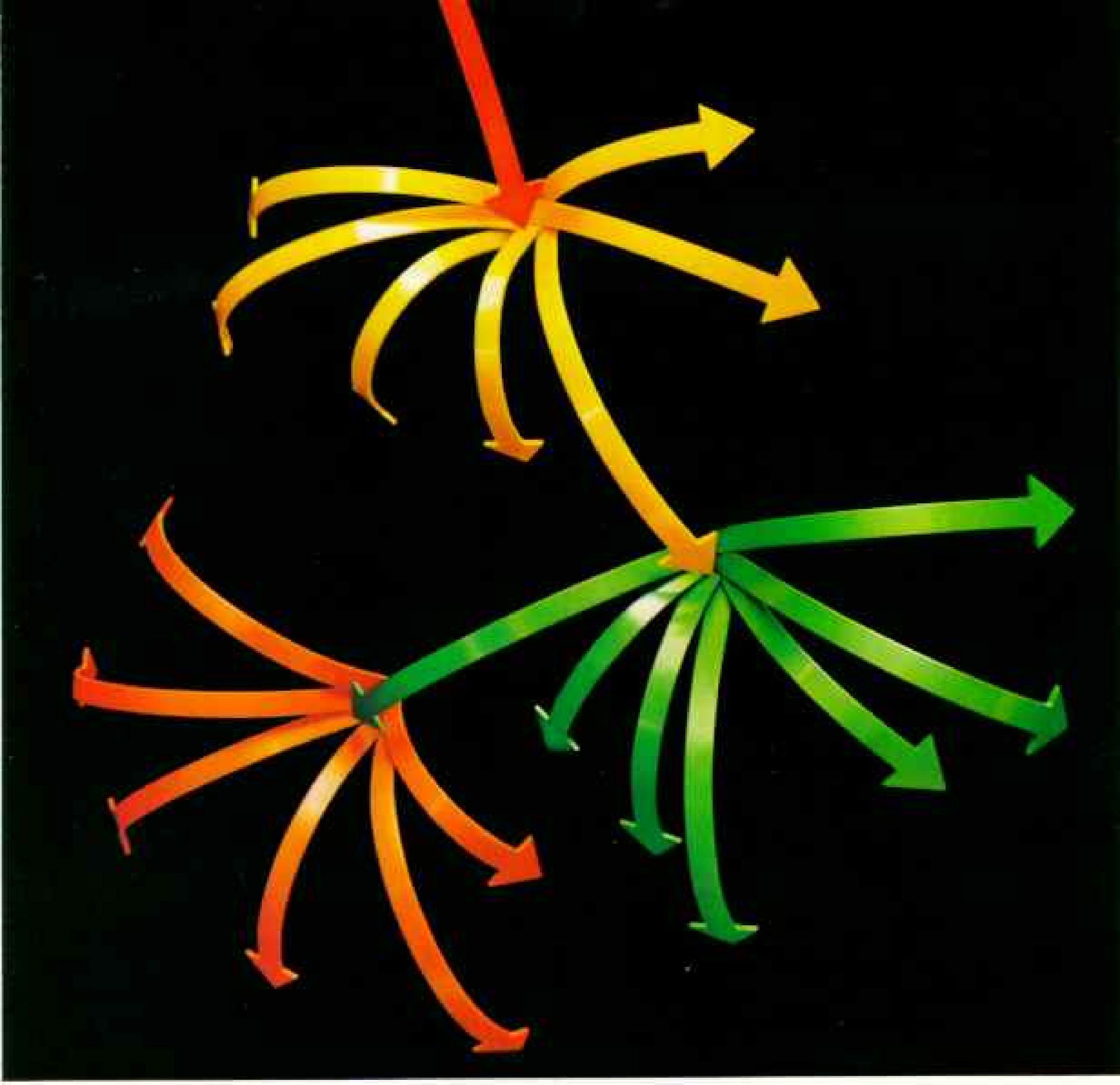
Then, take the technology of the widebody 1011. In a number of ways the 1011 has more advanced technology than the 747 or even the Concorde.

The widebody 1011 has one of the most advanced flight control systems in aviation today. Its computers make minute adjustments in the flight controls so that takeoffs,

flights and especially landings are incredibly smooth. TWA's widebody 1011, with its luxurious Rolls-Royce engines, delivers all the comfort you fly a widebody for. And then some. For reservations call your Travel Agent, Corporate Travel Department or TWA.

