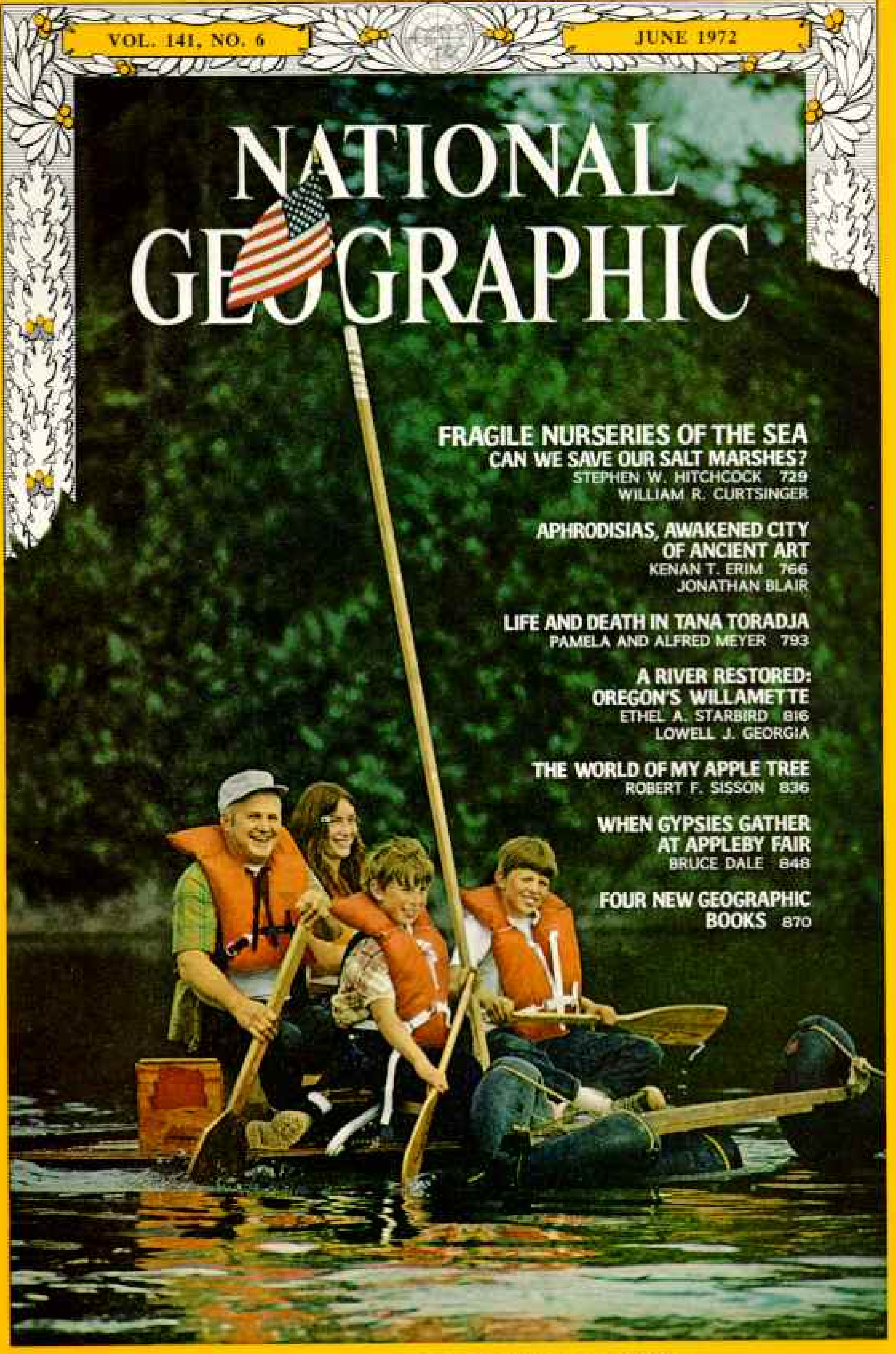


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NATIONAL GEOGRAPHIC

June 1972

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WHAT LINKS AN APPLE wearing a chill cap of snow, a canoeist skimming a crystal stream, a duck landing on a salt-water marsh? Beauty—beauty possessed by the urge to live.

"You'd be surprised how stubborn beauty is. It wants to live," writes a Georgia author, Celestine Sibley. And so it does. But as man puts greater and greater strain on the environment, not



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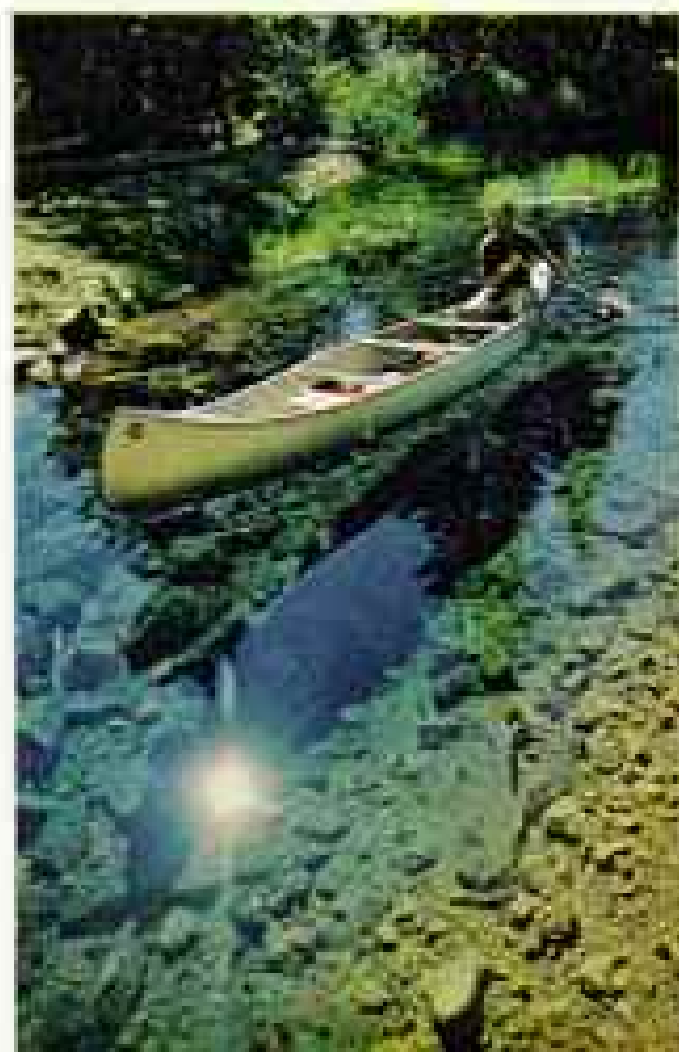
only beauty but also the support systems of life itself stand eye to eye with danger.

These three photographs bespeak the beauty and bounty of nature. They also remind us of man's newly awakened awareness that he must reestablish a harmonious balance between himself and the other living things of the earth.

Only recently, for instance, have we understood how important are the grassy "wastelands"

of our coastal salt marshes. Here, in an intricate network, living things depend one upon the other, with man the ultimate beneficiary. In a remarkable study by a biologist and a talented photographer, we see marsh creatures living naturally and free, as they have through the ages, unaware of the swinging scythe of man's increasing intrusion. We also see the marshlands paved with concrete, disfigured by automobile hulks, and polluted by wastes from farms and factories. Continued destruction will almost surely spell disaster for this delicately balanced natural resource that is so vital to man.

There are encouraging things to report, too. Bugles of hope sound along a river restored—the Willamette in Oregon. There a devoted band of citizens, armed with information and concern, have joined with industry and state and city officials in a successful crusade to convert



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the most polluted waterway in the Pacific Northwest into a playground for the joy of thousands. In a continent richly veined with rivers, the Willamette's success story will inspire other citizens and other states to rescue streams now being choked to death by pollution.

Finally, a simple tale of love for an old, ofttime shady, friend living on a Virginia farm. Staff photographer Bob Sisson's apple tree has little to distinguish it from millions of its kind. Yet, in this gentle portrait, we recognize the abiding worth of every tree as home and sustenance for insects, birds, and animals—and as a delight to human eyes and hearts. □



FROM FLORIDA TO MAINE there is a war. Between man and man, fish and bird, wave and sand. The battle rages and storms over the coast. Yet the battlefield is strangely quiet. Grasses bend softly in the wind. Herons stalk silently through shallow waters. This war is being fought in the narrow green-and-tawny band of salt marsh that stretches along our eastern shore.

For millenniums there could be no final victory or defeat. Nature's contending forces stayed in balance. The rising sea stole from the marshland, and the marshland rebuilt its defenses. The marsh grass died and, decaying, nourished the animal life of the estuaries. Fish warred on fish and the birds on them, but all at last fell in the battle, and, in dissolution, fed the grass roots. The circle closed, and the battle was joined again.

Now, however, we humans can impose a final decision in this immemorial war of the wetlands along all our coasts. We even have it in our power to obliterate the battlefield. And if we do, will that be victory or defeat? Are we about to conquer nature, or about to conquer ourselves?

The salt marshes are disappearing before the onslaught of factories, dump and fill, homes with a seaward view. As chemicals and sewage pollute the wetlands, the encroachment of industrialists and developers is also the rout of oyster dredgers, clambers, crabbers, sportsmen, and lovers of nature.

The acres of marsh covered by asphalt and concrete may be a triumph for builders, but for the commercial fishermen of the Atlantic Coast, those captured marsh acres mean a smaller catch at sea. In the salt marshes more than seventy-five species, including commercially important menhaden and striped bass, spend some part of their lives. No marshes—no fishing industry. In Virginia, where the annual catch is worth 22 million dollars dockside, commercial fisheries would suffer total disability, for 95 percent of that catch is nurtured by the marshes.

The grass that developers destroy is literally at the root of marsh life. I watched a piece of it float past in an arterial creek of the great marsh on Blackbeard Island, Georgia. This small bit of plant material, I reflected, could be called the basic unit of energy for which the creatures of the marsh contend. On this coarse-leaved cordgrass, *Spartina alterniflora*, most marsh animals depend. A few graze on it, many more feed on the products of its decay, and others feed on the feeders.



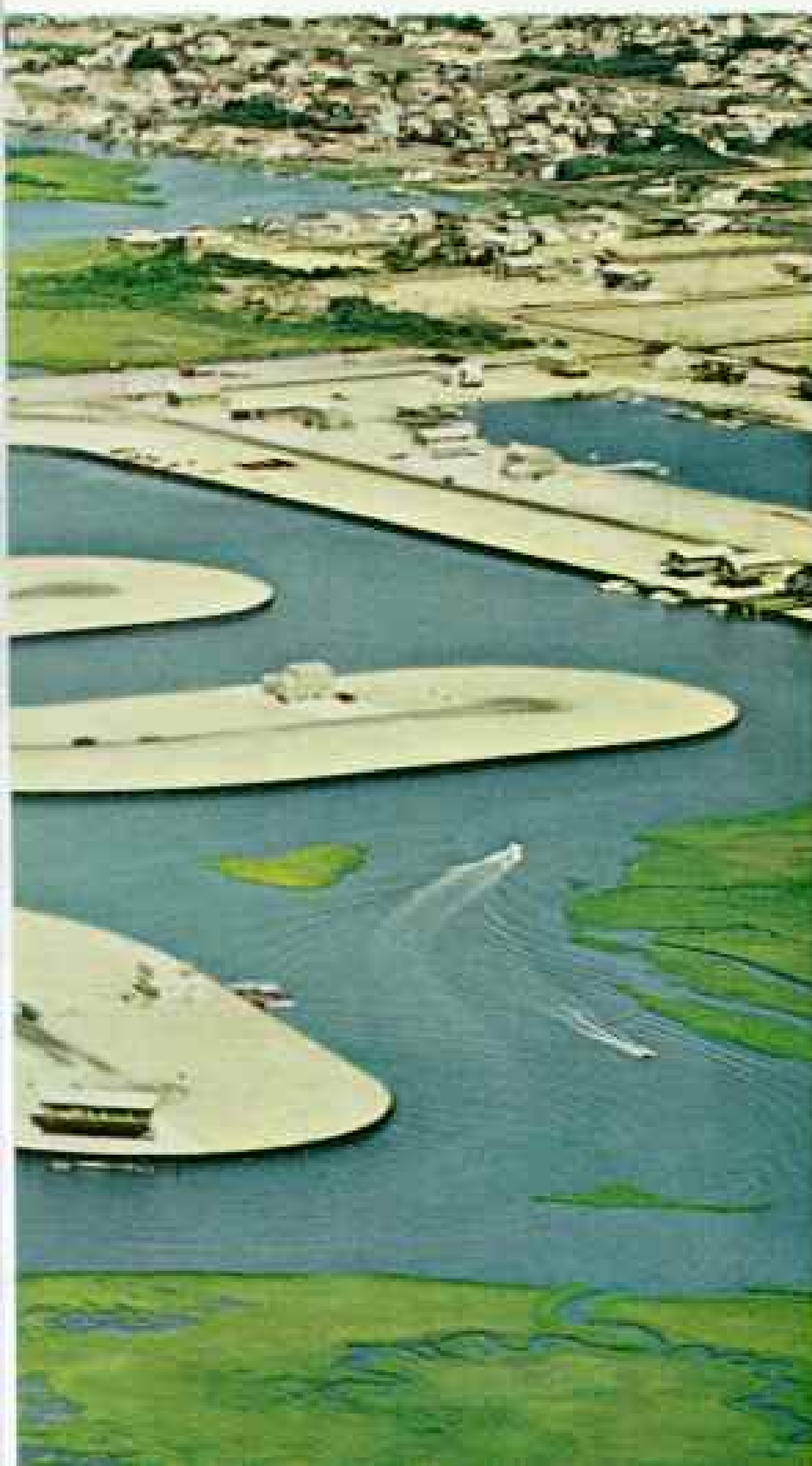
Safe for the moment, a clapper rail (left) scurries through a Georgia marsh. Conservationists have begun the battle to save such pristine tidal areas, menaced by human negligence and urban sprawl. In Maine a tern (above) perches over a warning sign in a marsh polluted by sewage.

Can We Save Our Salt Marshes?

By STEPHEN W. HITCHCOCK, Ph.D.

Photographs by WILLIAM R. CURTSINGER





I had joined two graduate students from the renowned University of Georgia Marine Institute on Sapelo Island, Blackbeard's near neighbor.* They were studying energy flow within the marsh. To estimate marsh production and reveal the interrelationships of wetland life, we were collecting, weighing, and measuring every plant and animal from specific areas that had been previously staked out in square meters.

Fiddlers Play a Role in Marsh Ecology

It had been a long walk to our destination. Glutinous mud had sucked the sneakers from my feet. I had stumbled into grass-covered channels and scratched myself on the sharp reddish tips of young spartina leaves.

That plant, sometimes growing more than six feet high, is a tough character in every way. Since few other plants can withstand the extremes of the environment, it dominates the marsh. Each day during summer the tidal marsh is alternately flooded with salt water and baked in the hot sun. In winter, chilling winds sweep it, and the cold waves of the Atlantic Ocean drown it. Incoming tides bring salt water; heavy rains and floods bring fresh water. Surviving this torture, spartina reaps the benefits of reduced competition and grows in abundance.

I wiped a hand across my sweaty forehead, leaving mud in my hair, and got to work on my job in the energy-flow project. Kneeling before a wooden frame thrown down on one experimental square meter, I began to capture fiddler crabs trapped inside. They scurried about, disappearing into the mud to pop up again for another run. The sweat dripped off my nose as I gathered them one by one.

Fiddler crabs, with a density of more than eight million an acre on Sapelo Island, play

*James Cerruti wrote of the laboratory's work in "Sea Islands: The South's Surprising Coast," NATIONAL GEOGRAPHIC, March 1971.

Giant jets roost where marsh creatures flourished before the builders of New York's John F. Kennedy International Airport (above) covered their habitat with concrete. Residential construction also invades the wetlands, as in southern New Jersey (left) where sand fill forms a new real-estate development. Federal and state legislatures increasingly act to preserve the remaining East Coast marshes—some 2,000,000 acres.



an important part in the ecology of the marsh. They consume the algae and food particles in the mud; then, in turn, they serve as food for birds, raccoons, and other creatures that range the marsh.

We watched the female fiddlers work the small pincers on their forelegs, vigorously shoveling food into their mouths, like a small hungry child using both hands on a plate of spaghetti. The male, who has one claw much larger than the other, does not use his large pincer in feeding, but makes do with a single foreleg. A major purpose of his big claw is to lure female fiddlers into his burrow. He sits at the entrance, waving his claw enticingly; if the female responds, they mate.

Spartina Keeps Grasshoppers Hopping

Fiddlers do not eat the living spartina. In fact, only about 10 percent of it is grazed on. One of the grazers is the salt-marsh grasshopper, which finds the grass a lifesaver in more ways than one.

On a later visit to Sapelo, canoeing through the marsh at high tide, I saw that the grasshoppers had climbed up the spartina stems to escape the rising waters, perching like squirrels in a tree. They jumped from stem to stem, inches above the hungry lurking fish. One brave hopper even ventured to swim across the creek, climbed a grass stem, and with a jump disappeared into the jungle.

The spartina leaves that are not eaten eventually die and fall into the marsh. There bacteria and fungi reduce them to organic detritus. The marsh exports great quantities of this detritus to the sea. Georgia's *Spartina alterniflora* marshes produce five to nine tons of plant material an acre a year; Virginia's, three; and Delaware's, two. About half of all this flows into estuaries to nourish the animals of the sea.

Some of the most productive acreage on earth lies untended in our marshlands. Its yield cannot be estimated in bushels an acre or in so many head of cattle, for its ultimate consumption takes place miles from its source of origin. (See the diagrams explaining the ecology of a salt marsh on pages 737-8.)

Are there ways for man to make even greater use of this food-rich detritus? It could become the basis of a new sea agriculture. Biologists have already started raising clams and oysters indoors in their early stages, so they can control breeding, growth, disease, and predators. But, as the shellfish mature, they must be moved to an estuary to feed on



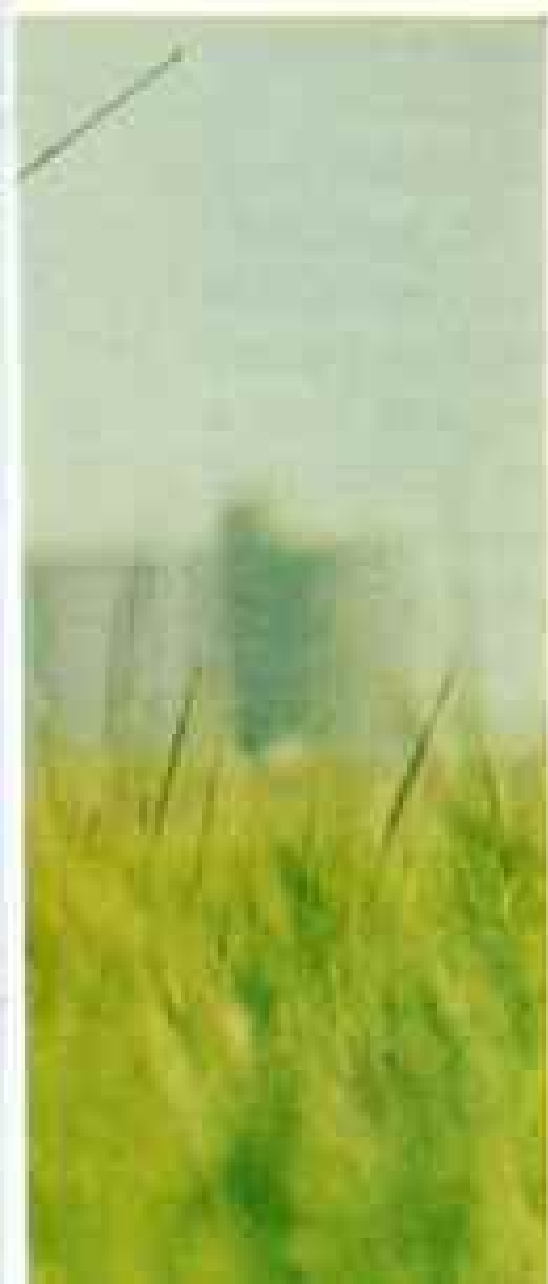
Mud bath aids science at the University of Georgia Marine Institute on Sapelo Island. Biology student Jennifer Jewitt brings up a sample of tidal-flat sediment to determine the types and distribution of marsh organisms.

Underwater at high tide, an adventurous periwinkle (left) rests atop a blade of cordgrass (*Spartina alterniflora*). The algae-eating snail and its kin provide nutrient-rich droppings that bolster growth of the all-important marsh plant.



Snaking seaward through the vast coastal marshes south of Savannah, Georgia, intertwining estuaries catch the first rays of the rising sun. Here, where briny tides rhythmically invade curling creeks and muddy lowlands, thrives the hardy cordgrass—the very marrow of a marsh. The growth traps pollution from cities and farms; much of it decays before reaching the sea.





Bare-backed anglers fishing for flounder, striped bass, and snapper take refuge from urban pressures along a tidal creek in New York's Jamaica Bay salt marsh.

Legislators hope to curb developments that are eradicating wetland acreage in the Boston-to-Washington megalopolis. Representing much of the remaining open space in the populous corridor, marsh real estate commands premium prices—in New Jersey as much as \$110,000 an acre.

microscopic plant life and detritus. Although there can be no more efficient way than nature's, such "mariculture," pioneered by the Japanese, may eventually serve as an additional food source for our own country, provided the salt marsh is preserved.

At present the marsh is man's hunting ground rather than his farm, and one of the most delectable of prey animals is the edible blue crab of the estuaries and bays. The blue-crab world is one of "sooks" and "jimmies," "sallies" and "buckrams," "doublers" and "peelers," "sponges" and "pickers." Each sex, each age, each stage in the life of the crab has a word to describe it.

Just before a sally (young female) molts to sook (adult) stage, a jimmy (male crab) cradles her with his legs. For two or more days these doublers may remain locked together, until the sally molts and backs out of her old shell as a soft crab. Before the female hardens to the leathery buckram stage, she mates for the first and last time in her life.

Odds Against Crab Larva: 1,000,000 to 5

Her courtship usually takes place in the middle of an estuary. The female may not lay her eggs for several months, until she has migrated toward the more saline mouth of a bay, where her young can survive. At that time she produces the egg mass, called the sponge, which she carries beneath her body. The tiny organisms that hatch develop into lobsterlike creatures and make their way into bays and tributaries, where they feed on the bounty of the wetlands—and are fed upon by various fishes. Only about five in a million reach maturity.

Half to two-thirds of the crab commerce of the East Coast centers on Chesapeake Bay and yields six million dollars a year to crabbers there. On the bustling docks at Crisfield, Maryland, I watched crab boats pull up to a covered wharf. The crabbers quickly off-loaded baskets of primes—large crabs for the fresh market—and collected payment on the spot from a big man with a fat roll of bills. As one crab boat pulled away, another came in. Baskets of pickers—crabs to be cooked—went to a seaside factory, and peelers—crabs ready to molt—to the shedding house for the soft-shell trade.*

Water flowed through large shallow tanks in the shedding house. Peelers are held in these until they molt, then they are frozen

*Stuart E. Jones described this industry in "Maryland on the Half Shell," *GEOGRAPHIC*, February 1972.

or packed alive in wet marsh grass, row on row, box on box, thousand on thousand, for the tables of soft-shell fanciers.

Nearby, I saw picker crabs cooking in metal pots six feet in diameter. The roseate delicacies were then spread over long tables, where women in white caps picked out the meat. I asked one of them what she earned. Her fingers flying in tireless rhythm, she told me, "Fifty cents a pound, and I can dig sixty pounds a day."

At the edge of the salt marsh near Crisfield, I met old-timer Carl Tyler, who rears soft-shell crabs in the traditional manner. Floating pens, tied to stakes, rocked gently in the water, full of peelers. Mr. Tyler, grizzled, unshaven, and toothless, tended them with a net. As soon as he saw that a crab had molted, he removed it and packed it in a box—not by thousands, as in the factory, but by tens.

The wind ruffled the marsh grass, and Mr. Tyler leaned on his pole to chat. Inside the shedding and packing houses there was artificial light, and pumped water, and instant freezing, and plastic packages, and efficiency. Here there was the sun, and the breeze, and memories. There was just himself, and the crabs, and the marsh. Enough to keep a man independent.

Lone Clammers Yield to Dredgers

The days when a man like Carl Tyler could make a living with nothing but rubber boots and a muskrat trap or clam fork are passing. In New England, only legal restrictions on mechanical diggers have kept the individual clammer going. In Maryland, escalator dredges exploit vast beds of clams that are underwater even at low tide. The dredges wash the clams from their muddy home with strong jets of water and carry them onto a belt that brings them to the surface. This mass harvesting gives access to previously unavailable beds and provides millions of pounds of clams, with less destruction to the young clams.

But while the man with the dredge finds ever-new sources of supply, the man with the rake sees his prey disappearing, as the beds are worked out and pollution spreads. The

hand diggers of New England, who produced 90 percent of the East Coast's clams 30 years ago, now find that the dredgers of Chesapeake Bay have 75 percent of the market, and are even shipping clams into New England.

Probably the most mechanized of marsh products is the Atlantic menhaden, also known as the bunker, fatback, or pogey, the principal commercial fish of the East Coast. It must spend part of its life in the bays and streams of the wetlands, though it spawns in the ocean. The female releases as many as 600,000 eggs at a time, which float free for two days before hatching. When the young fish are about an inch long, they enter the estuaries and remain in this protected nursery some eight months.

As they grow, the menhaden start the schooling behavior that makes them so susceptible to capture. Most menhaden move offshore as winter comes, and for the rest of their lives will be found in open water.

Big Business in Fish No One Eats

Though the menhaden fishery is concentrated off the mid-Atlantic states, many marshes of other states contribute to the catch. A school taken off Delaware may have been nurtured in a Massachusetts marsh. Menhaden move south in the fall, and young fish tagged in Rhode Island have been found three months later off North Carolina.

Menhaden are not a delicacy for human consumption. They are processed in large plants on shore—cooked with steam, fish oil pressed out, the remainder dried and ground into fish meal for animal feed. Menhaden are truly an industrial fish—in catching, processing, and use. The oil is used in the manufacture of paints, inks, soaps, and lubricants.

In the warehouse of a processing plant at Beaufort, North Carolina, I wandered among great Himalayas of brownish, dusty fish fragments reaching to the rafters. It was very quiet, except for rain drumming on the roof in the dusky reaches far above. No flies buzzed over the dried heaps, and there was only a faint, pleasant whiff of fish. From detritus that drifted from the marshes years before, through vicissitudes of tide and current, the menhaden had made flesh and bone, only to fall prey to a greater predator. Now their remains rested, to be ground into small bits of organic matter, quiet, passive, waiting. It would all come full circle. Detritus to detritus.

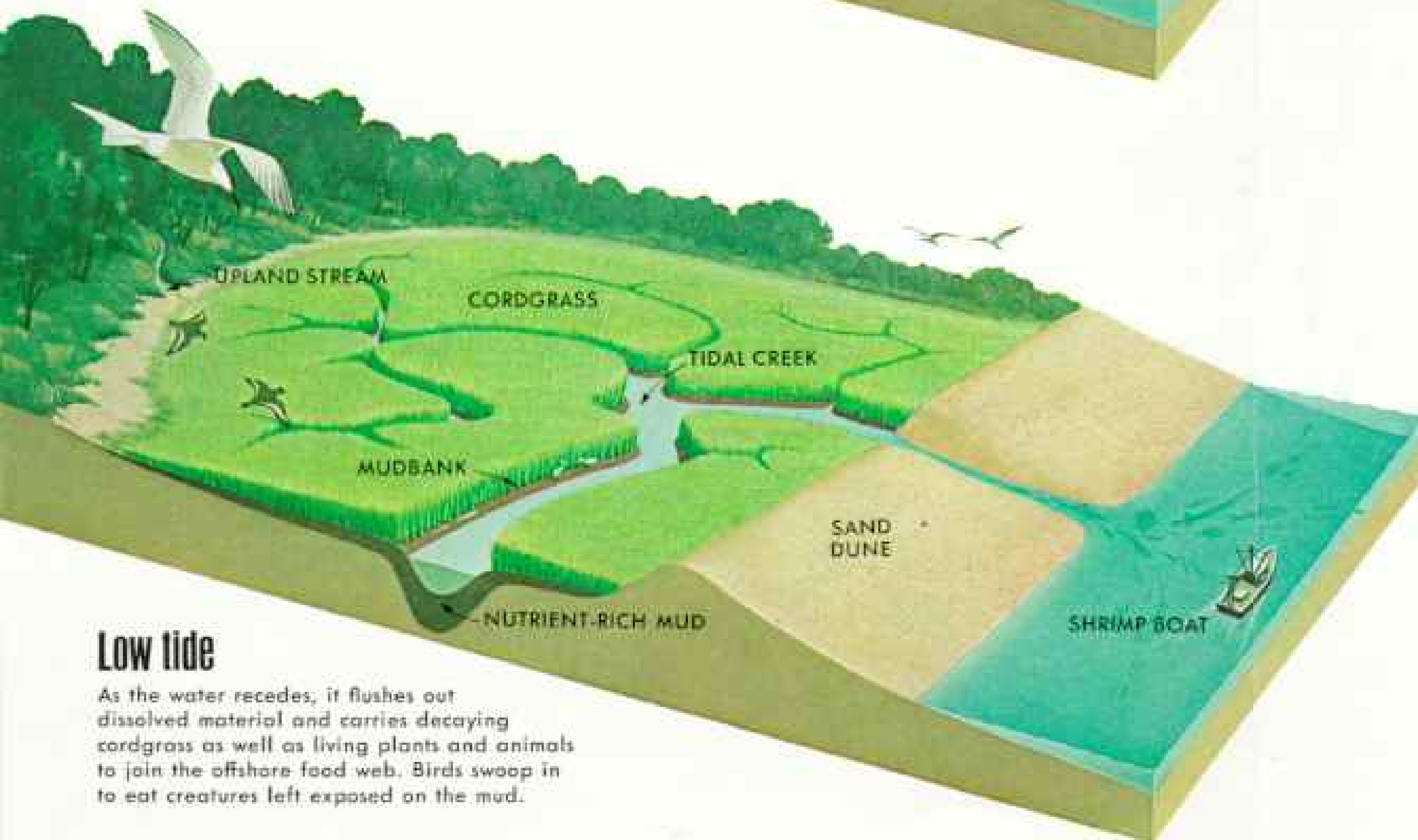
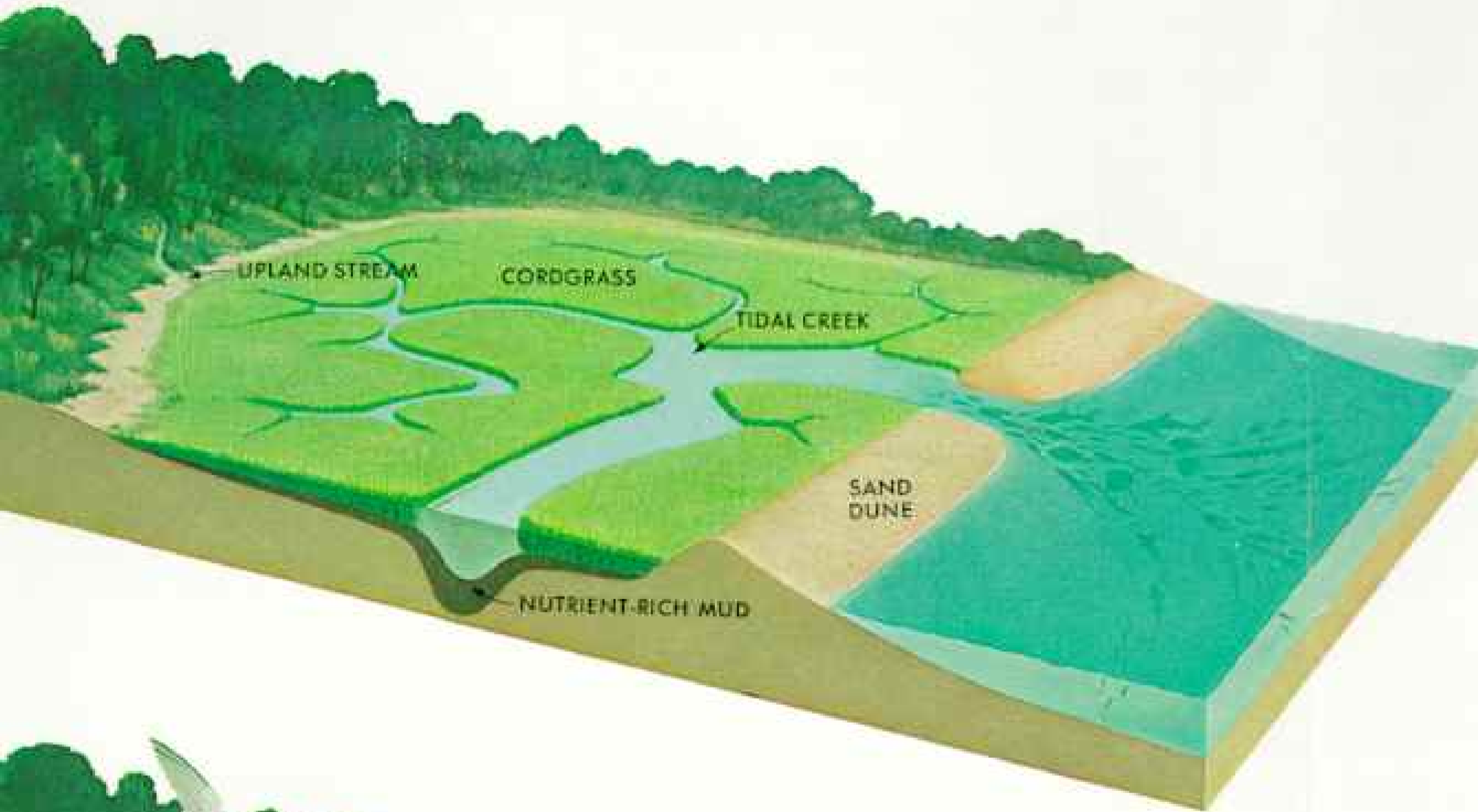
This biological cycle of the marsh is like
(Continued on page 742)

The Author: Dr. Stephen W. Hitchcock's familiarity with his subject begins at his front door; his home in Madison, Connecticut, overlooks a salt marsh. Holder of a doctorate in entomology from the University of California at Berkeley, and now with the Connecticut Agricultural Experiment Station at New Haven, he often roams the marshes to study aquatic insects, his current project.

Daily tides: heartbeat of the marsh

High tide

Sweeping in twice daily, the rising water stirs up nutrients and recharges stagnant pools with oxygen. Ocean fish ride in with the tide to feed.



Low tide

As the water recedes, it flushes out dissolved material and carries decaying cordgrass as well as living plants and animals to join the offshore food web. Birds swoop in to eat creatures left exposed on the mud.

A WEDDING OF LAND AND SEA spawns the salt marsh, a vast pantry on the ocean shore. The marsh begins to form when waves shape sand into offshore barriers; tidal creeks cut through these protective bars, flooding the coves behind them twice daily with seawater. Safe from the battering sea, cordgrass sprouts in the shallows; its dense growth so slows tidal currents that they drop their cargo of silt to form a floor of nutritive mud. The luxuriant grass forests rank among the most organically productive areas on earth, often supporting more life per acre than the richest of fertile prairie land.

Fed by both salt water and fresh, the marsh nourishes myriad creatures of sea and land. Fiddler crabs scoop up algae with their claws. Grasshoppers fatten on spartina leaves and are in turn eaten by birds, spiders, and fish. Anchovies wait for bacteria to turn fallen grass into a fine soup called detritus. The filter feeders—clams and

mussels—strain the soup from the water, along with microscopic plant and animal plankton. These mollusks in turn feed larger creatures. Incoming tides bring striped bass, flounder, and sea trout in search of marsh denizens (left, upper). Many of the large fish return to the sea on the ebb tide, which also flushes out detritus and other nutrients to feed marine life offshore (left, lower). Nearly all the commercially valuable seafood netted in East Coast waters owes its existence directly to the marsh. Thus does this balanced ecosystem become a factory for human food.

Bared by retreating tide, marsh mud serves up its bounty to land-based guests (following pages, key below). Raccoons hunt mussels and crabs in the muck, and a host of birds forage amid the pools and cordgrass.

STAFF ARTIST WILLIAM W. BOND (LEFT); PAINTING (RIGHT); BY STAFF ARTIST BOB W. STEINER

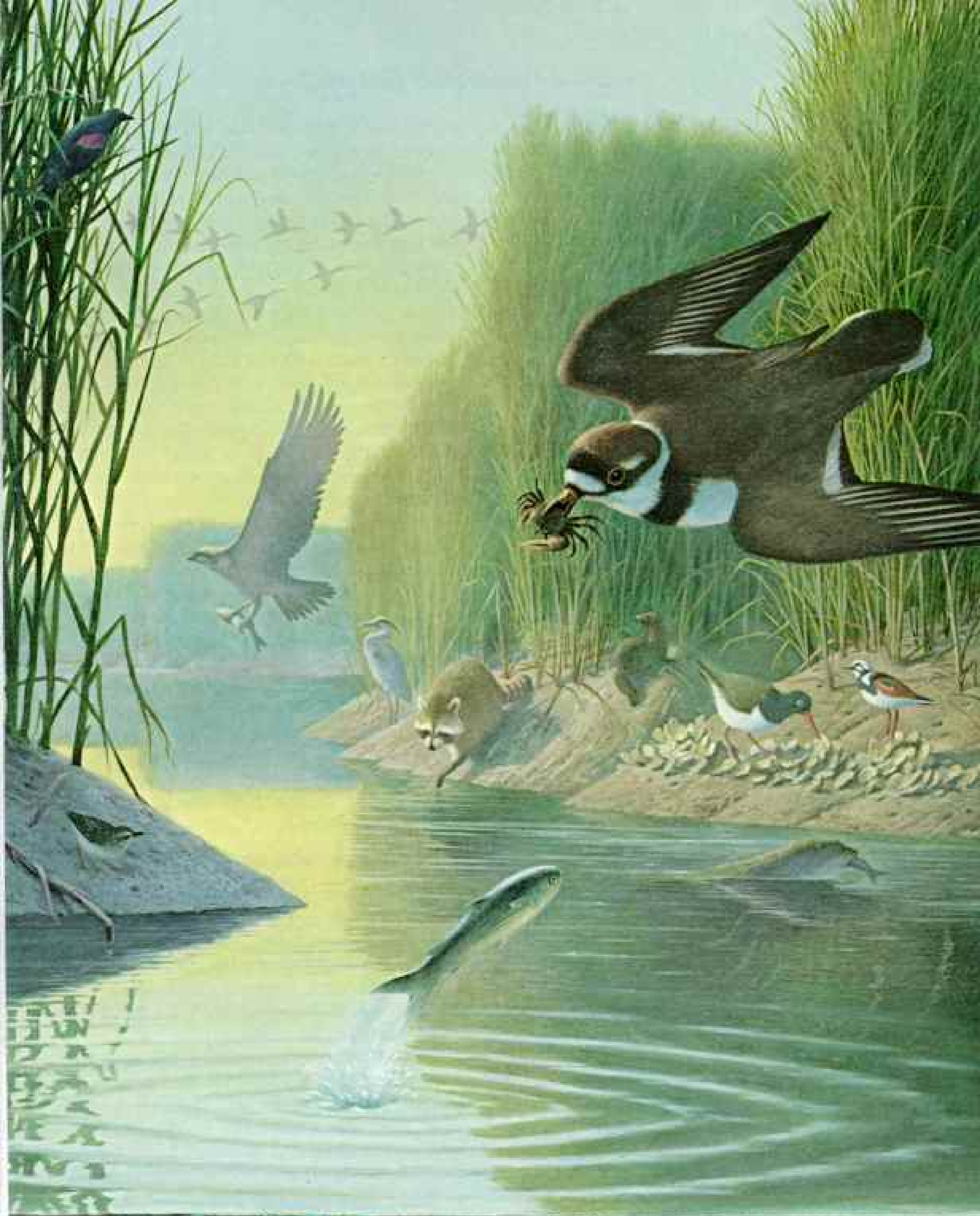


MARSH FAUNA

- | | | |
|---------------------------|--------------------------|----------------------------|
| 1. PURPLE MARSH CRAB | 10. WHITE SHRIMP | 20. RACCOON |
| 2. FIDDLER CRAB (FEMALE) | 11. CLAPPER RAIL | 21. MINK |
| 3. FIDDLER CRAB (MALE) | 12. BLACK-BELLIED PLOVER | 22. AMERICAN OYSTERCATCHER |
| 4. WHIMBREL | 13. GREATER YELLOWLEGS | 23. RUDDY TURNSTONE |
| 5. RIBBED MUSSEL | 14. LEAST SANDPIPER | 24. OYSTERS |
| 6. GREEN HERON | 15. REDWINGED BLACKBIRD | 25. RIVER OTTER |
| 7. MARSH PERIWINKLE | 16. WHITE IBISES | 26. MULLET |
| 8. LONG-BILLED MARSH WREN | 17. SEMIPALMATED PLOVER | 27. SPADEFISH |
| 9. COMMON EGRET | 18. OSPREY | 28. ANCHOVY |
| | 19. GREAT BLUE HERON | 29. BLUE CRAB |



W. M. Seidler



the seconds dial on a watch. The hours dial is the geological cycle within which it occurs. For the oldest, ever-continuing battle of the marsh is between the sea and the shore. The sea has risen as much as thirty feet in the past 5,000 years. The sea gnaws at the shore, but the roots of spartina and other marsh plants that colonize the mud flats barely above the ocean's reach at low tide anchor the shifting mud, and their stems catch the drifting silt. Gradually the surface builds—less than half an inch a year, but enough to equal the rise in sea level.