ROLLS ROYCE

TWA



From one form of energy comes strength
to develop another. And another.

Developing any source of energy —an oil field, a coal mine, a uranium deposit—takes a lot of time and money.

Fortunately, Conoco has revenues from all these sources. And we pool them. So we have the flexibility to apply financing where it's needed. And the stability to continue this financing over long years of development.

For instance, we've plowed additional money into coal—to increase coal production, mine safety and employment.

Now coal and oil help fund our development of uranium—and research into *new* forms of energy, such as synthetic gas and gasoline, that aren't commercially practical today but could be in the future.

This year alone, we plan to spend about $1 billion to develop more energy supplies.

From the many forms of energy Conoco produces today comes the financial strength to produce the fuels of tomorrow.

CONOCO

Doing more with energy.

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

DEAR ALICE,

I want everything in my pocket.

I want a pocketful of cameras called Kodak Tele-Instamatic™ 708 camera.

It shoots big, colorful pictures two ways, telephoto and normal. (Actual picture size is 3½" x 4½".) It's got automatic exposure control. And it'll focus from 3 feet (for clear, sharp close-ups) to infinity. And it's easy to use.

There's much more: a telephoto/normal viewfinder, electronic shutter that ranges from 1/300 second to 1/30 second automatically, low-level light indicator...it's like a whole Christmas list in one camera.

And it comes in a complete gift outfit with Kodak color film and flipflash—everything you need to take pictures on Christmas.

Kodak tele 708 camera outfit

less than $100

Price is subject to change without notice.

I borrowed a Kodak tele 708 camera. Was necessary to see how good it is.

Look how well automatic exposure works in light like this.

Look how the telephoto lens makes the best part of my picture bigger.

With the normal lens I can take more of the surrounding scene.

Kodak gifts say: "Open me first"

...to save Christmas in pictures.

ONE OF THE FEW LUXURY SEDANS IN THE WORLD THAT WOULDN'T BE LAUGHED OFF THE NÜRBURGRING.

In the heart of Germany there is a race course called the Nurburgring.

An awesome giant of a track, generally acknowledged to be the most arduous test of both cars and men.

Yet, few cars—and certainly no luxury sedans—have achieved a more impressive record on the Nurburgring than those built by the Bavarian Motor Works in Munich, Germany.

Luxury sedans? Yes. But luxury sedans built by racing engineers. German engineers who believe that extraordinary performance is the only thing that makes an expensive car worth the money.

PERFECTED ON THE RACE TRACK.

While it is, of course, feasible to develop an acceptable automobile in the relative vacuum of the test track and the laboratory, it is virtually impossible to simulate the perfection demanded by motor racing.

And the BMW 530i is a direct reflection of this cache of engineering intelligence.

Its suspension—independent on all four wheels—is quick and clean through the corners; its steering sharp and accurate.

Its four-speed manual transmission (automatic is available) slips precisely into each gear.

Its acceleration comes up smoothly, with the turbine-like whine so characteristic of the justifiably renowned 3-liter BMW engine.

And, while it provides all the luxury one could sanely require, the interior of the BMW 530i has been assiduously planned to facilitate total, precise control at all times, under all conditions. Engineered to include the driver as one of the functioning parts of the car itself—the human part that completes the mechanical circuit.

So successful is this integration of man and machine that the editors of Motor Trend magazine write, "The reaction to a BMW is always the same. The first time driver takes the wheel and after a few minutes no other automobile will ever be the same again."

If the thought of owning such a car intrigues you, call us anytime, toll-free, at 800-243-6000 (Conn. 1-800-882-6500) and we'll arrange a thorough test drive for you.

THE ULTIMATE DRIVING MACHINE.

Bavarian Motor Works, Munich, Germany

A simple truth about color TV:
Ordinary mechanical tuners have moving parts inside. They can wear out or corrode and cause picture problems. But Zenith has the Electronic Video Guard Tuner. With no moving parts inside. It's designed to keep your great Zenith color picture looking great. For a long time.

ZENITH®

CHROMACOLOR II

The quality goes in before the name goes on.®

The Electronic Video Guard Tuner is available in 13" through 25" (diagonal) screen sizes.
Shown: The Ellipse IV, SJ1951W in simulated Walnut highlighted with brushed aluminum color. Simulated TV picture.

PUT AN AUTOMATIC CAMERA IN A FRIEND'S POCKET.

The all-day, year-round gift. Because these little, easy-to-use Kodak Trimlite cameras take big, colorful pictures. Actual picture size is 3½" x 4½".

The Kodak Trimlite Instamatic® 28 camera has a sharp *f*/9.5 lens, electronic shutter, CdS meter for automatic exposure control and a low-light signal. It comes in a complete gift outfit with Kodak color film and flipflash—everything you need to take pictures on Christmas, and it is less than $60.

The Trimlite Instamatic® 38 camera has all the features of the Trimlite 28 camera plus focusing for close-ups, a faster *f*/8 lens and a wider electronic shutter range from 1/225 of a second to 5 seconds. The gift outfit is less than $73.

Automatic exposure means a better chance for better pictures. Here are some I took.

If my son were Santa, he'd give himself Kodak Trimlite 38 camera.

My daughter makes a pretty picture.

Look how close up you can get with the Kodak Trimlite 38 camera.

Kodak Trimlite 28 & 38 camera outfits

Both these Kodak cameras are also available in a KODAK Big Flash outfit with the new EKTRON II model A Electronic Flash. Prices are subject to change without notice.

Kodak gifts say: "Open me first"
...to save Christmas in pictures.

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She says I never give her flowers.

A diamond is forever.

To give you an idea of diamond values, the piece shown is available for about $1350.
Your jeweler can show you other fine diamond jewelry starting at about $200. De Beers Consolidated Mines, Ltd.

IT UNTYPES AS EASILY AS IT TYPES.