Dunes Form a Protective Barrier

Dr. Robert Byrne of the Virginia Institute of Marine Science at Gloucester Point is a historian of this warfare. Tanned, mustachioed, wearing a sailor cap, he spread maps on the ground to show me the field of battle. His finger traced the thin dark line separating land from water along the Virginia coast.

"Marshes can't grow unprotected on the open coast. They need sand dunes or beach to break the force of wave and storm. The marshes, in turn, act as defense works to protect the inland areas from the direct erosive powers of the storm waves. Barrier islands protect more than half of Virginia's ocean coastline. But erosion is still great, and the sea breaks through the barriers, changing the flow in the lagoons and smothering the productive mud flats. Since 1852 at least 17 square miles of marshes along Virginia's shore have been lost."

He pointed to a spot on the map labeled Hog Island, off Virginia. "That was once a thriving community, but coastal currents gobbled up fifty feet a year. People finally had to abandon homes, businesses, the cemetery to the oncoming Atlantic."

Sand carried away by the sea's attack is generally deposited elsewhere along the shore. But this is small consolation to former residents of Hog Island.

I traveled with Dr. Byrne and his assistants as they took measurements of this ceaseless

flux between land and sea. On one beach he showed me where a storm had broken through the dunes and spread a delta of sand over the marsh, smothering plants and animals caught in its path. In the lagoons behind the barriers, the marsh grasses built anew.

As the waves push the dunes back, they may expose beds of peat, remnants of old marsh, on the beach. These once-flourishing marshes were covered with sand, compressed, and then uncovered, only to fall victim to the sea. It is a familiar contest. Individual marshes may be ephemeral, the survivors varying in age—those of New England perhaps 3,000 years old, those of Virginia about 1,000—but they represent the continuity of the battle between ocean and land.

As I moved north along the coast, the high marsh, that area flooded only by occasional high tides, took on a different appearance. The dominant grass became narrow leaved and fine, and lay over in broad swirls.

This is *Spartina patens*, a cousin of *Spartina alterniflora*. Called salt hay, it provided sustenance to the foraging cattle of early colonists, and is in demand today as mulch for gardens and strawberry beds. In southern New Jersey farmers manage thousands of acres of high marsh to produce tons of baled salt hay for shipment all along the East Coast (page 753).

Hay Farmer "Whupped" by Bay Water

On the farm of Glenn Robbins, harvest was in full swing. The marsh quaked underfoot as his tractors, balers, and wagons coursed the meadows. He showed me dikes built to keep out the sea. Sluice gates in each one allowed him to let fertilizing tides flood the meadows when he wished.

We paused at an abandoned dike near the open water. It had been breached, and sand had flowed through the gap. "Nobody knows what work I've done," Mr. Robbins said. "I built and built, but it wouldn't hold. I even used wire fence to catch debris, but it wouldn't

(Continued on page 755)

Tidal-creek tenement: Barnacles glue themselves to the shells of mussels near Kennebunkport, Maine, and periwinkles stroll across the barnacles, seeking algae. All add grist to the food mill with their larvae. Superbly camouflaged, a yearling flounder lies motionless, alert for small shrimp. Secure from deep-water enemies, the six-inch predator may have grown in quiet backwaters of the marsh, as do many ocean fishes. Before the flounder was an inch long, its left eye migrated to the right side of its head, allowing full vision while lying flat.



Ghostly grazer, a two-inch sand shrimp munches on a cloud of sea lettuce—a form of algae—in a New England marsh (right). Nurtured by sunlight in the shallow pools, verdant pastures of algae join cordgrass as the major sources of food in the Nation's wetlands.



Nature's disposal system removes a dead anchovy; drifting with the tide, a sand shrimp scavenges a meal. The armored hunter feasts on both plant and animal matter until another predator—perhaps a skate or ray—comes along to gobble up the little creature. The adults of larger, commercially valuable shrimp live and spawn in the sea, but the marsh serves as a nursery for their young.









Rubbernecking towhead, a Louisiana heron chick peers from its nest on the Virginia shore. The 20-inch-high youngster will soon join its parents in snatching small fish and crustaceans. Millions of birds, including those migrating along the Atlantic flyway, use the marshes as feeding grounds.

Packaging its prey, an orb-web weaver wraps a grasshopper in a silken shroud. The spider caught the long-horned jumper feeding on a blade of spartina. Grasshoppers, abundant in the salt marshes, provide a juicy feast for a host of finned, feathered, and web-spinning predators.



Jellylike meadow offers plentiful fodder for a quarter-inch-long grazing snail near Kennebunkport, Maine. The miniature pasture materialized in a stagnant pool as live bacteria and algae developed the gummy sheaths that enclose them. Fungi or bacteria



form the powdery pink "frosting." Gases released by microorganisms at the bottom of the marsh create the bubbles trapped in the translucent slime.

To stay alive, fungi and bacteria—simplest forms of life in the wetlands food cycle

—consume dead cordgrass. Thus these microorganisms perform one of nature's most important functions; they break the spartina down into the detritus broth that spreads throughout the marsh and supports the animals unable to eat the grass directly.





Dawn of a marsh: From a single stalk of *Spartina alterniflora* may spring a meadow of waving cordgrass. In briny ooze that kills most land grasses, runners quickly spread, transforming a barren mud flat into a bustling community.

Amid watery silence, life-giving rhythms maintain a flow of energy. As high tide stirs detritus from dying portions of spartina, half-buried mussels pump the nutrient-laden water over their gills. Contributing their own waste to the silted floor, the mollusks nourish the plants in return. The periwinkle scaling the spartina feeds on algae that have also been fertilized by decaying plants and animal waste.



Bleeding salt from leaf pores, *Spartina alterniflora* maintains the chemical balance that permits its survival in baths of seawater (opposite page). Specially adapted glands discharge excess salt that enters the coarse grass through its roots.

A finer, shorter species, *Spartina patens*, covers silt-filled areas that are reached only by the highest tides. Thriving where other land plants fail, it finds



popular commercial use as a garden mulch. Seaboard pioneers pastured stock on the meadows until other grasslands were developed. Near Port Norris, New Jersey, salt-hay farmer Austin Berry (left) inspects a crop that wind has pushed into swirls like the cowlicks of a youngster's hair.

Sluice-gates regulate the flow of water. The soggy field produces a heavy harvest that farmhands load onto a drag pulled behind the baler (above). Attempts at diking more wetlands to farm salt hay in the 1960's damaged about 4,000 acres of marshland by disrupting the normal flow of seawater.



Squirming harvest fills the buckets of worm diggers on coastal mud flats of Maine. Sport fishermen seeking bait buy the eight-inch bloodworm and longer, softer sandworm (left). Both wear fringes of oarlike parapodia that assist in breathing and locomotion. About 1,200 diggers seek their fortunes in the mud, an enterprise that in 1971 grossed Maine diggers and packers some 5 million dollars.

Four hours of stooping labor in foot-sucking slime may bring a steady digger \$40 at a dealer's counting shed. Worm merchant Frank Hammond (left) examines part of a day's haul before it is packed in seaweed for shipment to bait shops on both East and West Coasts.

hold. I fought the bay water like a man, but it whopped me."

Another dike, 150 yards back of the breached one, had intercepted some of the fury of the storm, and behind this dike lay Mr. Robbins's fields of salt-marsh hay.

"When I first started working on the marshes—45 years ago, when I was 14—all the farmers round here used to have a patch of salt hay," Mr. Robbins said. "In those days we used horses to pull mowers and wagons over the marsh at harvesttime. Had wooden clogs on each hoof, but still some mired down and had to be dragged out."

Salt hay can be harvested even in winter, but winter storms and ice are something to contend with. Mr. Robbins pushed back his weathered straw hat and said, "My father came down to help hay one winter; we even hayed on Christmas Day. The marsh was froze up hard as a bullet. A big tide came and washed our hay into the creek."

Besides the useful salt hay, the high marsh produces the vicious salt-marsh mosquito (*Aedes sollicitans*). The female of the species requires a meal of blood before she can lay eggs, and she flies to the residential uplands near the marsh to obtain it. The battle to reduce this nuisance has absorbed the energies of several generations of men.

Ditches Let Predators Reach Their Prey

Aedes sollicitans lays its eggs in dry depressions of the high marsh, which ordinary tides never reach. When rain or extra-high tides flood these low spots, the eggs hatch. Then, as the water recedes, it leaves small pools turned black by thousands of floating larvae, but devoid of predators that swim in and out with daily tides. Safe from their natural enemies, the larvae mature and go forth to plague wildlife and man.

In southern New Jersey I joined Fred Ferrigno as he knocked short stakes into the marsh in various esoteric patterns. "The stakes are to direct the ditchdiggers who'll come along later," Fred told me. "The ditches will link the pools with tidal streams and allow small predatory fish to come in and snap up the larvae. Where we can't do this, we dig deeper pools that will support live fish, even when the small pools dry, and so keep predators present all the time.

"Many of the old systems of ditching in routine grid patterns wasted money and

wrecked the marsh. This is not the old type of ditch. We are trying to establish physical control that will eliminate the use of chemicals. This will both save money and prevent contamination of the food chain.

"Chemicals are no measure of progress. When the breeding area here is eliminated, we will not only have banished the mosquitoes, we will also have freed 16,000 acres of marsh and parts of Delaware Bay from contamination by insecticides."

Progress in mosquito control is often wrongly measured in miles of ditches or pounds of insecticide, not in long-term reduction of mosquito larvae. Man hopes of course to win the battle, but surviving mosquitoes offer a stubborn challenge.

Salt Hay Grows in Digger's Wake

Fred's work is confined to the high marsh where *Spartina patens* grows. The low *Spartina alterniflora* marsh that floods with each tide requires no treatment.

"We need to go over every foot of high marsh to check mosquito breeding and lay out ditch lines. In unditched areas, we want regular surveys to determine when adult mosquitoes are due to emerge. Then, if necessary, we can spray to give temporary aid, but we should be phasing out chemicals."

A monstrous, clanking green machine approached as we talked. This was the ditch-digger, and the marsh trembled under its giant caterpillar treads (pages 758-9). Twice the height of a man, it looked like an over-size snowblower as it scooped mud and turf from the marsh and cast it out in a swath twenty feet wide. In its wake the digger left a ditch running with muddy water, pervaded by the stench of hydrogen sulfide, a gas released by decaying organic matter.

Unlike other ditchdiggers, the green monster left no row of turned-up turf at the edge of the ditch to act as a dike, or as mounds on which less desirable plants from outside the marsh might grow.

"Within three weeks," Fred told me, "the hay grows up through the mud thrown over the marsh, and in a year it's difficult to tell that the marsh has ever been disturbed."

The machine roared and clattered. The marsh shuddered and quaked. Fred gathered an armful of stakes and bent to his work again.

Man pursues the mosquitoes in earnest, but he pursues the birds for fun. Pity the

fiddler crab gulped down by the bird. Pity the bird gunned down by the man. Pity the man when the marshes and the birds are gone.

If one bird had to be chosen as representative of the salt marshes, I would nominate the clapper rail (page 728). This gray-brown creature is a popular target for the hunter's gun. One hunter told me of his advice to neophyte rail hunters: "Go down on the marsh, and if you see a chicken, shoot it."

Rail Rebuilds If a Storm Destroys Its Nest

I came on the nest of a clapper rail while exploring Sapelo Island in Georgia. The female rail, with either consummate bravery or stupidity, stayed close by while I examined her nest in the marsh grass. The eggs, large and speckled, were once gathered for food. Audubon, in 1840, recorded that it was not uncommon for a person to collect a hundred dozen eggs in a day.

Contrary to legend, the nest of the clapper rail does not float up and down with the tide. Spring tides and heavy storms destroy many nests, but the rail, as if in perfect faith that the meek will inherit the earth, rebuilds her nest, lays more eggs, and continues her quiet and prolific course (page 760).

Waterfowl coming down the Atlantic flyway from as far north as Greenland and

Labrador rest or winter in the marshes that band the sea. From Delaware southward, ducks and geese funnel in, and men still shoot them. But it is not like the old days.

Once upon a time a market hunter could support his family by selling his feathered victims. An early writer, commenting on the numbers of waterfowl, said, "The rivers... are covered with flocks of Wildfoule... in such abundance as are not in all the world to be equalled." Except for a few species, the great flocks are gone, their habitat narrowed and polluted.

Still, there are ways a man can make a living off the marsh. Worms, for example.

I stood on a knoll in an old cemetery at Wiscasset, Maine, overlooking salt marsh and mud flat. Nearby was the home, office, warehouse, packing shed, and counting house of Frank Hammond, who deals in the most valuable animals on the East Coast. More costly a pound than lobster, crab, or fish are the lowly bloodworms and sandworms, the fisherman's premier bait. If sold by weight rather than by number, these worms would cost from six to nine dollars a pound retail. Mr. Hammond carries on all of his worm business in his home. His office is a desk upstairs, and his packing and warehousing operation occupies the basement.



Eyes aloft on slender stalks, a female fiddler crab watches marsh life from cordgrass bleachers. Well-equipped for its half-wet, half-dry existence, the fiddler has a primitive lung, as well as the gills common to all crabs.

Like a general reviewing his troops (right), a four-foot alligator surveys a herd of fiddlers from a marsh creek in Georgia. The reptile does not eat the inch-wide crabs, but where they come to play it lies in wait for the raccoons, terrapins, herons, or clapper rails that are sure to follow.





Bloodworms occur down to 1,400 feet in the ocean, sandworms down to 500, but diggers harvest them exclusively on the intertidal mud flats that adjoin the salt marsh (page 754). As the tide recedes, the worm harvesters follow it, digging a trench to low-water mark, and then, as the tide returns, they work back up ahead of it.

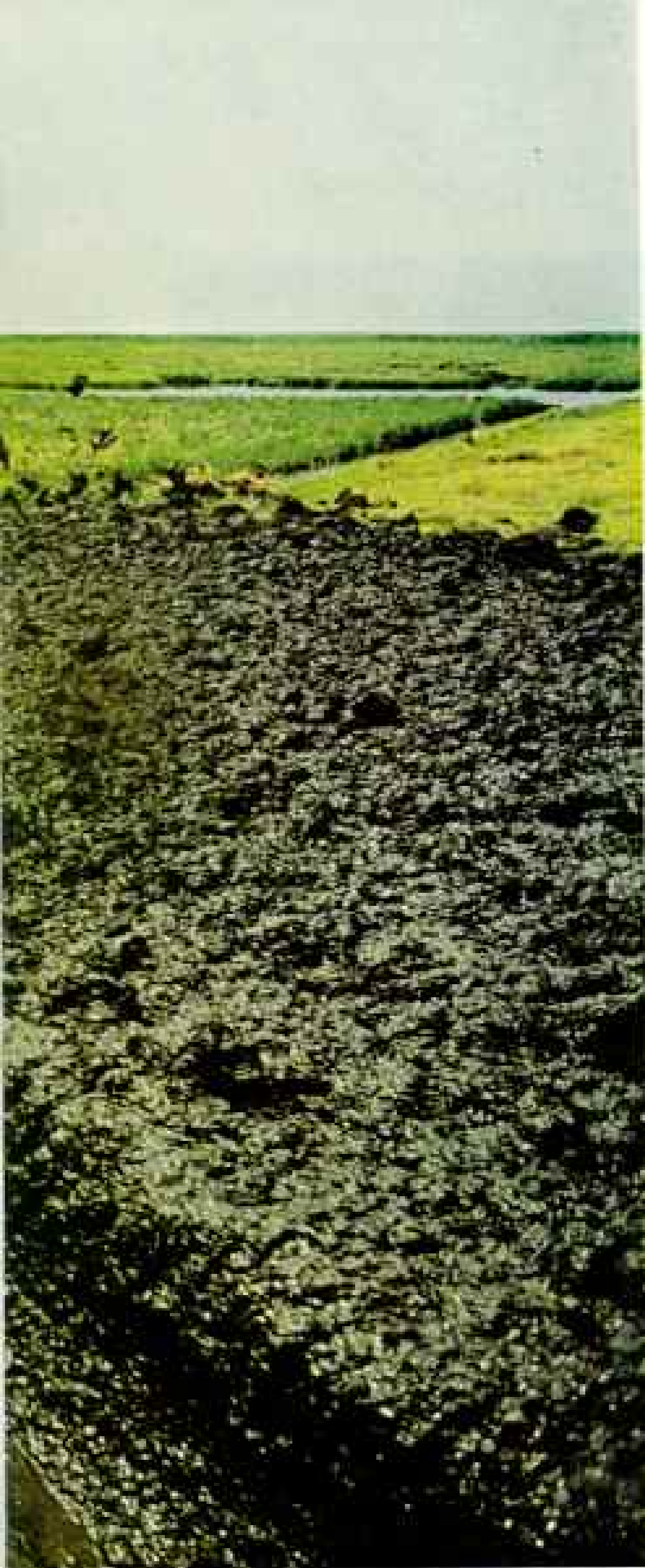
They bring their worms to dealers like Frank Hammond, who has them counted, sorted, and packed for shipment. Mr. Hammond and the five other worm dealers of Wiscasset ship thirty million worms a year, some even to the West Coast, which qualifies Wiscasset as the bait-worm capital of the country.

Unlike the demand, the supply of worms is not inexhaustible. "Ten years ago there were

200 diggers; now there are 1,200," Mr. Hammond said. "Worms are being dug in twice the area, twice as deep, but finding a bucketful now takes twice as many men, and half again as many hours. Twelve years ago a man could dig 1,200 on a tide; now it's about 500 per tide. Maybe by 1980 I'll be buying from Nova Scotia."

Counting the Catch Calls for Silence

We went into the basement, a low, dank room where men worked in eerie silence. Wide benches lined three walls, and at each bench the diggers were counting their daily catch. Bulbs lighted the counting area. Worms squirmed in tangled mounds on enameled pans. A fast jiggle of the hand, and a digger



Birth-to-death enemy of mosquitoes, an adult dragonfly (above) poises on a broken stem of cord-grass before resuming pursuit of its winged prey. In an earlier growth stage, dragonfly nymphs avidly dine on mosquito larvae.

Man joins the biological battle against mosquitoes on a Delaware Bay marsh (left). Rejecting insecticides, workers instead dig canals to link mosquito breeding places with tidal creeks so that fish can swim in and eat the larvae. An eager candidate is the little killifish (below), a prowler of the shallows that dotes on larval mosquitoes.

separated worms from the pile. Then his hands flew rapidly, pushing small worms to one side, counting only the larger ones.

State inspectors check periodically to ensure an accurate count. A sign on the wall said, "PLEASE, no unnecessary talking while anyone counting, a mistake of one worm could cost me \$100 fine."

One by one the diggers finished counting and chatted in hushed voices, while one man counted on and on. Finally he was done. Two thousand one hundred and ten worms. At 4 cents each, they'd bring him \$84.40, and the sun was still high in the sky.

"Everyone thinks he can get rich digging worms," explained Frank Hammond, "but this man might have started digging at 6 a.m.,



As if counting its chicks before they hatch, a wary clapper rail keeps tabs on seven speckled eggs (right). The cordgrass nest, situated in a Georgia marsh, may suffer from inundation by spring tides. The precocious hatchlings will escape drowning by trailing their parents to higher ground when the sea surges into the lowlands.

Snuggling "muskmice" (opposite), eyes still closed, sun on the "front porch" of their house in a Connecticut salt marsh. The parents preened nearby, disregarding the photographer. Muskrats may breed three times a year, producing from three to a dozen or more kits a litter—a boon to predatory minks, hawks, and men.

Duckling armada follows the leader on a food-hunting foray. The black ducks nest in the tidal marshes amid a bounty of snails, mussels, and vegetation.







Stranded by ebb tide while gathering cordgrass samples, researcher Irving Mendelsohn (above) mucks his way back to a boat manned by Jim Mercer, a colleague at the Virginia Institute of Marine Science. A trap for the unwary, daily tides vary in range from 20 feet in Maine to as little as a foot in Florida.

Death means life for a black vulture, here staking its claim on a deer carcass (opposite). Left by the tide after having met death from an unknown cause, the decomposing mammal will provide nutrients for other marsh creatures whose lives are also ruled by nature's remorseless cycles.

depending on the tide. That means he left home at 4:30 a.m. and quit digging at 10 a.m. He also had to drive about a hundred miles. It's hard work digging worms, and even experienced men may get only half the number this man has."

It is to Frank Hammond's economic advantage to keep the marshes the way they are. But many other people with an economic stake in the marshes wish to modify them in multifarious ways: for agriculture, boating, filling. Most of these ways are incompatible with nature and with one another. And where conflicts occur, lawyers appear.

"Marsh Lawyer" Plans a Battle

Alfred A. Porro, Jr., of Lyndhurst, New Jersey, is a specialist in what might be called marsh law. I saw him in his paneled office, surrounded by books on science and law. Phones rang, secretaries rushed in and out, clients demanded attention. Porro rubbed his hand across his balding head down to the long hair curling over his collar, leaned back, and contemplated a fish tank against the wall.

"Man is outwitting himself," he said. "Technology has taught us to conquer, and many marshes have lain undisturbed only because man at first couldn't modify them. Now wetlands are prime areas for development—for housing, recreation, industry. Scientists say, for nature's sake—and for man's sake—don't blacktop it all. The scales must tip in favor of conservation and restoration. Land for development must be found elsewhere."

Nowhere are these conflicts of interest better exemplified than on the Hackensack Meadows, a few miles from counselor Porro's office. These marshlands sit in the midst of a booming industrial area where smoke and steam rise into the air, cars crowd the highways, and machinery roars and clatters in a hundred factories. Yet most of the Meadows seem remote from man, except for an occasional helicopter spraying mosquitoes. Thousands of acres of tidal marsh are here, becoming more valuable by the minute, as much as \$110,000 an acre.

New Jersey wants to save almost all her tidal wetlands, and has passed a law to that effect. *Almost* all her wetlands. The bill specifically excludes the Hackensack Meadows. In order to build a sports complex and racetrack there, the state is claiming jurisdiction over several hundred marshland acres. In an improbable alliance, both private developers, who have been paying taxes on





Monster of the marsh: Rusting, half-submerged car hulk dramatizes man's unthinking destruction of one of his most essential natural resources. Scientists believe there

these acres, and conservationists, who wish to preserve the Meadows, are now arrayed against the state. Watching with interest is the borough of East Rutherford, which thought it had jurisdiction over part of the Meadows, and the Meadowlands Development Commission, which had formulated an elaborate plan for the whole area.

I sat in a meeting counselor Porro called to plan strategy for the coming battle of the Hackensack Meadows. Around a long wooden table sat scientists, conservationists, lawyers. I reflected that the future of the flounder depends not on fishermen or predators or the tides, but on men sitting far inland in offices and government buildings.

At the conclusion of the meeting, Al Porro invited us on a trip through the Meadowlands salt marsh. As our boat left the dock on the Hackensack River and headed up a tributary, we felt somewhat like actors in a soap opera. Can a salt marsh find happiness on the outskirts of a big city?

We rounded the first bend. Factories, trucks, and civilization dropped behind. Red-winged blackbirds teetered on tall reed grass. A green heron flushed out ahead of us. More than two hundred bird species have been identified on the Hackensack Meadows. In the short time we were there, cruising about in a motorboat, we saw nearly a dozen. The Meadows are, however, just as important for



may still be time for public concern and enlightened legislation to halt the wetlands' march to oblivion.

people as they are for birds—one of the last open green spaces in the metropolitan area.

Our boat rounded another bend, and we could see a section being filled for industry. A giant dragline had dredged out mud and peat, leaving a large elongated hole. A procession of trucks dumped a mountain of gravel at the edge. A bulldozer filled in the hole with the gravel, and packed it solid. Builders, hardly able to wait until the gravel had settled, were ready with concrete blocks to begin putting up the walls of sprawling factories.

Once developers had to drive pilings deep into the marsh to hold up their structures, and the expense and uncertainty made extensive building unfeasible. But now man can force

the marsh to submit, and nothing will separate the factories of New York from the factories of New Jersey.

Another turn in the meandering tidal stream, and reed grass reached over our heads to conceal the world again. Reed grass will not grow in water as saline as the sea, but thrives in brackish water, where salty water mixes with fresh. Cedar stumps showed through the mud. The trees had stood at the marsh's edge, until encroaching wetlands killed them. More evidence of a rising sea.

Where the remains of an old garbage dump showed through an eroded bank, three people were crabbing from a boat. For the first time in twenty years, blue crabs were being found on these shores. Why? Had the pollution at the mouth of Newark Bay momentarily lessened to allow the crabs to migrate in? No one knew, but seldom had such large delicious crabs been taken.

The Marshes Are Surviving, But . . .

Ashore once more, we motored past the factories that are supposed to bring prosperity and low taxes, but don't always. At the end of the road, a reeking county dump flowed over the marsh in a tidal wave of paper, orange peel, and broken dolls. We slogged through piles of dredged mud to gain the forward wedge of the refuse. This garbage was another filling operation in action: The same pattern of dredge, dump, cover, and compact was being followed.

The project is a fortunate one, county officials feel. Four hundred loads of garbage a day come in; if an incinerator were installed, the county's cost per load would double. The bulldozer pushed trash over the face of the dump, while more trucks stirred up dust as they deposited their loads. Blackbirds sang happily in the nearby reeds. And the bulldozer came closer.

Such contrasts epitomize the war of the salt marshes everywhere. Tin cans rusting in the water and a white egret against the sky. The smell of a sea breeze and the stench of a pulp plant. The roar of a bulldozer and the splash of a feeding fish. A thousand pounds of oysters and a thousand pounds of trash. Steamed clams and beer, summer sultry hot, canoes on the tide, clammers, dredgers, sweat, mussels, reeds, salt, and survival.

Yes, the marshes are surviving, but in too many places, only barely. And yet, if we all awaken to the danger, it is not too late to save them. □

APHRODISIAS

AWAKENED CITY OF ANCIENT ART

By KENAN T. ERIM, Ph.D.

PROFESSOR OF CLASSEN, NEW YORK UNIVERSITY

Photographs by JONATHAN BLAIR

IN TEN SUMMERS of rewarding work at Aphrodisias, a great ruined city of the Greco-Roman age in Turkey's Anatolian uplands, I have learned that past and present often merge. For example, as we excavated the city's agora, or marketplace, we came upon some 300 fragments of inscribed stone panels. Fitted together like a giant jigsaw puzzle, they proved to be exactly what Americans find posted in neighborhood supermarkets today—a table of fixed prices.

In A.D. 301, runaway inflation had threatened to destroy the economy of the Roman Empire. To deal with this situation so closely paralleling that of our own era, the Emperor Diocletian froze all prices. It was his edict, and the prices he established, that we discovered in the agora of Aphrodisias. The roster of items is exhaustive, including commodities as varied as melons and marble, kerchiefs and cattle. Violations of the edict drew severe penalties, even death.

Diocletian listed the prices in denarii, a monetary unit virtually impossible to define in modern terms. One reason, all too familiar in the light of today's restless world economy,

stems from the fact that, in this period of Roman history, the value of gold and silver rose steeply in relation to the coinage.

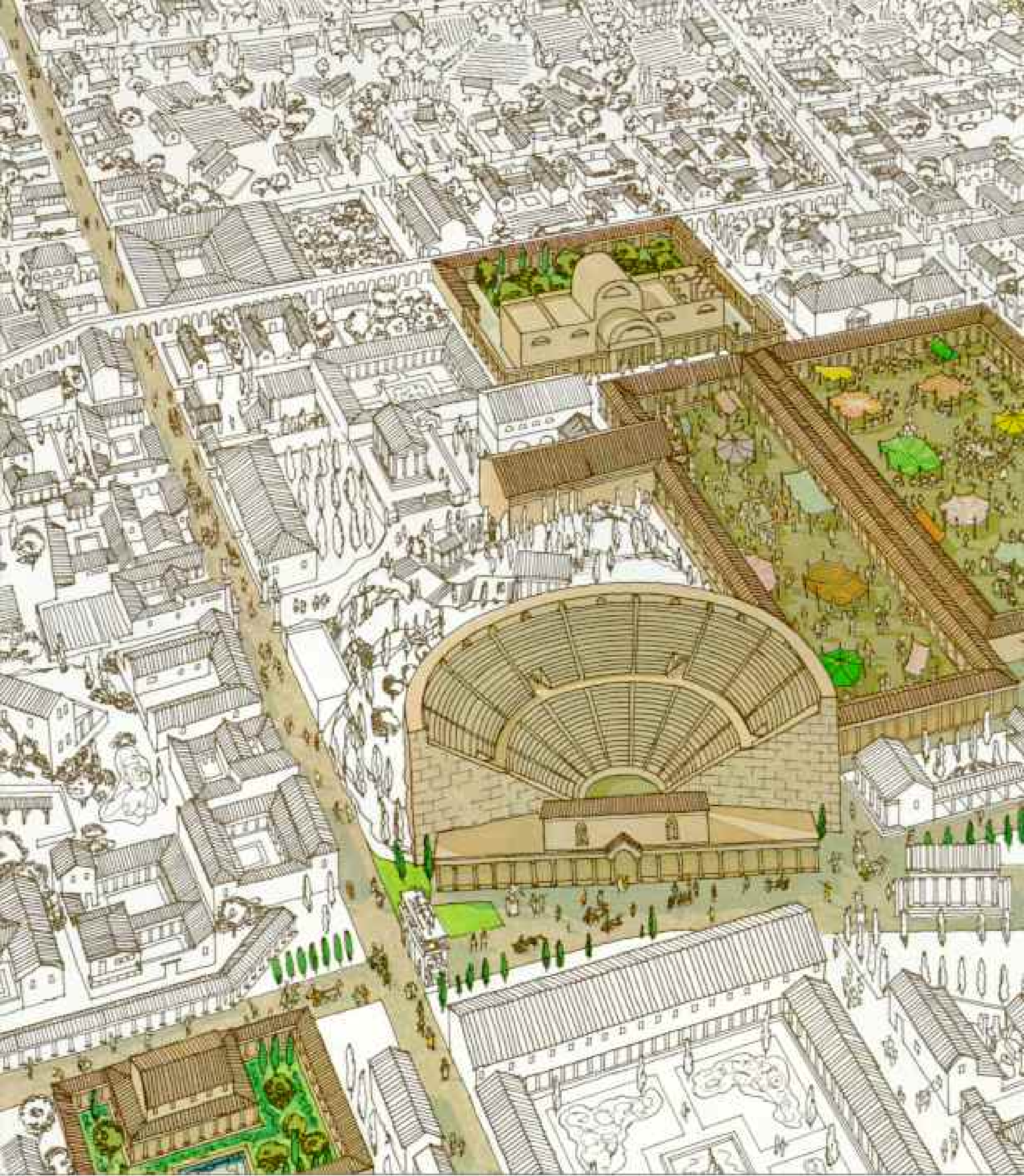
Diocletian tried to remedy that situation in yet another startlingly familiar fashion: He devalued the denarius. His proclamation, fragments of which we have also found in the agora, castigated profiteers and speculators: "Raging greed blazes on without limit and, with no respect for mankind, races after its own gains and profits not only every year, month, and day, but almost by the hour or minute. . . . The sole desire of these insatiably greedy men is to disregard completely the public good."

Just about the time this inscription came to light in 1970, Turkey devalued the lira. When Prime Minister Süleyman Demirel proclaimed the measure, his denunciation of speculators echoed almost exactly the words of Diocletian 1,669 years before.

At Aphrodisias we have unearthed a treasure trove of the ancient world, including some 15,000 coins and countless potsberds. Some 200 statues of extraordinary beauty prove that sculptors of the Roman age, far

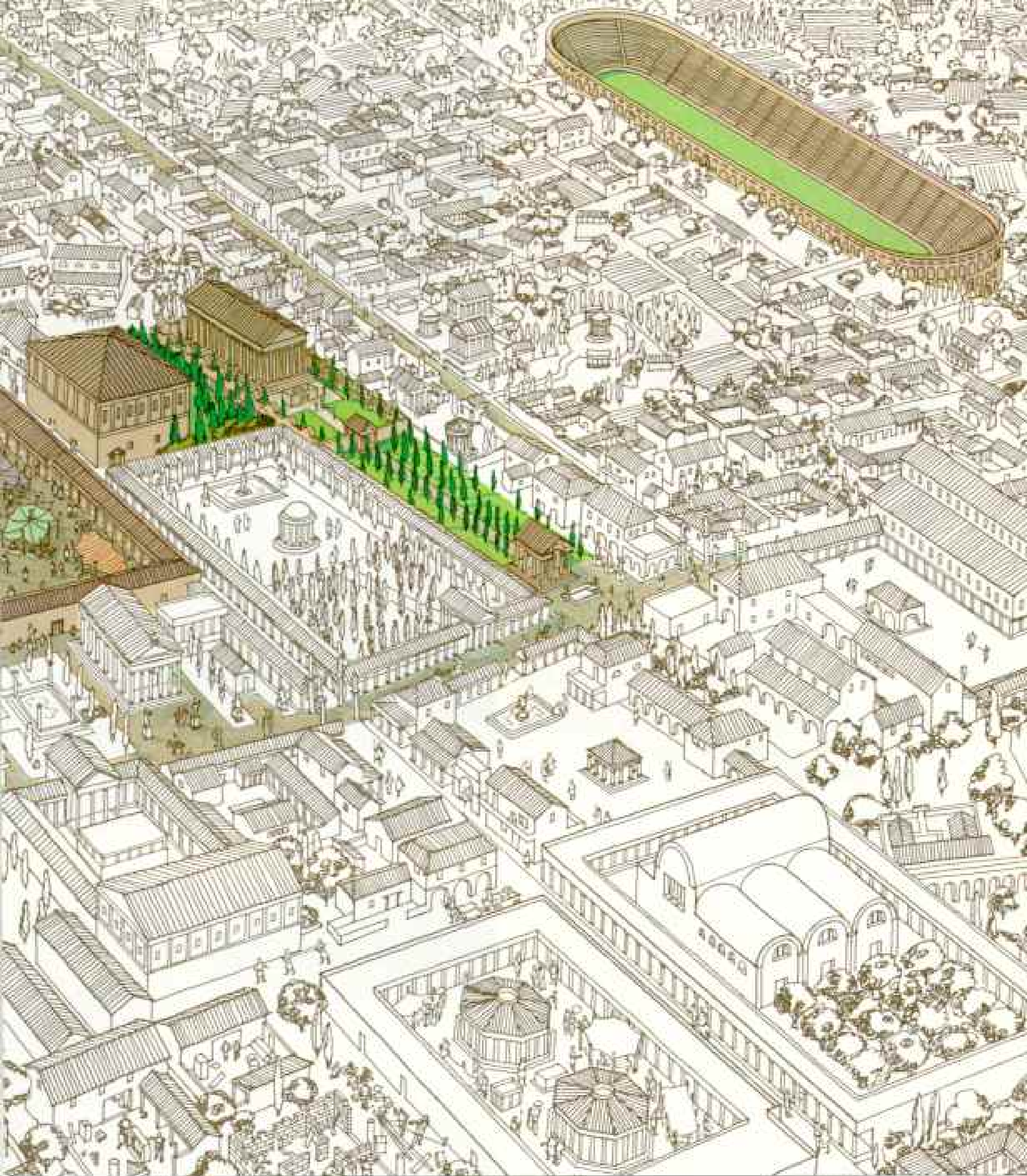
Citizen in stone attests to the genius of a lost city's sculptors. The headband identifies the 4th century A.D. figure as a high priest of Aphrodite, whose cult thrived in Aphrodisias for centuries. Aided by National Geographic Society grants, the author has unearthed a dazzling array of artistic and architectural treasures from this ruined metropolis in southwestern Turkey.





At the height of its glory—late in the second century A.D.—Aphrodisias knew few rivals in Asia Minor. The city's opulence speaks eloquently from ruins already excavated, shown as tinted areas. Colonnaded building at lower left may have been a school. A cockle-shaped theater echoed with the

dramas of Sophocles, while behind it pulsed the agora with its gaily canopied stalls. Vaulted roof marks luxurious Roman baths. The odeon, or concert hall, stands to the right of the agora, and next to it the columned Temple of Aphrodite. The oblong stadium at upper right could hold



STAFF ARTIST ROBERT W. NICHOLSON

the city's entire population, estimated at 30,000.

Lying inland (right), safe from attacks by sea, Aphrodisias thrived successively as a Bronze Age, Greek, Roman, and Byzantine center before succumbing to a series of earthquakes and to the raids of 12th- and 13th-century invaders.

Aphrodisias, Awakened City of Ancient Art



Mediterranean Sea

from merely copying Greek originals, as scholars have so long believed, had a high and original artistry of their own.

Hundreds of inscriptions afford new insights into the history of Anatolia in Roman times. One in particular, a letter from the Emperor Augustus, underlines the great importance of Aphrodisias in antiquity. "I have," declared Augustus, "selected this one city from all of Asia as my own."

Beloved of the emperors, protected by the legions of Rome, Aphrodisias experienced its golden age early in the Christian Era. Dedicated to Aphrodite—goddess of life, fertility, and love—the city reveled briefly in wealth, art, and beauty.

FIRST VISITED Aphrodisias in 1959.* Eager to undertake an excavation in my native Turkey, I had come to scout a suitable site. Since my student days, Aphrodisias—reputedly the home of a school of sculptors whose work was prized throughout the Roman Empire—had haunted my imagination. An expedition under Frenchman Paul Gaudin had dug briefly but with promising results in 1904 and 1905; in 1937 an Italian, Giulio Jacopi, worked there for a few weeks. Nonetheless, in the archeological sense, the surface remained relatively unscratched.

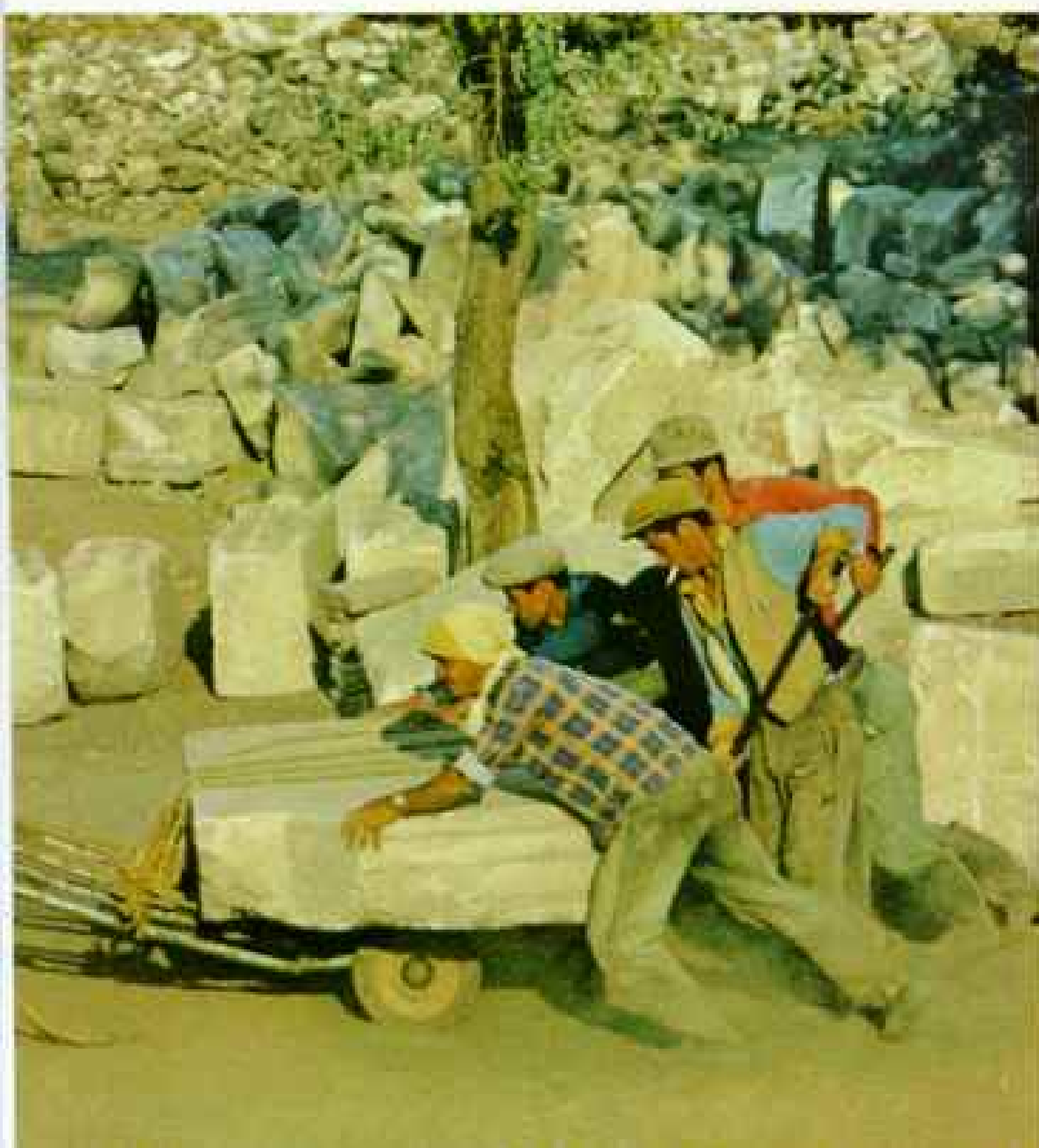
Aphrodisias lies in the rugged interior of Anatolia, 135 dusty miles southeast of Turkey's major Aegean port, İzmir (map, preceding page). The ancient world knew this region as Caria. Alexander passed this way in the fourth century B.C.† Greek settlers left their mark for centuries. Long after Aphrodisias came under Roman rule in the first century B.C., its people spoke Greek, and most of the important inscriptions we have found are written in that tongue.