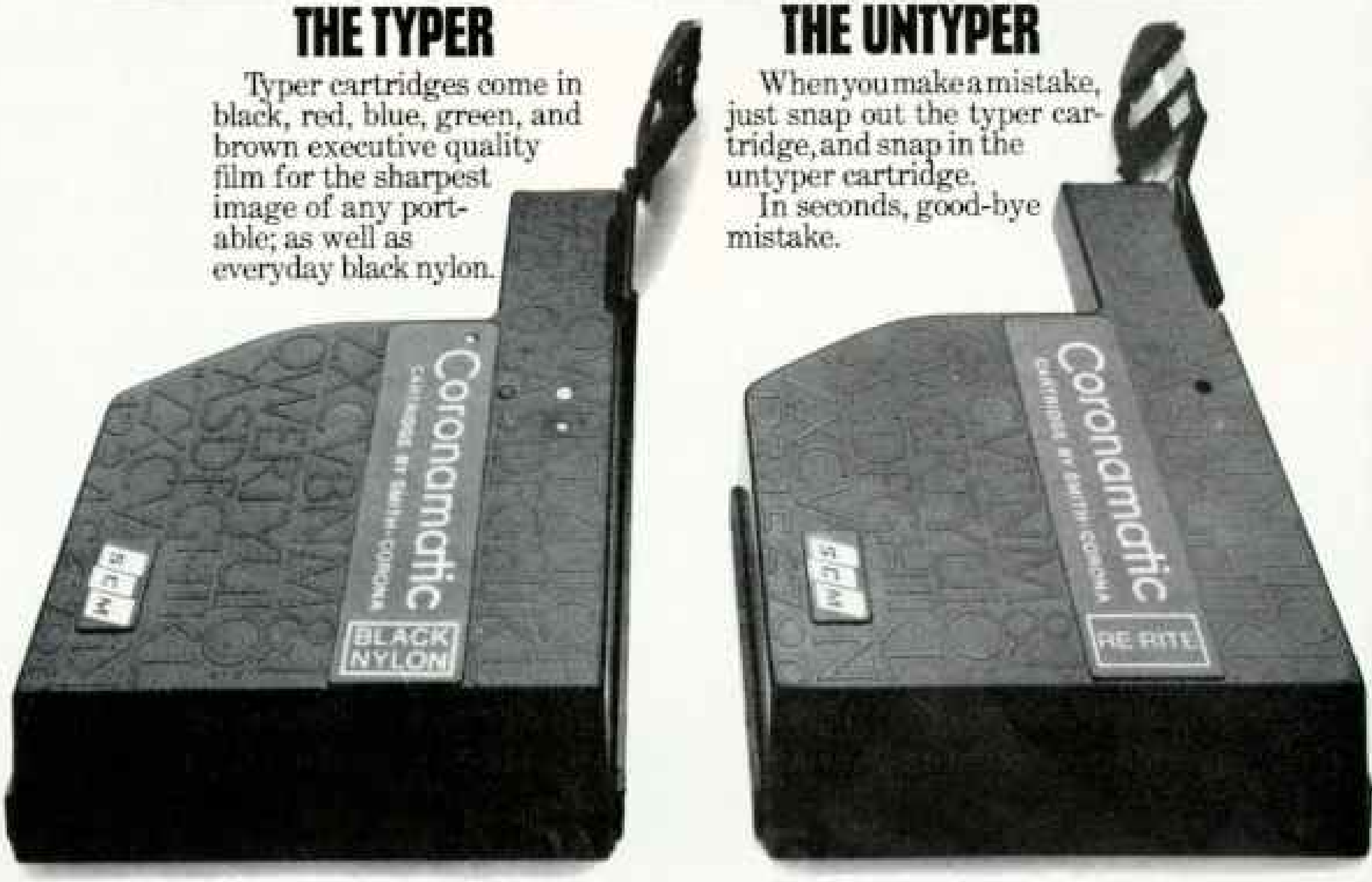
THE TYPER

Typer cartridges come in black, red, blue, green, and brown executive quality film for the sharpest image of any portable; as well as everyday black nylon.

THE UNTYPER

When you make a mistake, just snap out the typer cartridge, and snap in the untyper cartridge.

In seconds, good-bye mistake.



SCM SMITH-CORONA
SCM CORPORATION

Another Turner-Bradshaw Collectors' Lithograph

TUTANKHAMUN

THIRTY-THREE CENTURIES LATER

In all the annals of archaeology, no moment has surpassed the breath-taking spectacle of this young pharaoh lying in the splendor of his 3,300 year-old tomb. Turner-Bradshaw & Associates felt that the profound impact of this event should be honoured and commemorated for today and generations to come.

To do this, Turner-Bradshaw commissioned Roger Lex to do an original oil painting with the freedom of his artistic license to express the funerary mask of Tutankhamun as he sees it . . . detailed so fine, you need not be a connoisseur of fine art to appreciate the dedication this project demanded. Roger Lex has captured the brilliant colour of inlaid lapis lazuli, quartz, obsidian and solid gold in this remarkable, breath-taking lithograph (18"x24") available for $15, or signed, numbered for $100.

To insure the beauty and value of this limited edition, Turner-Bradshaw has spared no expense. Your quality lithograph will be color separated from the original oil painting by Omega Graphics . . . renowned for fine art reproduction, and printed on the finest quality 100% rag paper.

For the very special few, Roger Lex has signed and numbered a limited edition of 1,000 lithographs, available on a first-come basis. For the ultimate collector . . . the original oil painting is offered. Price $25,000

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LAKE GENEVA, WI 53147
(414) 245-5325 No. C.O.D.'s

Please send _____ "Tutankhamun" print(s) @ $15.00 each plus $1 shipping & handling.

Please send _____ "Tutankhamun" print(s) signed and numbered by Roger Lex @ $100.00 each plus $1 shipping and handling.

☐ Please include gold metal frame @ an additional $15.

☐ Mastercharge ☐ Visa

Card # _____

Expiration Date _____

Signature _____

Name _____

Address _____

City _____ State _____ Zip _____

Wisconsin residents add sales tax © 1977

THE TURNER-BRADSHAW GUARANTEE:
You must be completely satisfied or we will refund your money.

Kodak mailers: Memorable stocking stuffers.

Wrap up Christmas memories with Kodak mailers—an easy way to give someone quality Kodak processing.

When their Kodak color film is exposed, they can just drop it into a Kodak mailer, and mail it to Kodak. Kodak will mail the color prints, slides or movies right back. (We treat all your memories as if they were our own; and that careful treatment shows up in quality pictures, time after time.)

Stuff a stocking with Kodak mailers this Christmas; and stock up on enough Kodak mailers for your merry Christmas memories, too.

Kodak mailers

Kodak gifts say: "Open me first"
...to save Christmas in pictures.

Hellmann's® also BAKES!

(The Real Mayonnaise is the shortening.)

BUBBLE BUNS

(Quick and easy pull-apart buns)

1/2 cup finely chopped walnuts
1/3 cup sugar
1/2 teaspoon ground cinnamon
1 package (10) refrigerated biscuits
1/3 cup HELLMANN'S Real Mayonnaise

Grease ten 2 1/2-inch muffin pan cups. In small bowl combine first 3 ingredients. Separate biscuits. Cut into quarters; shape into balls. Coat each with Real Mayonnaise, then roll in walnut mixture. Place 4 in each muffin pan cup. Bake in 400°F oven 15 to 17 minutes or until browned. Serve warm. Makes 10.