I will always remember my first glimpse of the ruined city. It came just before dusk on

*Dr. Erim reported on his first six seasons at Aphrodisias in *NATIONAL GEOGRAPHIC* for August 1967.

†See "In the Footsteps of Alexander the Great," by Helen and Frank Schreider, January 1968 *GEOGRAPHIC*.





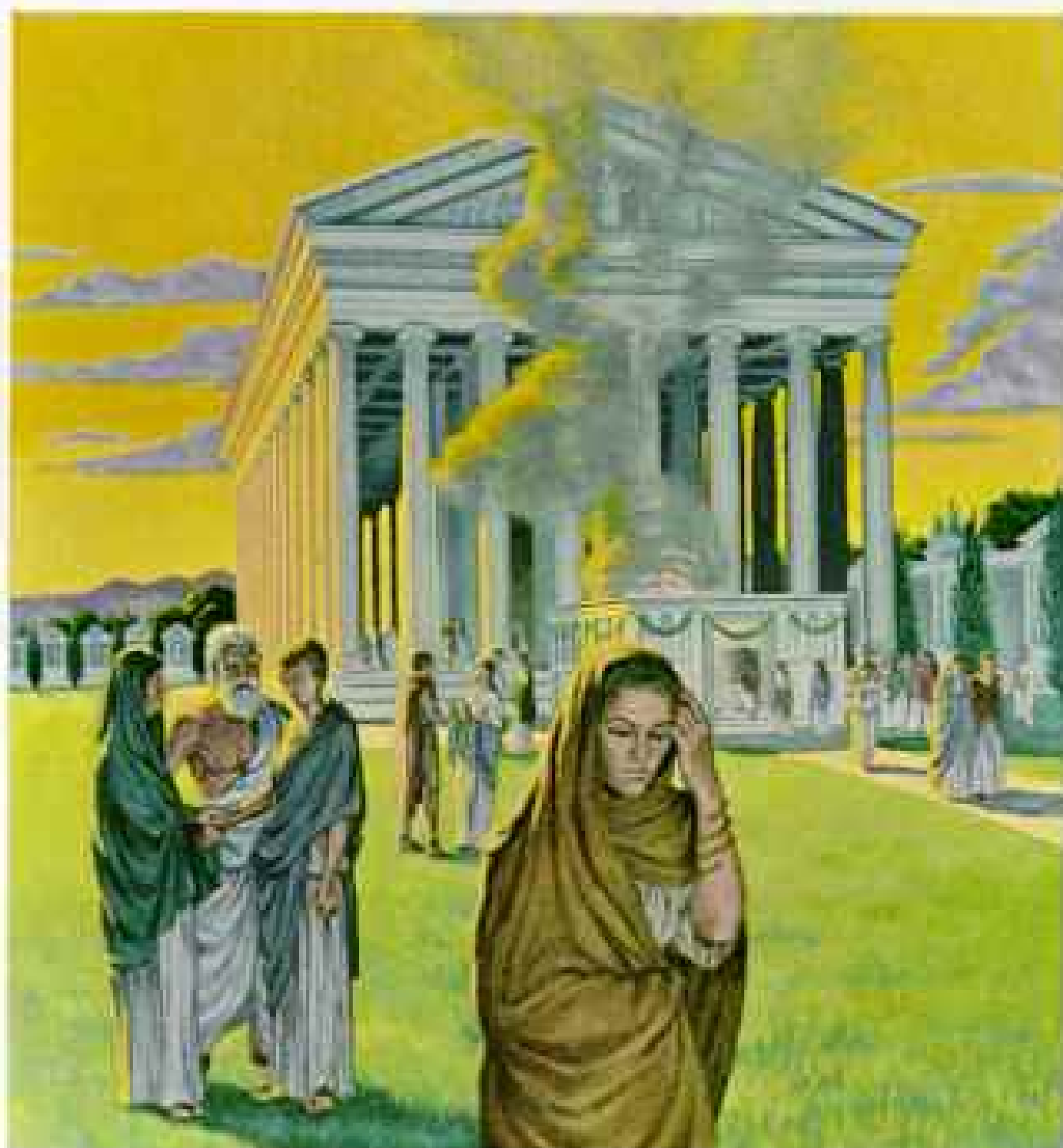
Theater's time-battered bones, numbered as to when and where found, crowd a storage field. Beyond the houses of an abandoned village rise marble-rich mountains whose quarries supplied the city's sculptors and artisans.

Workmen (left) strain to roll a theater slab to the field.

God and man commune on a storage-house shelf (next pages). The busts—probably Apollo at left, and an idealized athlete—bear traces of paint on eyes and hair. The city's gifted artists created a renowned school of sculpture, and demand for their works spread across the Roman world.







STAFF ARTIST ROBERT W. RICHARDSON

Glory of the city, the Temple of Aphrodite towers behind its blazing altar. Women enter to sacrifice their hair in annual mourning for the death of Aphrodite's lover Adonis—a rite recreated by the artist from fragmentary ancient accounts. Later Aphrodisians transformed the temple into a Christian basilica. A cross (right) still adorns one portal.



a July day. In Karacasu, a town seven miles away, I had rented a jeep because no conventional vehicle could negotiate the horrendous track that then led to Aphrodisias. As we jounced into a high, fertile valley, my eye roamed across the green of cultivated fields, the hazy brown of enveloping hills, the hulking grandeur of 7,572-foot Baba Dağ, or Father Mountain. Suddenly, looming above the plain, I saw the columns of the 2,000-year-old Temple of Aphrodite. They stood like the last wounded sentinels of a vanquished army.

In that magnificent setting, they seemed ineffably lovely and ineffably lonely.

SOMETIME in the 17th century, a village called Geyre (pronounced GAY-reh, almost certainly a corruption of Caria) had been built atop the ruins. As I wandered the narrow village streets on that initial visit, I noticed chunks of marble—some inscribed in Greek or Latin, some obviously sculptured—embedded in walls and houses.

All about me, past met present. The



residents used ancient sarcophagi as troughs for their livestock and as vats for making wine. Delicately fluted columns doubled as hitching posts, and many a temple lintel served as a farmer's doorstep.

Quite literally, the site enchanted me. Then and there I determined to excavate Aphrodisias. Two years later, under the sponsorship of New York University, I returned to commence our first campaign.

In the interval, I had combed through ancient sources. References to the city were scant,

and none afforded any hint of the size and magnificence that we have discovered. However, a sketchy history emerged. Coins minted in the city first appeared in the late second century B.C. The historian Appian recounts that, in 82 B.C., the Roman dictator Sulla made an offering of a double ax and a golden crown to "the Carian Aphrodite"; the oracle at Delphi had so commanded him.

Later both Julius Caesar and Augustus granted Aphrodisians local autonomy, including the right of asylum in the temple of the



DAVID DILLON

Faithful pilgrim, a stork nests atop one of the temple's Ionic columns. Each year the bird and its mate return—an omen of good luck. Bad luck—probably an earthquake—destroyed the column's ancient symmetry.

goddess. Tiberius and other subsequent rulers confirmed these privileges.

Above all, Aphrodisian sculpture had gained wide fame. Its artists carved works for every corner of the empire; they maintained a workshop in Rome itself.

With only this meager data for guidance, I led a modest expedition to Aphrodisias in 1961. Our beginnings were both humble and rugged. As I had anticipated, we were unable to obtain accommodations in Geyre, so we strung our tent between an olive and a fig tree outside the city wall.

Actually, Geyre—then as now—lay under a death sentence. Because of the presence of valuable antiquities beneath the hamlet, as well as damage wrought by an earthquake in 1957, the Turkish Government had built a new village a mile and a half away called Yeni—or New—Geyre. The old settlement had been legally condemned, and the residents ordered to move. But the people departed with the utmost reluctance. Even now, some linger in the houses of their fathers.

THAT YEAR violent windstorms clawed at our tents by night; the blistering sun spoiled our food by day. All in all, our first fortnight of digging at Aphrodisias passed in nightmare fashion.

Then came rescue, and with it a portent of the friendly assistance we have come to expect from the villagers of Geyre—those who have tilled this land from time immemorial, those who may very well be descendants of the citizens of ancient Aphrodisias. One of the village elders, a Moslem religious teacher, offered us the use of his house. "Kenan Bey," he said, "I must spend the coming weeks afield tending my vineyards and harvesting the crops. My house will be vacant. Though poor, it is yours."

Ten of us crowded gratefully into the teacher's two rooms for the balance of that first season—a season that afforded an enticing foretaste of the treasures that slept beneath the fields of Geyre.

How can I describe our plenitude of finds? The superb head of Tyche, a goddess who symbolized the destiny of the city, that we recovered from an irrigation ditch... the monumental sculptured body of Aphrodite that after a rain appeared in a ruined wall... beautifully carved sarcophagi turned up by the passing plow... a cache of silver coins unearthed by a farmer doing his chores.

Each year since then, with the coming of June, I have led an expedition back to Aphrodisias. Since 1966 generous grants from the National Geographic Society have permitted a steady expansion of activity.* Some 12 to 15 graduate students and scholars from American, European, and Turkish universities accompany me. They donate their skills as surveyors, epigraphists, and numismatists in exchange for their keep and the thrill of participating in an archeological dig.

Some of our students are new each year, but our operation derives continuity from our Turkish staff: Adil, the driver; Lâtif, former mayor of Geyre and now site superintendent; and, above all, from silver-haired Reha Bey Arican, of the Istanbul Archaeological Museums. Each summer sees Reha Bey leading a nomad's existence, for the government dispatches him from one archeological site to another to restore and preserve newly unearthed statuary, mosaics, and murals.

At Aphrodisias, I often marvel as he gathers together seemingly disparate chunks of marble—using the texture of the stone or perhaps telltale chisel marks as guides—to reconstitute a piece of ancient sculpture. A man of few words, he murmurs three of them repeatedly as he works on our finds—“*fevkalâde*—superb,” and “*çok güzel*—very beautiful.”

The impact of our yearly expeditions upon the village of Geyre has been little short of revolutionary. Prior to our arrival families

*Professor Erim has also received invaluable support from the Andrew W. Mellon Foundation, as well as from the American Research Institute in Turkey, Dumbarton Oaks, the Littauer, Irvine, Robert O. Lehman, Vincent Astor, and Ford Foundations, and from the U. S. Department of State through counterpart funds.



Rare likeness of Aphrodite, her features intact, survived earthquakes and idol-smashing Christians. “Theodoros dedicated this,” says an inscription on the relief, which rests on the base of another statue.



DAVID SILVER

Doodle during a dull performance? A bored spectator may have scratched this crew-cut figure into a theater seat. The circular design on the man's chest suggests a gladiator who may have fought in the city's arena using only a small shield and short sword.





EDAN WOOLFITT

Super Bowl of antiquity: The splendidly preserved stadium (left), enclosing a field 760 feet long, ranks among the largest of the Roman world. Here throngs roared their approval of foot racers, javelin throwers, relay teams, gladiators, and duels in which men fought wolves and bears. Here, too, citizens may have flocked to political meetings and to festivals honoring Aphrodite.

The circular, walled arena at the near end probably was installed as a place to hold animal fights after earthquakes damaged the city's theater in the seventh century A.D.

Directing a real-life extravaganza, the author takes a brief respite from the summer heat during the excavation of the theater. Nearly a hundred workmen wheel the rubble of centuries to a temporary dump, far left, where a truck will haul it away. Dr. Erim and graduate-student assistants move among the diggers, investigating, labeling, and recording all important finds.

Pits in left foreground outline the stage; overburden at center covers tiers of seats. Arch at top may have been a *vomitorium*, so called because it disgorged spectators from the theater.

eked out their livelihoods on a subsistence level. Now we employ dozens of men from Geyre and neighboring hamlets.

From the citizenry we purchase our staples—eggs, milk, vegetables—injecting a steady flow of cash into the village economy. As a result, farmers have been able to expand their flocks and increase crop production; some have even acquired much-envied tractors.

Friendliness has always characterized the interplay of village and expedition. The Turks address me as "*Hocam*, my teacher," by virtue of my university post. Hardly a day goes by without a farmer appearing at our compound with a brace of sweet-smelling melons or a cascading cluster of golden grapes. "*Hocam*," he will say shyly, "I have brought these for you and the strangers."

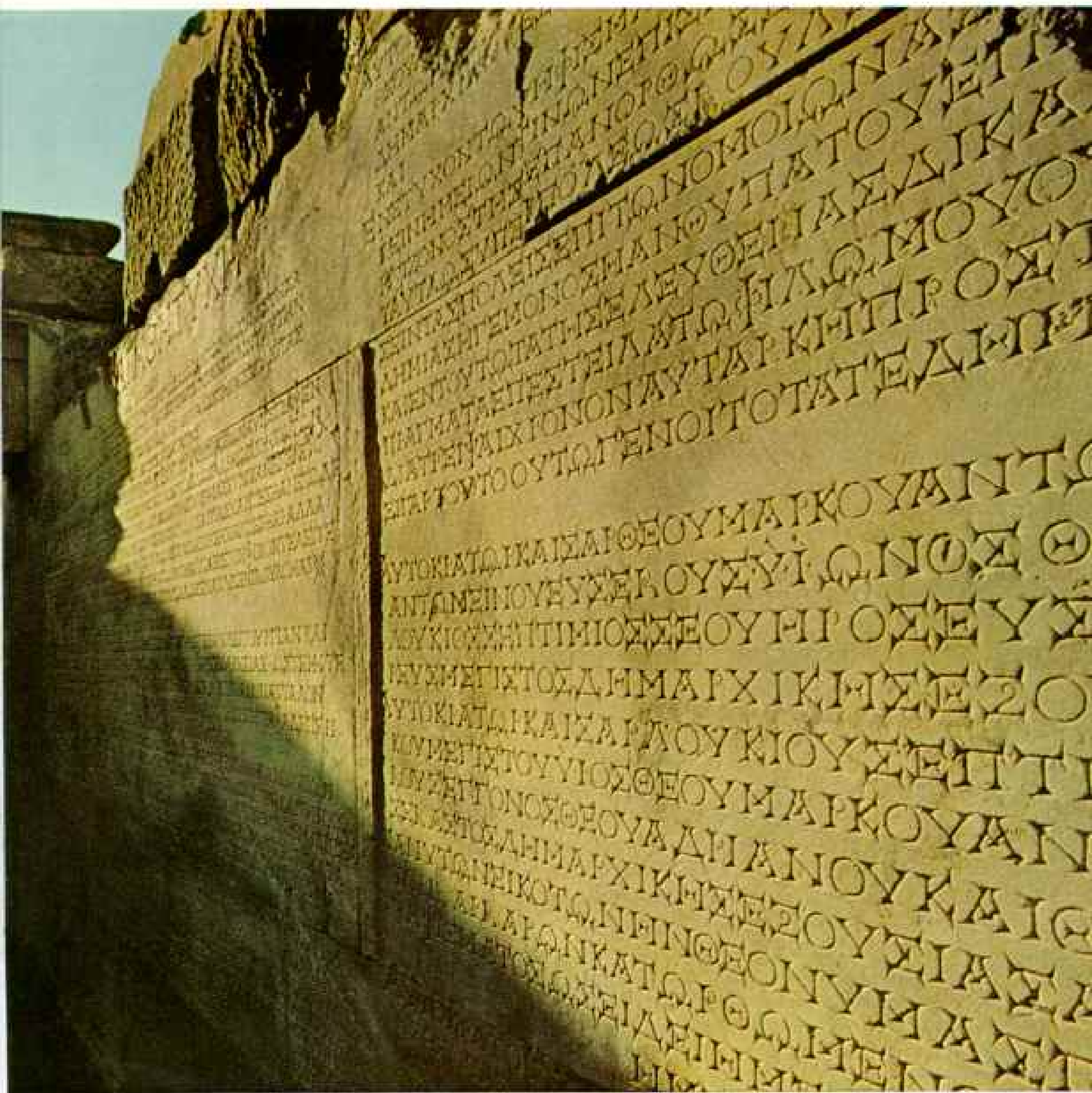
THE RHYTHM of our days seems to adapt to the timeless pattern of life in Geyre. The old village never had a minaret, so the *müezzin* climbs a platform just outside our compound—now a walled complex of three houses. His first call at dawn ushers in the day for us as well as for the villagers. We rise to that haunting, melodic cry born in the Arabian desert: "*La ilaha illa llah!*—There is no god but God!" The call to worship continues, "*As-salatu khayrun mina n-nawm*—Prayer is better than sleep."

At 6 a.m. the students troop through the streets of stone houses to their assigned excavation areas. There they join the local crews with Turkish greetings of "*Merhaba*—hello; *Gün aydın*—good morning." Promptly at 6:30 a foreman sounds a piercing note on his whistle, and work begins to the clank of picks, shovels, and wheelbarrows.

As the sun climbs toward the meridian, the day grows scorchingly hot. Digging and hauling continue amid the clinging dust roused by restless spades. But fugitive, delightful scents leaven the acrid smell of dust—the clean, almost ozone odor of the fig trees that dot the site, intoxicating wafts of wild thyme, blossoming capers, pomegranate trees.



Imperial edicts still speak from a wall within the theater. This extraordinary archive, inscribed in Greek, adds new pages to the history of



ACORN WOODLIT

Rome and her empire. Beneath a bold greeting that reads "Good Fortune," center, unfolds a letter from the Emperor Trajan. Another, from Hadrian, exempts the privileged

city of Aphrodite from a tax on nails. A directive from Octavian—later the Emperor Augustus—orders neighboring Ephesus to return a gold statue looted from Aphrodisias.

Midday brings pause. A perfect stillness falls across the land as we lunch and then sink into the obligatory siesta of the Near East. Three-thirty finds us once more at the dig, where we work past six. Even dusk brings no respite. Far into the night, we labor over fragments and potsherds found during the day—identifying, classifying, recording.

Dramatic discoveries, however, often sever the skein of this daily routine. While excavating Aphrodisias, I have again and again encountered emotions peculiar to archeology, emotions that elude description. For me, such an experience usually starts with a summons to a particular point; the shovels have revealed yet another fragment of marble, another sculpted head.

Once on the spot, I begin to furrow gently around the head with my bare hands. Silent and expectant, my colleagues watch. The workmen share our excitement, but they think it unseemly for a teacher to soil his hands.

"Let me do it, Hocam," reproves one.

"But I'm the one who saw it first," says another.

Lâtif sadly shakes his head. "This is not proper work for you, Hocam."

My fingers continue to probe around the head. What have we found? A hero, an emperor, some personage who dominated history? Slowly, as I scoop away the earth, the features reveal themselves. Soon the blind marble eyes stare up at the blue Anatolian sky. And, as I brush the last of the dirt away, we see the face of a fellow man whose memory lives still in this bit of stone, a fellow man whose image we have resurrected from centuries of darkness.

OUR ACTIVITIES at Geyre have infected villagers with a lively interest in archeology. Our workmen vie to unearth new finds; farmers range their fields, alert for relics of the past; children comb outlying areas for coins and statuary fragments. Upon our annual arrival, they bring the accumulated treasures of the winter to us.

The finds of the children, in particular, amaze me. One evening last June a worker burst through the gate. "Hocam," he shouted, "Selim's boy just found the bearded head of a man." Far too heavy for its discoverer to carry, it proved to be a handsome likeness of the philosopher Epicurus.

A few weeks later another youngster brought an unusual chunk of marble. "I found it near Ali's anise field, Hocam," he said. He guided us to the spot, and we dug up two intricately decorated sarcophagi of the Roman period.

Our investigations to date have produced a fairly clear picture of the rise and fall of Aphrodisias. At the very start

Puckish "face pot" might have held wine. Bronze Age Aphrodisians baked the clay jug some 4,000 years ago.

Byzantine sundial held a shadow-casting gnomon in its center. The 3-inch-wide disk is divided into 28 parts, each bearing the name and latitude of an ancient city or region.

Knobby perfume bottle, made in Roman times, acquired its iridescence from the chemical effects of burial. Glass objects, many intact, abound at the site.

Silver birds perch on a Byzantine pin, here clasping a piece of velvet. About the size of a 50-cent piece, it came from a Christian tomb.

Apollo, god of music and the arts, adorns a silver coin issued between 577 and 553 B.C. by the Carian satrap Mausolus. His huge tomb, the Mausoleum at Halicarnassus, was one of the Seven Wonders of the Ancient World.

Laughing satyr, a fragment about 15 inches high, came to light near the odeon. Part goat, part human, the mythological creature was a companion of Dionysus, god of wine.





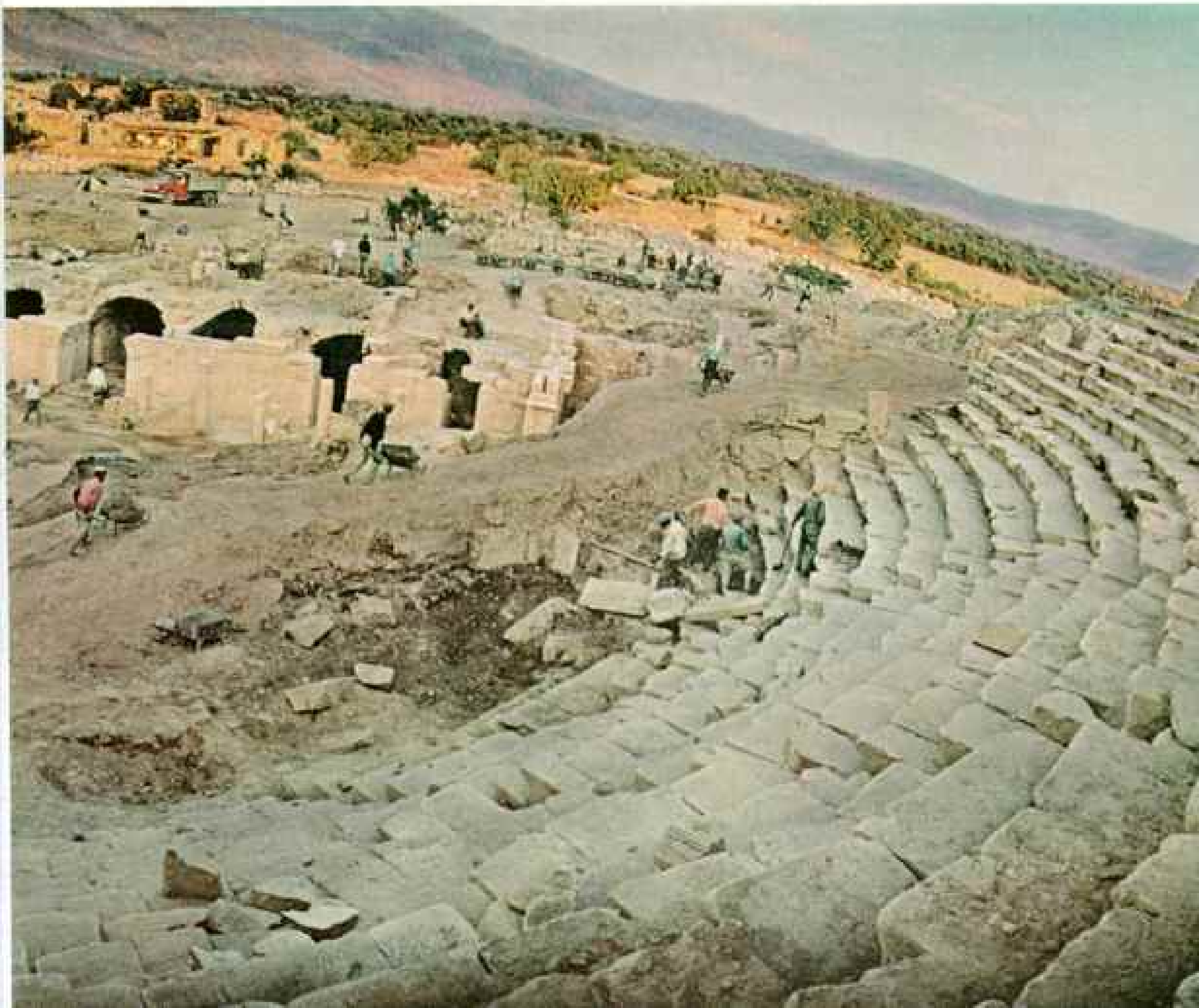


NATIONAL GEOGRAPHIC PHOTOGRAPHER BYTES LITTLEHALE

Raising the curtain of time, workers begin digging overburden from Aphrodisias's theater. The 1968 assault (far left) clears some of the houses that villagers had built over the buried theater. The 1969 campaign (left) probes to the orchestra floor, 25 feet down.

After a 1,300-year intermission, the theater emerges in its full beauty (below) during last summer's excavation season. Marble seats held about seven thousand spectators for such attractions as drama, dance, wrestling, and boxing on the stage, and animal fights in the orchestra pit.

785



we directed our efforts toward the only eminence on the flat site, a conical mound that rose some 80 feet. The Frenchman Gaudin in 1904 had labeled it "the acropolis." Though this small hill bore no resemblance to the lofty citadel of Athens, we kept the name.

On the Aphrodisian plain, this solitary rise screamed of artificiality. Sure enough, our first trenches confirmed it. We were digging into a *hüyük*, a mound composed of the superimposed layers of successive civilizations. We found the stratification confused by erosion as well as by building activities in the 12th and 13th centuries A.D.—when, apparently, the acropolis served as a redoubt against Seljuk raids. But from a thousand years earlier, we discovered the remains of a great theater (pages 778-9).

Digging on the west side of the *hüyük*, we turned the clock even further back. Potsherds revealed that men settled here well before 3000 B.C. Several storage jars of the Middle Bronze Age (1900-1600 B.C.) held seeds, indicating that, then as now, the inhabitants lived by tilling the soil.

ABOUT 700 B.C., the Anatolian populace began to build a series of shrines. We have located the remains beneath the precincts of the Temple of Aphrodite. Presumably the shrines were dedicated to a primeval mother goddess, a deity widely worshiped in Anatolia. She much resembled—and eventually assumed some of the attributes of—the fertility goddess Ishtar, or Astarte, whose cult flourished throughout the Mesopotamian world.

In the wake of Alexander, who in the fourth century B.C. built a cultural bridge between Greece and Asia, this mother goddess, also known as Cybele in parts of Anatolia, passed into the Greek pantheon in two forms: as an Artemis, with a sanctuary at nearby Ephesus; and as Aphrodite, with a sanctuary at Aphrodisias.

From the first century B.C., when pagan Aphrodisians erected it, to the sixth century

A.D., when Christian Aphrodisians converted it into a basilica, the great marble Temple of Aphrodite ranked as the most important structure in the city (painting, page 774). For Aphrodisias owed its great prosperity—probably its very existence—to the widespread worship of this goddess.

Ancient sources shed little light on the cult of Aphrodite. But such testimony as exists has been corroborated by our findings.

One writer mentioned a well of salt water in the temple; we have indeed found a deep well in the ancient floor. We are told that doves, sacred to Aphrodite, flitted in the gardens and groves within the temple precinct; to this day, doves flock here in unusually large numbers. Lions and bulls were also sacred to the deity; we have identified the figure of a lion in the temple grounds, and an inscription tells of ritual bull games which may have taken place in the stadium.

Popular devotion to the goddess may be measured by the fact that Aphrodisias was one of the last pagan strongholds in the Roman Empire. In fact, one inscription dating from the reign of Justinian I in the sixth century A.D. implies that paganism was still alive in Aphrodisias almost 200 years after Christianity became the state religion throughout the Roman Empire.

IN MANY RESPECTS the excavation of the theater has proved to be the most rewarding of our activities. The shroud of earth that formed the acropolis concealed the descending tiers of seats carved from marble (preceding pages); it also preserved the edifice virtually intact. Murals retain many of their brilliant hues; inscriptions are clear and sharply defined.

From this vast semicircular well that once accommodated about 7,000 spectators, we have mined sculpture of consummate artistry. The heavy damage we have encountered—fallen columns, toppled statues, smashed benches—leads us to surmise that an earthquake shook the city violently sometime in

the seventh century A.D. Thereafter, the inhabitants erected houses on the ruins, frequently employing chunks of marble from the rubble.

The theater clearly served as a political as well as a cultural focus of Aphrodisian life. One interior wall displays a series of documents inscribed in stone (pages 780-81). On this unique "archive wall" we have identified letters from no fewer than eight emperors—Augustus, Trajan, Hadrian, Commodus, Septimius Severus, Caracalla, Alexander Severus, and Gordian III. These inscriptions illuminate the complex relationship that existed between Rome and such provincial cities as Aphrodisias.

Septimius Severus congratulates the citizens for having "been pleased when we conquered the insolent barbarians." Trajan, paying the city a signal honor, vows that "at games, gladiatorial contests, hunting shows, and athletic competitions in the city of Rome or within one mile thereof, the ambassadors of the . . . Aphrodisians shall be permitted to sit . . . in the places reserved for senators."

Hadrian remitted an odious tax on nails. "Knowing that your city deserves honor for other reasons and is exempted from the tax-roll of the province," he stated, "I declare it free from this levy." And Gordian III, in exempting Aphrodisians from a locally unpopular decision, pointed out that "it is not possible to order free men around."

Sculpture sifted from the debris of the theater testifies to an unprecedented degree of decoration; marble images must have towered everywhere. They run an incredible gamut from tragic muses to gods. Two of them possess a startling aura of timelessness.

Resurrected piece by piece over three summers, a nearly life-size image, believed to represent Hercules, displays the vitality imparted by artists of the school of Aphrodisias. "Marble seemed almost malleable in their hands," marvels the author.







RIGHT BY ADAM WOOLLEY

Artistry in stone paves the columned courtyard of a rich Aphrodisian's house. The mosaic dates from the fifth or sixth century A.D., when control of Asia Minor had shifted from Rome to Byzantium. Columns in the background formed a tetrapylon—an arched gateway—that led to the Temple of Aphrodite.

Fighting fang to fang, tigress and serpent duel in the mosaic (left). To enliven their designs, the city's mosaic artisans often added bits of glass to the traditional stone pieces.

Pugilists, they peer at us out of the past with the same professional stigmata that mark their present-day counterparts—broken noses and cauliflower ears.

Hard by the agora, which served as a daily meeting place for Aphrodisians, lie the imposing baths dedicated to Aphrodite and the Emperor Hadrian. Beneath the floors of this ornate edifice, we discovered an elaborate system of plumbing and heating. Water coursed into the building via channels from mountain streams. Wood fires heated it, as well as the floors of shallow pools where bathers could soothe their bodies in steaming water, then plunge into a cold pool.

The baths, according to the inscriptions, were either built or enlarged during the reign of Hadrian, in the first half of the second century A.D. One inscription near the door informed patrons: "The customer is held responsible for the loss of any money from purse or belt not previously checked."

On another flank of the agora, through sheer good luck, we stumbled upon the almost intact remains of an exquisitely proportioned odeon, or concert hall. During our long summers of excavation, on nights when the moon waxes full, we set up a phonograph on its ancient stage. There, with the moonlight imparting a chaste, nacreous glow to the marble benches, we sit in the silence of the Anatolian night and listen to music, as did Aphrodisians almost two millenniums ago. Never does it sound so sweet, so melancholy, so charged with tragedy.

In 1969 we unearthed, adjacent to the temple, several sculptors' workshops that suffered sudden destruction in the fifth century A.D. Since this date coincides with the beginning of Christianization of the city, and since the sculpture carved in Aphrodisias possessed a decidedly pagan character, I adduce that the destruction followed some kind of Christian-pagan struggle that ended with the rout of the latter. Many of the statues we have recovered, not only here but elsewhere on the site, have been decapitated,

with faces smashed on one side—clearly the result of purposeful blows.

Several sarcophagi, found empty, testify that the sculptors of Aphrodisias had discovered the merits not only of mass production but also of advance planning. The stone caskets were finished and ready for delivery—often to destinations abroad—save for the portraits of the deceased and members of his family in the inevitable reliefs on the front panels. These were merely roughed out, but a clever chisel could quickly impart the features of the stricken client.

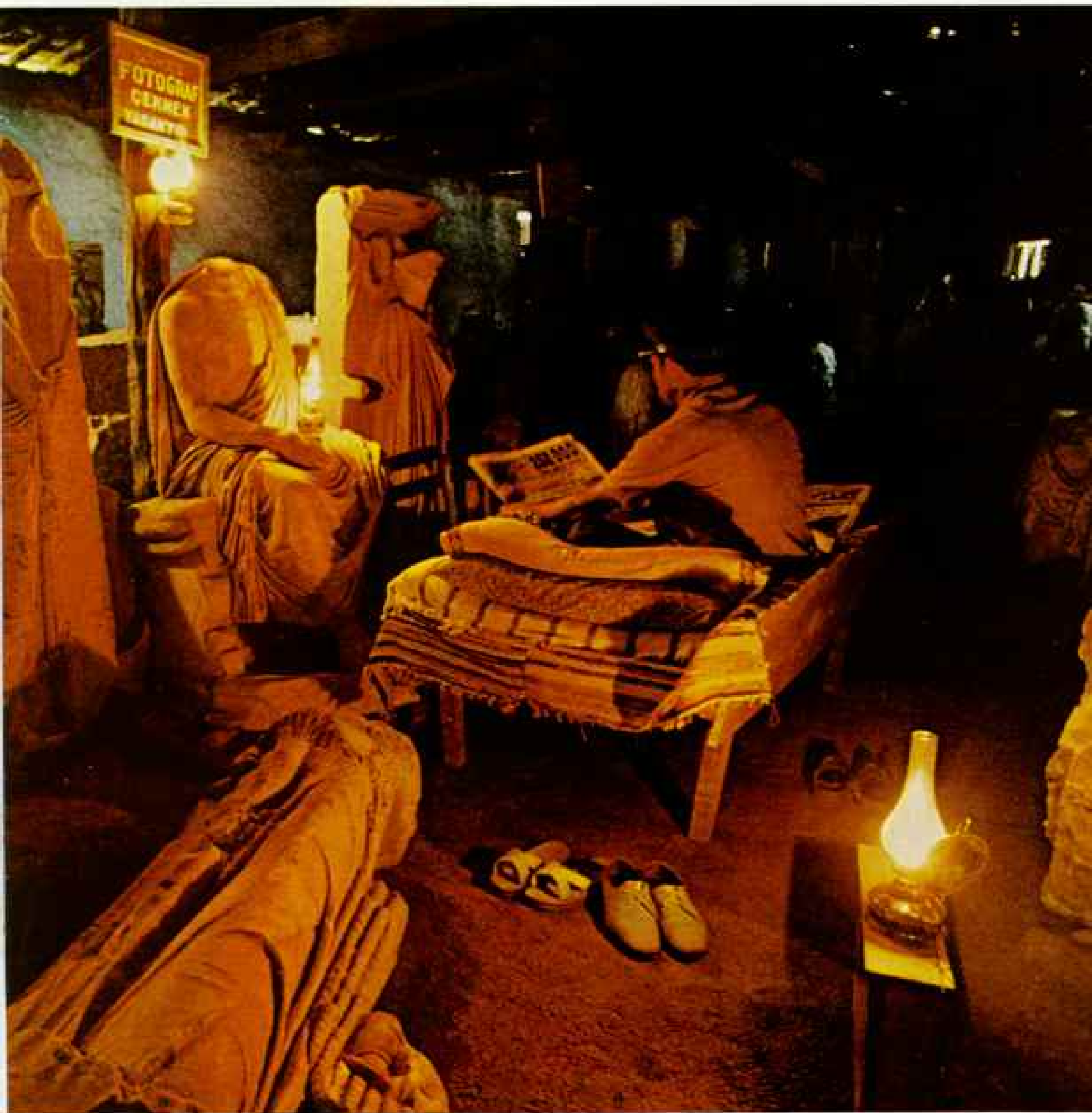
THE PASSING of paganism and the arts of the cult of Aphrodite coincided with the city's gradual decline. Aphrodisias existed primarily as a shrine. Deprived of its goddess, it lost its reason for being. Even its illustrious name fell victim to religious strife. Under the followers of Christ, it was briefly known as Stavropolis, City of the Cross.

Decline continued during the Byzantine era, and the fading city, victimized by vandals and shocked by earthquakes, slipped into obscurity. Finally, in the 12th and 13th centuries, Seljuk raids drove the last inhabitants from the acropolis, and the restless dust enshrouded the once-dazzling metropolis.

Often, at the end of a long day's work amid its tumbled ruins, I stroll to the temple to watch as the sun melts in a splendor of burnt gold behind the western hills. The evening breeze sighs among the columns, and tall poplars nod against the sky. The glow of the day pales, fades, dies. Darkness as gentle as velvet enfolds the city of Aphrodite.

But night brings no sleep to these ancient ruins. Awakened from its earthen tomb, Aphrodisias has emerged as a sublime witness to the grandeur of the Greco-Roman world and to the long continuity of civilization in southwestern Anatolia. □





Relaxing amid ghostly roommates, a watchman guards a depot that literally overflows with the excavation's treasures. The priceless

collection will eventually be displayed in a museum erected jointly by the National Geographic Society and the Turkish Government.





Life and Death in Tana Toradja

By PAMELA and ALFRED MEYER

THE INVITATION was too intriguing to resist, though it meant a journey halfway around the world. The cable, signed by J. T. Sampetoding, a prominent Toradja businessman, announced that his people would soon begin ancient funeral rites for Sa'pang, one of their last great aristocrats, four months deceased.

Would we come to the highlands of Sulawesi—the Indonesian island formerly called Celebes—and attend this important event?

We seized the chance to witness the ceremony and to travel among a people so genial, we had been told,

Festive funeral in Tana Toradja—the land of the Toradja people on Indonesia's island of Sulawesi—draws thousands of guests. These mourners, come to celebrate the passing of a nobleman with feasts, dances, games, and centuries-old rituals, arrive with gamecocks and basket cages. Prow-roofed granaries and guesthouses rise in the background. PAMELA MEYER



Isolated by the sea and walled off by mountains, the Toradja lived for centuries in a rigidly stratified society ruled by nobles, variously called *puangs*, *to makakas*, or *ma'dikas*. Even now the noble classes retain much of their power and prestige, though their ranks have been diminished through intermarriage, and few remain to receive the funerary honors and rewards accorded their predecessors.

Thus the deaths of men such as Puang Sa' pang and Puang Laso' Rinding, whose funerals were attended by the authors and National Geographic photographer Winfield Parks, take on special significance as a twilight burst of pageantry from the past.

Bee on a string delights a sarong-wrapped Toradja youngster (left), drawn to funeral festivities as his Western counterpart might be lured to a carnival. Red-and-gold paper hats identify the two maidens below as funeral hostesses.

that even their funeral rites are more joyous than somber.

Tana Toradja, or Toradjaland, is a bright and abundant region in the most mountainous part of Sulawesi, the orchid-shaped Indonesian island (map, opposite). Laced with footpaths, Tana Toradja is preeminently a place for walking. Especially on market days, we met Toradja in droves sashaying along the roadsides and steep mountain trails. They streamed down to Rantepao, their largest town, eager for news and the socializing of the marketplace.