PECAN JUMBLES

(Crispy drop cookies with a nutty taste)

1 1/2 cups firmly packed dark brown sugar
1 cup HELLMANN'S Real Mayonnaise
2 eggs
1 teaspoon vanilla
2 3/4 cups unsifted flour
1/2 teaspoon baking soda
1/4 teaspoon salt
1 cup chopped pecans
1 cup pecan halves, optional

In large bowl beat first 4 ingredients until smooth. Stir in next 4 ingredients. Drop by level tablespoonfuls 2 inches apart on greased cookie sheets. Top each with pecan half. Bake in 375°F oven 8 to 10 minutes or until lightly browned. Immediately transfer cookies to wire racks. Makes about 4 dozen.

CHOCOLATE MUNCHIN' CAKE

(The lacy look makes this moist cake beautiful)

1 1/2 cups unsifted flour
3/4 cup sugar
1 teaspoon baking soda
2/3 cup strong coffee or water
1/2 cup HELLMANN'S Real Mayonnaise
1/3 cup chocolate flavored syrup
1 tablespoon vinegar
1 teaspoon vanilla
1/4 teaspoon salt
Confectioners sugar

In 8 x 8 x 2-inch baking pan stir together first 3 ingredients. Add next 6 ingredients. Stir with fork, scraping corners and sides of pan, until mixture is uniform. Bake in 350°F oven 30 to 35 minutes or until top springs back when touched lightly. Cool on wire rack. Place paper doily on top; sprinkle with confectioners sugar. Remove carefully.

Introducing the wagon that has America singing.

You guessed it.

After all, you don't find people singing about ordinary wagons. Just extraordinary ones. Which, we modestly propose, is precisely the category the 1978 Plymouth Volaré wagon fits into.

Reason number one is the most obvious. That cavernous space you see below. Where those kids could lug home about 60 bushels of shells, or fish, or something else suitably exotic. (Parental guidance suggested.)

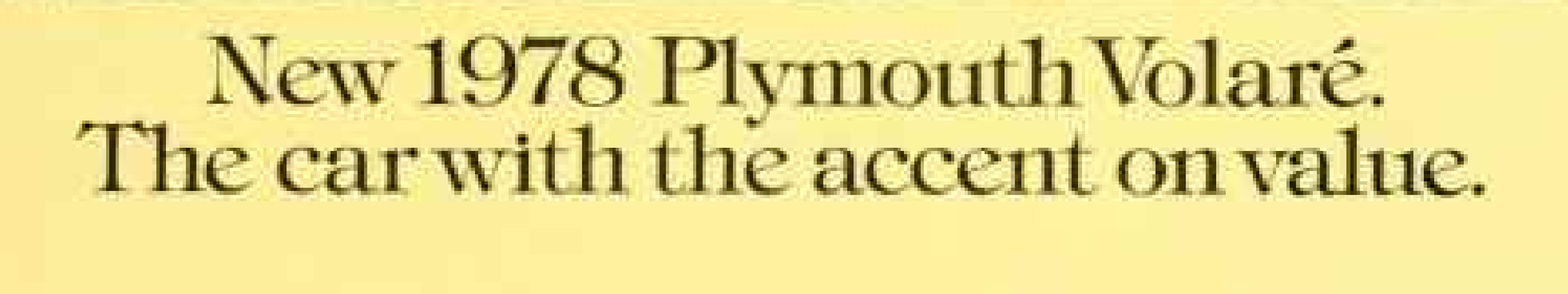
Of course, the nice thing about lugging anything around in a Volaré is that you never lug around a lot of car. Because Volaré is a trim, compact wagon. Maneuverable. Easy to park. And, a pure joy to drive. Thanks to the Isolated Transverse Suspension. An ingenious system designed to keep life's bumpy road as far away from you as possible.

Other comforts also abound in Volaré. Like a gas pressurized liftgate that opens part way on its own. And two optional lockable storage compartments to keep "out-of-sight" valuables out of sight.

Volaré. People have been singing its praises since the day we brought it out. So much so, in fact, that last year, they helped make it the No. 1 selling wagon in America.

And if we're hearing it right (ah, what a great sound) that's exactly where it's going to remain.

Buy or Lease a Volaré at your Chrysler-Plymouth Dealer today.



New 1978 Plymouth Volaré.
The car with the accent on value.