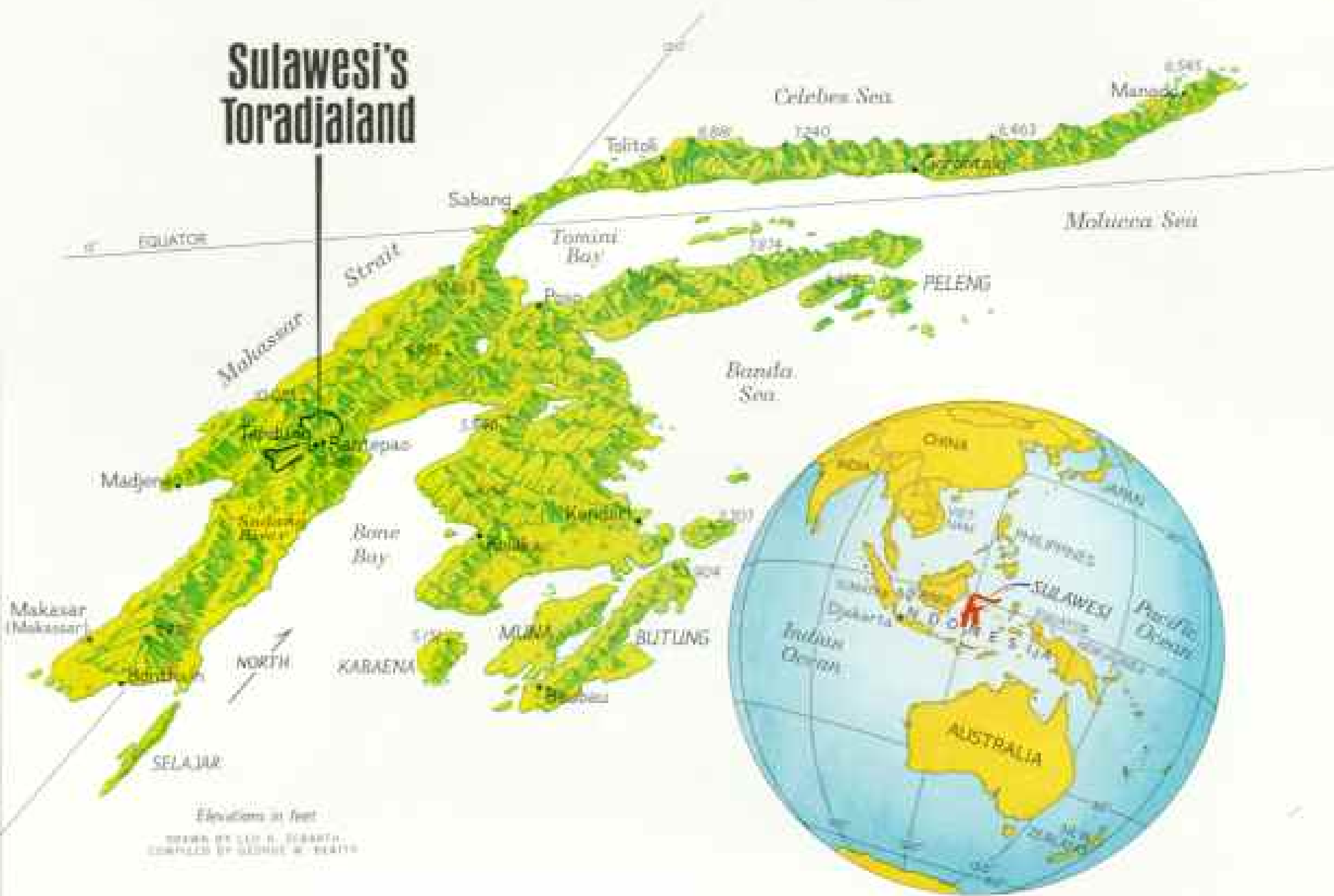
All around us towered high, sharp peaks, gathering massive cumulus clouds as the day wore on. We crossed and recrossed the sinuous Sadang River, running red with mountain silt, rippling southward past naked bathers and women washing cotton laundry. The rattan-and-bamboo footbridges bounced disquietingly under our feet.

Shimmering rice terraces climbed the spring-green slopes above us (pages 796-7), and groves of bamboo waved in the wind like Victorian feather fans. Scarecrows of bizarre designs and appurtenances flitted and jangled.

WINFIELD PARKS (FOLDING) AND PAMELA HEYER



Sulawesi's Toradjaland



Water buffaloes loafed while egrets studied them. Everywhere we went, the rumble of rice pounding resounded like thunder, as women hulled grain in wooden mortars shaped like canoes.

One market day we rode on horseback up one of Toradjaland's highest mountains.

"Selamat pagi."

"Selamat pagi," we returned.

The pretty barefoot girl who had bidden us good morning smiled shyly and continued on her way. She carried a five-foot length of bamboo filled with *tuak*, the mildly fermented juice of the sugar palm. Later, at the market, the *tuak* would contribute substantially to the joviality of the Toradja men. Vendors dispense the liquid in thin, short lengths of bamboo, the island's version of disposable paper cups (page 807).

Farther up the trail, in a shady oasis of sugar-palm trees and bamboo, we passed a newly painted Toradja house, handsomely decorated in black, orange, white, and yellow. Facing it stood several rice granaries, smaller versions of the house, and like it, elevated on stout wooden pilings.

We paused to study the house's ornate facade. The carved wooden head of a water buffalo—symbol of Toradja wealth—was attached to it. Below the painted white head ranged a set of panels depicting entire buffaloes, some black, some spotted. The Toradja rank buffaloes rigidly, basing their evaluation on color. *Bonga*, piebald buffaloes, are the most valuable, worth ten to twenty times the price of an ordinary black animal.

Bamboo Roofs Shed Monsoon Torrents

From a distance the roof of the traditional Toradja dwelling resembles an ark floating in a sea of tropical foliage. The eaves curve upward, like the prow and stern of a ship, projecting dramatically beyond the ends of the house. Interlocking layers of split bamboo covered with flat strips of pounded bamboo form the roof and act like a thousand sloping gutters to keep the house snug and dry through torrential rains.

Rain! We had blithely ignored the graying clouds hugging the peaks, though we knew that the annual rains were overdue. Even the three soldiers who rode with us—"a safety



Veiled by rain clouds, lush highland valleys produce bountiful crops. Largely farmers, Turadjaland's 300,000 people subsist mainly on rice, but also plant maize and cassava. Livestock—usually slaughtered and eaten only at feasts—forms the basis of wealth.

Watery field mirrors the grace of a two-way procession on an earthen dike (right). Black-clad mourners, all from the same village, pass pink-gowned hostesses laden with food and drink for newly arrived guests.





FAMILIA WETER

measure," officials insisted—had scoffed at the prospect of rain.

A few drops and then, within minutes, we were deluged. Dismounting, we hugged the side of a cliff for shelter. Rice fields became lakes, overflowed their banks, and turned the mountainside into a waterfall. Frightened by the thunder, the horses panicked and disappeared down the trail, and, to our bewilderment, so did our military escorts.

Warm Welcome in a Cold Rain

Groping downhill, we searched through sheets of chilling rain for the house we had admired an hour before. Finally it appeared, and we went to the door. A surprised Toradja farmer let us warm ourselves by the raised open hearth in the kitchen. While the rain thundered on the roof, his wife prodded the glowing coals into a fire and prepared a pot of hot musty tea. A boy appeared with dry sarongs, and we exchanged

our sodden clothes for these most versatile and indispensable of Indonesian garments. Sarongs serve the Toradja alternately, and sometimes concurrently, as shirt, skirt, jacket, and sleeping sheet.

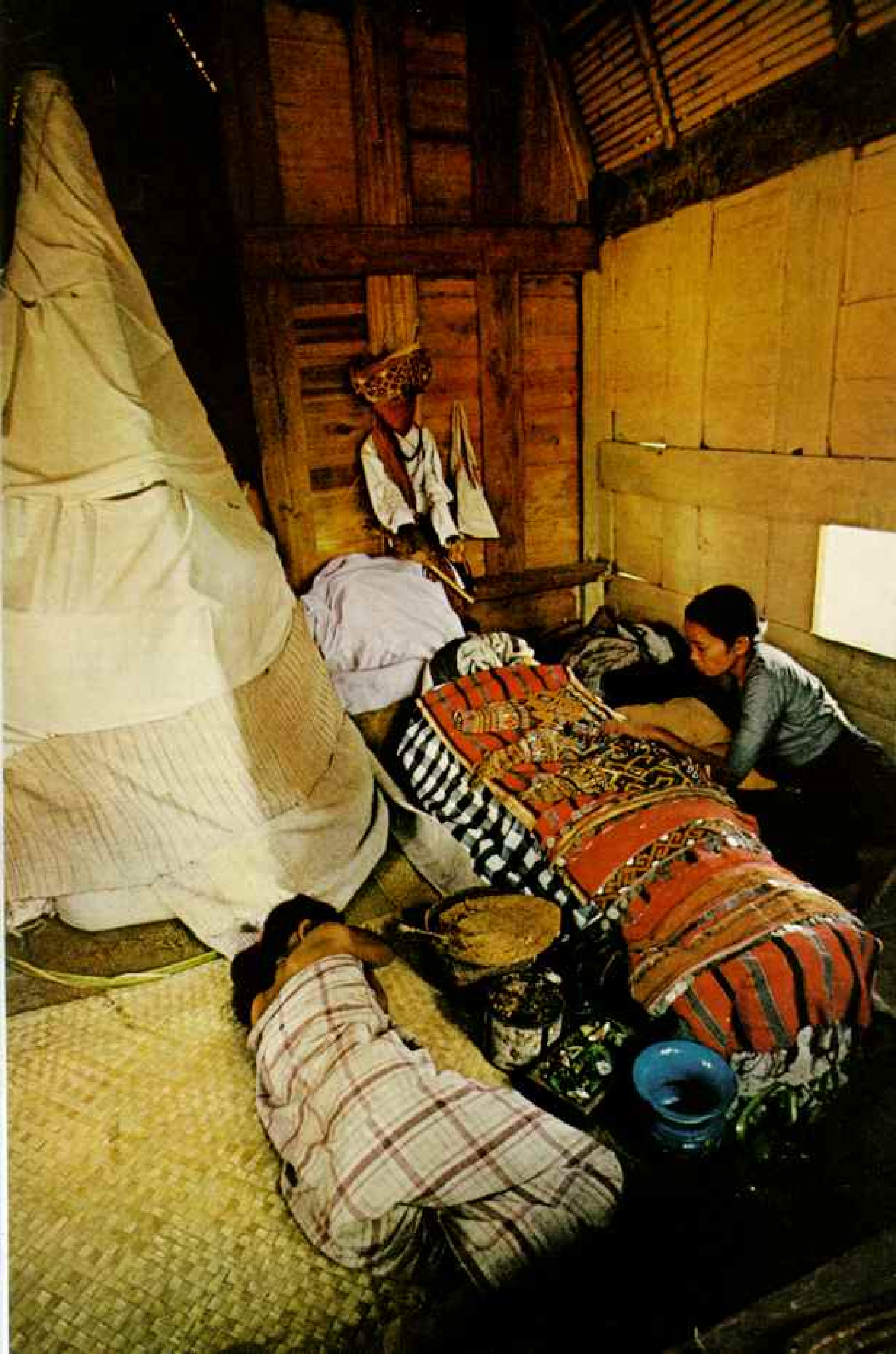
The rain persisted. It was clearly impossible to attempt a descent to Rantepao before morning. We anticipated spending the night huddled in sarongs on woven reed mats rolled out on the floor. The typical Toradja home is sparsely furnished. Only a few rude benches and a single table stood in the main room. Dinner was equally simple—rice and a fresh-killed chicken broiled over the open fire.

Then a thunderbolt of sorts struck. We were led to a room, the only room in the house that had a door. Inside we beheld an improbable sight—a vision, a hallucination. There, in the middle of a room in the house of an isolated Toradja farmer high on the upper flanks of a tropical Asian mountain, in jaded but emphatic splendor, stood an ornate,



WHITFIELD PARKER

In lonely vigil, a widow of Puang Laso' Rinding keeps watch near his body (left), her unending duty throughout the funeral ceremonies. A portrait of the nobleman, who died when he was 90, hangs on the front of his house (center). Another wife (right) rests beside food offerings for Rinding, still unburied four years after his death, while an attendant adorns the desiccated body with a necklace. An effigy dressed in the clothes of the deceased hangs on the far wall. During the wake, his favorite wife stays in the tepee.



canopied four-poster bed, carefully made up with embroidered linen.

The next morning, in a world fresh washed and glistening, we learned the history of the bed on which we had slept so luxuriously. A year before, a Czech geologist had stayed with this family for several months while prospecting for copper in the mountains. Wedded to his comforts, he had brought the bed with him. When he departed, he left it as a gift for his host, never considering that the farmer and his family preferred their reed mat and hard floor as strongly as he preferred his European bed.

A Lesson in Village Economics

"*Kurra sumanga*," we said to the farmer. "Thank you." We bade him good-bye and walked with his wife toward a rice granary.

With a basket on one arm she started to climb the short ladder leading to the granary door. In a flash all the chickens and ducks in the vicinity converged below her. Here was a nice lesson in economy, for as she opened the granary door and began to fill her basket with bundles of rice, many grains unavoidably spilled and were picked up by the ravenous poultry. Chickens and ducks, the lesson goes, are an efficient way to convert spilled rice into eggs and chickens and ducks.

The following day we found ourselves in front of another lovely Toradja house, also freshly painted. The *tongkonan*, or family home, had just been refurbished as a memorial to departed ancestors, but a living one, since the family would continue to occupy it. We had been invited to a feast to celebrate the joyous occasion.

We joined the family and their guests in the rectangular plaza before the house. It was a large crowd—the people of nearby compounds, local government officials, foreign diplomats, journalists.

Brightly colored bunting hung from the granaries and temporary guesthouses that surrounded the plaza. We took our places on a second-story gallery, acutely conscious of the curious and delicious odors that wafted up to us. Below, waves of sedate young women were passing through the company offering tuak and assorted Toradja foods, and pouring tea from kettles.

Then, in the center of the plaza, women covered with dazzling gold and silver jewelry and silk scarves began to perform traditional

Toradja dances. Moving delicately and with restraint, they harkened only to an internal rhythm, disregarding the more frantic tempo of the drums. The songs they sang were quiet, almost private. As guests, we were expected to approach the dancers, choose the one we most appreciated, and tuck a gift of rupiah, Indonesian currency, into her silken sash even as she continued her dance.

After the dances, deep-throated, frenetic chanting filled the plaza. Groups of men lurched in, bearing on their shoulders decorated bamboo cages in which prized pigs shrieked and squealed. Each offering of pigs was presented, acknowledged, then shunted aside to make room for the next. Pigs, some gargantuan, some lean, were brought singly and in groups of up to six. Soon the plaza became a maelstrom of men and pigs.

As the procession moved out of the plaza to a sacrificial area, gaiety filtered back. Fires sprang up, and pig carcasses were placed over them, as well as green bamboo containers filled with pork, red peppers, and blood, a Toradja delicacy. Much of the meat was consumed on the spot, although many villagers walked happily home that afternoon carrying chunks of pork for a future meal.

Feast Enhances Family Standing

It had been a rousing housewarming. The family members had fulfilled their obligations, both to the memory of their forebears and to their neighbors. They had reinforced their family's reputation, strengthened ties, and displayed their own wealth and largesse by distributing vast quantities of meat. The next day the head of a water buffalo would be presented to the household by the villagers, its horns later to be affixed to the facade of the refurbished house, where they would serve as a reminder of this generous feast.

Such feasts are part of a religion the Toradja have developed over many centuries. Fundamentally ancestor worship, its ritual falls into two types: one dealing with death and symbolized by darkness, descending smoke, and the setting sun; the other a celebration of life, with its symbols of light, rising smoke, and the morning sun. It had been an unexpected pleasure to attend a feast that fell under the rubric of the rising sun. Now, at the funeral we had come so far to see, we would witness the pageantry and solemnity of the ceremonies of the setting sun.



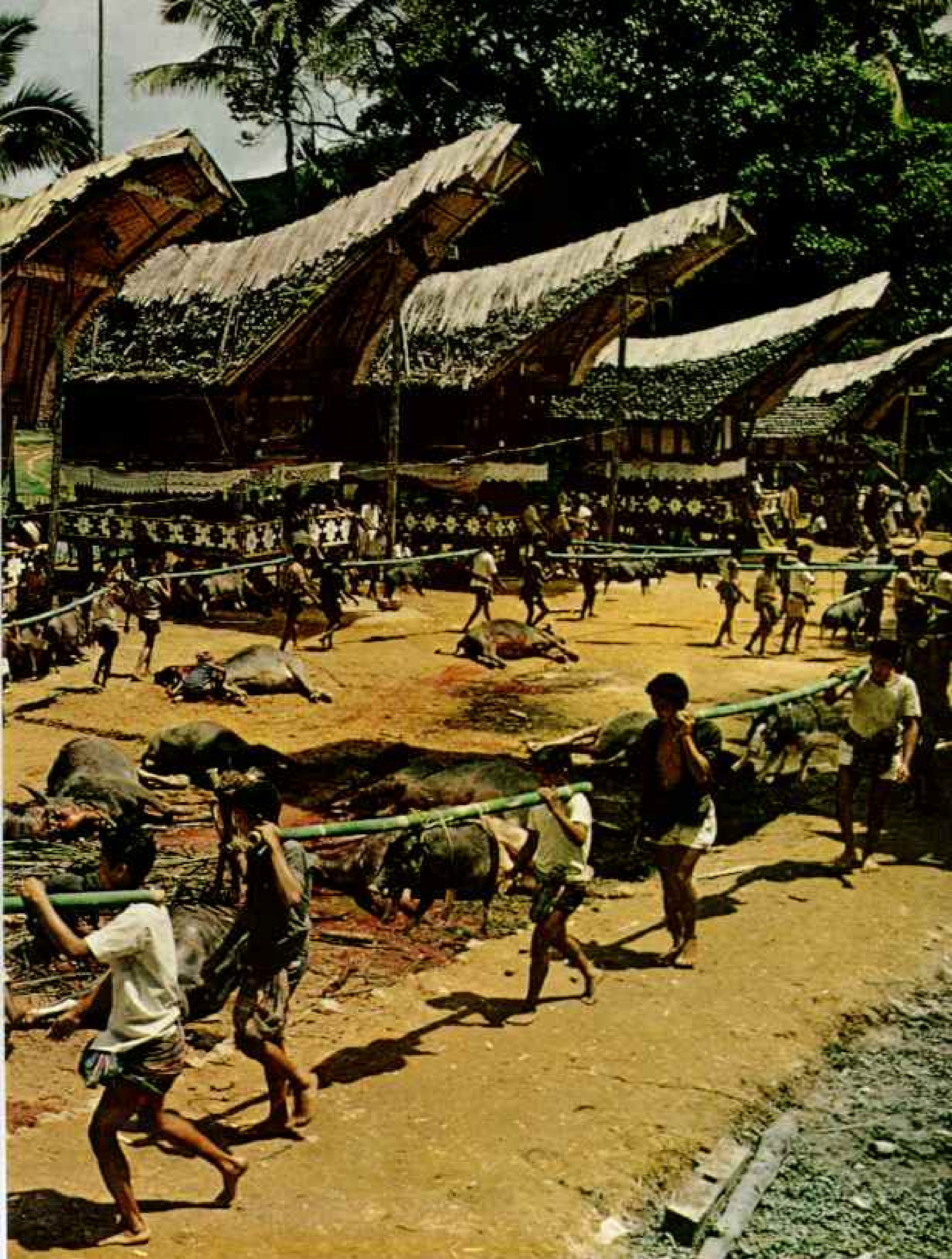
Feet, not fists, mark impromptu Toradja contests as kicking teams try to bruise opponents into disgraceful retreat. Spectators' enthusiasm soon turned into a free-for-all that strained the peace-keeping efforts of the helmeted Indonesian police.

Strength, not skill, wins in water-buffalo bouts staged at funerals. Though the bulls battle fiercely, with great clashing of horns, the first animal to fall usually quits the fight.





Proclaiming cancellation of old debts, funeral guests display live pigs they have brought to repay Sa'pang's past generosity. Newly sacrificed water buffaloes, to be eaten at the funeral feast,



BARBARA HEVIA

lie strewn on the central plaza. More than a dozen were offered, attesting to the wealth and high rank of the dead man. Platforms beneath the high-roofed granaries house relatives and close friends.

Our hosts showed us to one of a row of comfortable bamboo houses built for the occasion beside a rice field near the village of Tandung. A bamboo aqueduct brought fresh water from a spring more than a mile and a half away. Across the paddy in his homestead lay Puang Sa'pang, who had been dead now for more than five months.

J. T. Sampetoding, the businessman who had invited us to Tana Toradja, operates copper, tin, and gold mines throughout Sulawesi. One evening he briefed us on the ceremonies surrounding a great Toradja funeral.

As we sat cross-legged on the mats in our house, he told us: "Everyone in Tana Toradja has a hereditary rank. The highest are the *puangs*—nobles, the lowest, *kaunans*—servants. Once there were many puangs, but today their 'white' blood has been diluted through intermarriage, and only a few pure puangs remain." We smiled at Mr. Sampetoding's reference to the color of blood, so similar to our own illogical notion of aristocratic blood running blue.

Web of Debt Links Generations

"Sa'pang is of the highest rank," he went on, "and because of this at least twelve buffaloes must be sacrificed at his funeral."

"Who will contribute them?" we asked. We knew that the Toradja people live in a network of debts that stretch back for generations and fall due at the time of funeral feasts.

"In past time, when there was a feast such as this, Sa'pang gave buffaloes. Now, at his funeral, the descendants of those to whom he and his ancestors gave will bring gifts to honor Sa'pang."

In all, some thirty temporary two- and three-story bamboo buildings, rising like Elizabethan galleries around Sa'pang's property, had been erected to house funeral guests (pages 792-3). Platforms beneath the 13 granaries would also serve as sleeping quarters. Quilted sheets, rolled up during the day, would ensure privacy at night.

From our window we could now see guests streaming to the feast site. The road into Tandung became clogged. Whole villages arrived in single file, walking solemnly with their contributions.

Buffaloes led the processions, some destined for sacrifice, others for fights staged to entertain the guests. Pigs hung from bamboo poles and chickens clucked in baskets. The villagers also carried bundles of rice and bamboo tubes

(Continued on page 809)

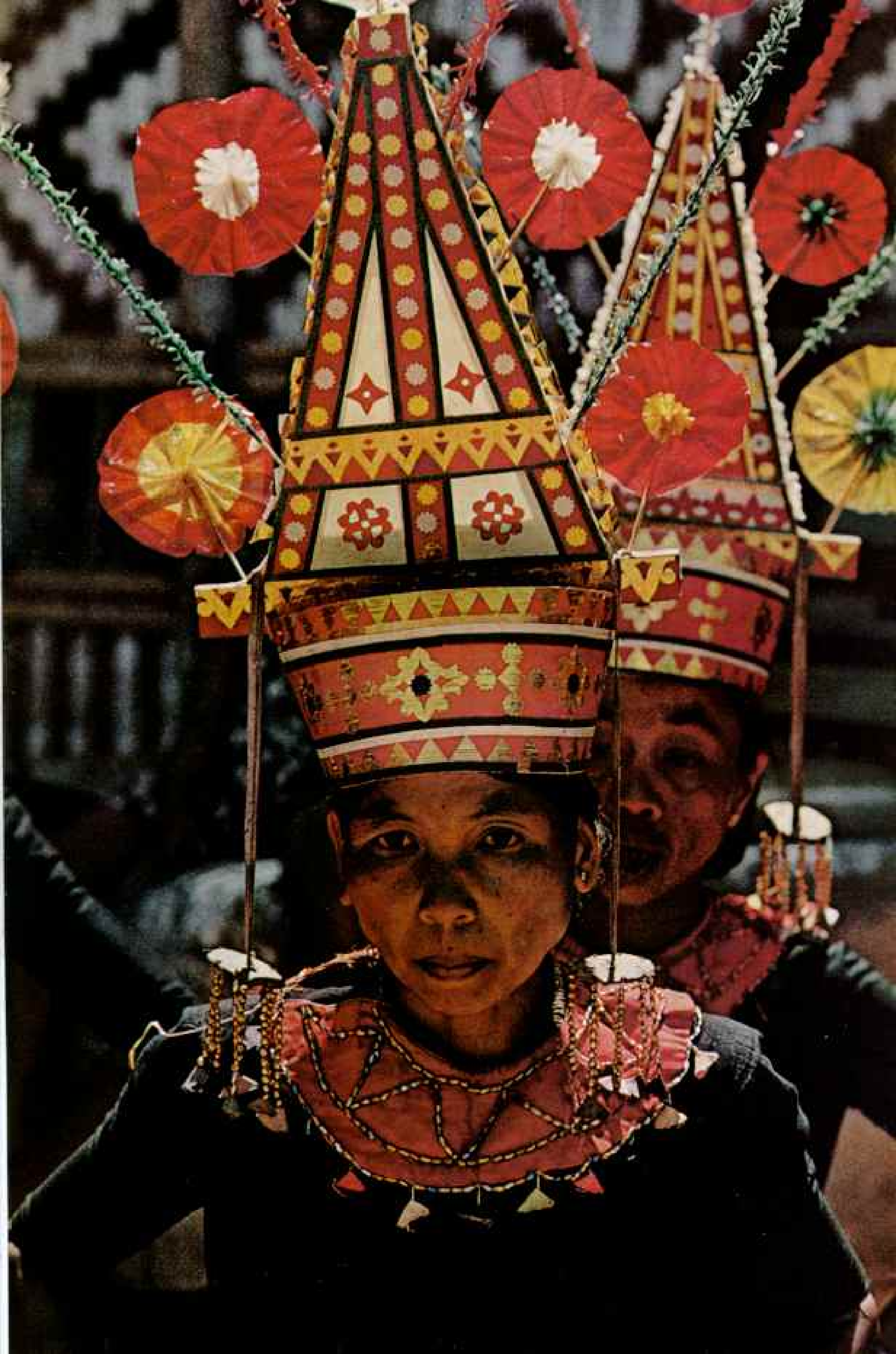


WIFFOLD PARKS (RIGHT) AND PAMELA MEYER

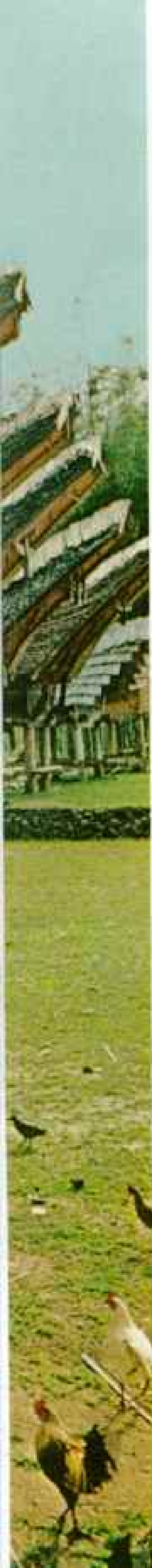
More craftsman than artist, a Toradja paints a stylized buffalo on a carved wooden panel that will decorate a house. He must overcome imagination, for his main responsibility is to keep traditional designs alive in their purest form.

The omnipresent buffalo also adorns the home of a weaver (above). The village sculptor fitted his creation with real horns, probably taken from a sacrificial beast at a funeral.

Glittering headdresses (right) cap the intent faces of funerary dancers.







FAMULA HEDER (LEFT) AND BRUCEY AND ERIC CRIVALE

Everyday life in Toradja remains tied to a basically vegetarian diet, except during funerals and festivals. Women (far left) buy unhusked rice, stored in a rich man's armada of ark-shaped granaries. Their resemblance to ships suggests to some anthropologists a seafaring past for these mountain people.

Frothy tuak, a mildly intoxicating liquor made from sugar-palm juice, flows into a jug (left). Bamboo stems behind the vendor serve as collecting pails; smaller ones are for passersby, who select tubes sized to their thirst.

Fiery appeal for a bountiful harvest climaxes the rice festival, a nightlong procession of song and dance (below). The ceremony includes animal sacrifices and reenactment of the planting-to-harvest cycle.





MARTELA WEYER (TOP) AND ERIC CRISTAL

Gleaned from past burials, skulls stare eerily from their natural sepulcher, a limestone cavern. Today most mourners bury their dead in narrow crypts chiseled by hand into cliffs of solid rock.

Months after her death, relatives of a commoner (below) wail over her body. Unlike a puang, she receives only a plain shroud and a simple farewell ceremony and burial.



of tuak, slung across their shoulders like rifles.

As each procession arrived, it was met by an official greeter, who paraded the villagers around the central plaza (pages 802-803). Two men, seated at a table, eyed the procession critically and, like bridesmaids at a bridal shower, carefully recorded the gifts. Formerly all this was entrusted to the memory of the elders, but today a detailed account is kept to guide descendants through the maze of old obligations paid and new ones incurred by the gifts brought to the dead man's feast.

Beyond the plaza, the guests were led to a reception house. There they were welcomed with offerings of betel and cigarettes. Next to the reception house, a large group of men, uniformly clad in black sarongs and white shirts, formed a wide circle. They performed *ma'badong*, songs and dances of mourning, which function both as prayer and as entertainment.

Mourner Tells Cat of Master's Passing

A runner appeared at our apartment.

"It begins," he said. "It begins."

We were about to witness the opening ritual of the funeral ceremony, which marks the return of a dead nobleman to the bosom of his ancestors. Months and often years in preparation, feasts of the setting sun are the supreme event in the religious and social life of the Toradja.

The wooden shutters of the main house stood bleakly shut. Across them, entwined in long bands of ribbon, stretched a row of crises, the ancestral daggers that are among the chief heirlooms of the Toradja. A framed photograph of the dead nobleman dangled from the carved buffalo head that dominated the facade. Upstairs in a darkened room rested Sa'pang, his head to the west, his familiar cup and saucer placed next to him, implying that he was merely ailing.

One of Sa'pang's sons invited us into the dead man's house. The stairway was dark and narrow. We stumbled as we went up and did not know what to expect. In a corner of the room lay the body, abundantly swathed in homespun quilting. In the months since Sa'pang had died, his corpse had dried out within its absorbent chrysalis.

Suddenly four men stepped out of the small gathering of onlookers. With a shout they took the wrapped body in their arms and lifted it. "Aieeeee, aieeeee, aieeeee," they

shrieked, as they tossed the body into the air, catching it as it came down. Again and again they tossed and caught it, changing the body's direction as they did so. Then they quietly lowered it to the floor. The atmosphere became somber once more. In its new position, the body lay with its feet pointing south, toward *puya*—heaven. Sa'pang was now truly dead.

An old man took a cat by the scruff of the neck, placed it on a rafter, and gently pushed it off. This act informed the cat that its master had died. Ritual mourning now began in earnest. One of Sa'pang's wives fell heavily to the floor and threw her arms over him, moaning and weeping in long sobs. We were nearly overwhelmed ourselves, so powerful was the expression of grief.

Descending the stairs, we moved out to the plaza. A gong resounded and a single buffalo was killed, the public proclamation of death. Its slaughter symbolically rendered the body of Sa'pang insignificant, releasing the spirit, *bombo*, so that it might undertake the journey to heaven. Moments later a second buffalo was sacrificed to assist the spirit in making contact with its forefathers.

The male dancers, meanwhile, formed their circle again and started a new round of dirges. In another part of the plaza, women sang and danced the *ma'katia*, songs of solace and comfort. All night long they would keep vigil.

Songs Salute the Living and the Dead

Late that night in our apartment, we were wakened by another kind of singing, now deep and resonant. We looked out across the rice field to the houses and the plaza, where a host of fires and lanterns flickered.

We quietly dressed and made our way to the plaza. Two vast circles had formed, and many villagers had joined the *ma'badong* dancers. Arms interlocked. Voices were strong and foot movements precise. As we sat at the edge of two circles listening, we sensed that, though the songs mourned the dead Sa'pang, the singing was directed as truly to the fellowship of the living.

During the next two days many pigs and buffaloes were sacrificed. Their meat was distributed to the assembled relatives and guests according to a complex system of guidelines based on rank and obligation. In all, 16 buffaloes were slaughtered—clear evidence of Sa'pang's importance.

On the second afternoon buffalo fights were staged in a fallow field. Lively betting on the outcome took place and then, at a signal, two monstrous and virtually identical black bulls were led onto the field from opposite ends.

The bull handlers taunted one another as a prelude to the battle. Finally they untied the ropes from the nose rings of the combatants and leaped nimbly to the levees.

Battle of Horns Resembles Swordplay

The bulls now performed a kind of ritual. They arched their necks and pointed their noses to the sky, searching for confirmation in the wind that the scent they detected was indeed that of another male. Each had one glassy eye fixed on the other.

Abruptly, one of the bulls savagely attacked a levee, sinking his horns deeply into it. His neck muscles bulged as he twisted his head from side to side. The other plunged his horns into the mud of the paddy floor. They worked themselves into a rage. Straightening out, they again tested the chemistry of the air, but now they approached one another, slowly, cautiously.

Clack! One bull had thrust with his horns—four feet tip to tip—and had been neatly parried (page 801). Clack, clack, clack, three thrusts and three parries, each raising an enthusiastic howl from the spectators. The adroitness of the fencing between such ponderous beasts was astonishing.

Then, doing away with the niceties of horn play, the bulls charged headlong into one another with a deep thud. The earth itself seemed to vibrate. The bulls' shoulders hunched, back muscles rippled, feet churned. For a moment, an impasse. Buffalo matched buffalo. The crowd screamed deliriously.

Now one buffalo moved, the other faltered, then lost ground. The stronger bull gained momentum and drove on like a four-legged locomotive. He never let up till he sent his opponent tumbling backward over the levee.

The loser scrambled to his feet, turned tail, and, acting more like a rabbit than a buffalo, fled through a scattering band of spectators and across a rice field. The winner lurched after him, but only briefly, preferring to return to the fighting arena, where he thrust his nose skyward again, sniffing for other bulls.

During all these rituals, the body of Sa'pang lay in his home. It would continue to lie there



Gazing with unseeing eyes, a *tau-tan* stands before a tomb entrance. Its carved features reflect those of the person whose



FAMILIA BRYER

corpse lies inside. Sun hat and pierced ears identify this effigy as a memorial to a woman. Only the wealthy can afford such statues, which are erected at the time of burial, ending a series of funeral observances that can stretch over a period of months, even years.





Tattered sentries share a ledge (left) outside a family crypt. Lasting for centuries, these tau-tau may represent many generations. A bamboo scaffold (above) provides access to the statues, which are periodically brought down, oiled, and dressed in new clothes and wigs of human hair. Using toeholds cut in a bamboo pole, a lone bearer (right) returns an effigy to its position before a vault.



WORLD NEWS (OPPOSITE) AND THE CRUISE

Final journey ends for a puang (above), wrapped in a funerary sack decorated with a gold sunburst design. A lithe climber bears the remains to its tomb as assistants keep the ladder from twisting. At the crypt another Toradja will place the body in a coffin and seal it behind a wooden door.

So ends the ceremony, "a vital part of the rich and varied culture these people have managed to preserve in their semi-isolated homeland in modern Indonesia," says Eric Crystal, an anthropologist who has lived and studied in Toradjaland.

until the burial. No one could tell us when this would take place—it might be months, even years, later. We had other commitments, so we left Tana Toradja at this point. But we carried with us a vivid memory of the kind of grave in which Sa'pang would finally rest. At a place called Londa, five miles from Rantepao, we had moved from under a warm sunny sky into the shadow of a vertical limestone cliff. Suddenly we found ourselves alone in a

chilling confrontation with Toradja death.

We might have been on a stage setting for some macabre Gothic play. More than a dozen human effigies, carved from hardwood, gazed fixedly at us from a long wooden balcony half-way up a cliff. Some sat, while others stood; all were fully garbed. Like a supremely remote and implacable jury, they seemed to be weighing the meaning of life and of everything beyond.



As if painted with an impressionist's brush, guesthouses shimmer in a sunlit shower.

A funeral had recently taken place here, for below, at the base of the cliff, stood an empty bier in the shape of a Toradja house or granary. A wide-brimmed sun hat hung from one end—a melancholy note. Slightly above the bier, on ledges running across the cliff face, perched several boat-shaped coffins.

We entered a cave in the cliff and saw other coffins tucked, almost haphazardly, into the nooks and crannies of the limestone wall.

Many of the coffins had neat piles of personal clothing heaped on them. Bones lay strewn on the floor and four skulls—from accidentally dislodged coffins—sat on a small outcrop facing the entrance. A dank odor permeated the cave, and a garish green light diffused through it.

Outside again, we scaled the cliff and climbed onto the ledge of the balcony to look more closely at the effigies. Called *tau-tau* by the Toradja, they serve to recall the memory of the dead. A tau-tau accompanies the body in the final procession to the grave site.

As we moved along the ledge, we saw 14 individual faces and had the haunting sense that we were violating their territory. Though their expressions were impassive, cheekbones, noses, chins, and mouths conveyed the character of real people. Only the ears were stylized, looking like fiddleheads.

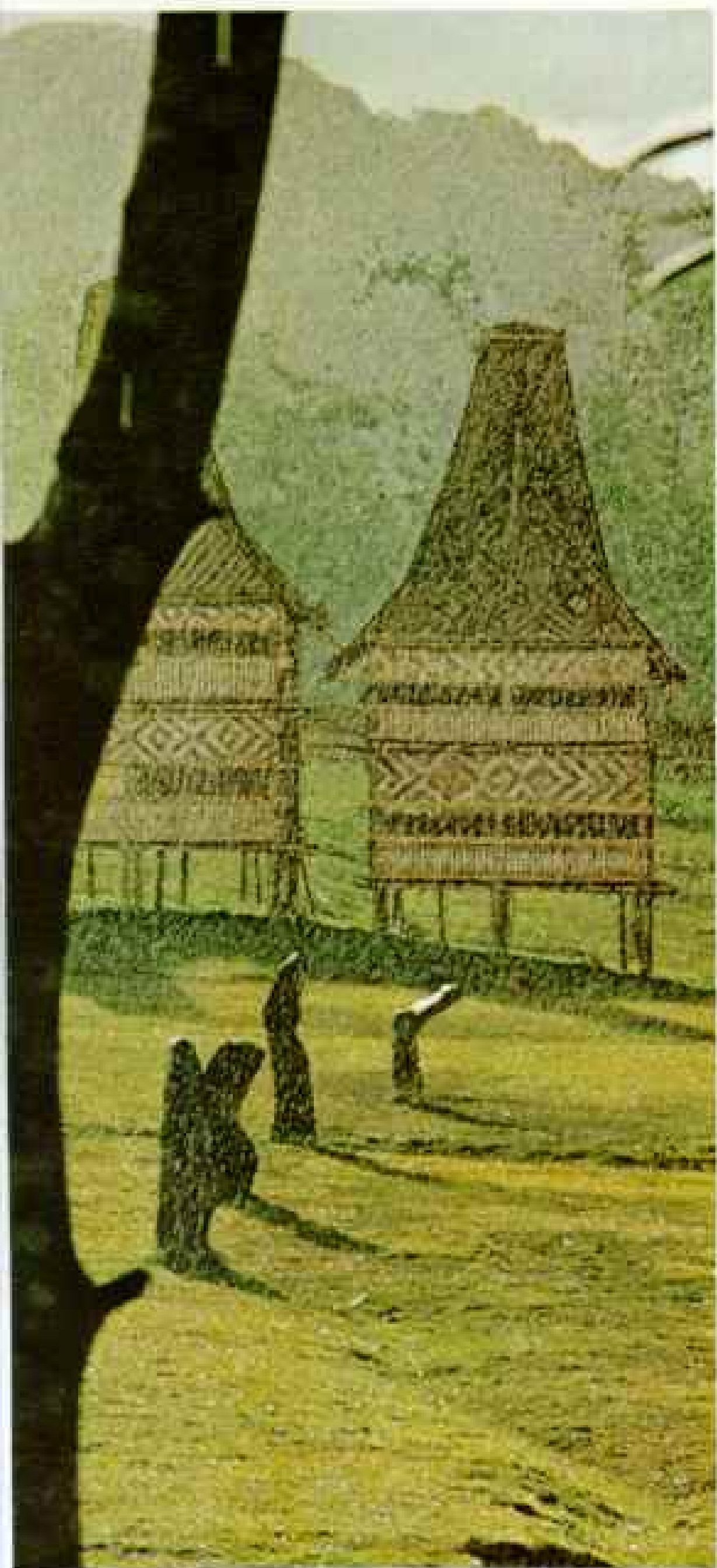
The figures were about a third smaller than life, but they wore baggy full-size jackets and tunics. One woman had golden earrings and a wig of real hair. As the wind skittered through the balcony, an out-of-place strand fluttered in front of her unblinking eyes.

Pallbearer Climbs a One-pole Ladder

The placing of the coffins on ledges and in natural caves, as at Londa, is a survival of earlier burial customs. Today most Toradja tombs are individually chiseled in places inaccessibly high on towering cliffs. There the bodies and personal effects interred with them are safe from pillage. Often small porticoes or balconies are constructed at the narrow openings of the tombs.

At the conclusion of a funeral, a lone pallbearer carries the remains in its funerary wrapping on his shoulders. He scales the cliff with the aid of a bamboo pole into which footholds have been cut—while strategically situated assistants steady it. He then places the body in a coffin previously set inside the crypt. Another helper seals the entrance with its wooden door. Finally, the tau-tau, perhaps with golden eyes, if it is a sumptuous one, is stationed at the entrance.

Many months after we left Indonesia we learned that, contrary to our expectations, Sa'pang had been buried shortly after our departure. We were sorry we had not been able to stay to see the old nobleman's body borne to its high mountain tomb. But we can imagine his tau-tau there, forever gazing from the cliffside upon the realm of the living. □



Monoliths memorialize dead puangs.



From shame to showcase: Less than a decade ago, the Willamette was the Pacific Northwest's most polluted waterway. Today it flows free of 90

A River Restored: Oregon's



percent of the wastes that once drained into it. Here, where the river slices between Oregon City and West Linn, fishing boats lie anchored in clear waters as chinook salmon make

their spring run to breed in headwater streams. Harmless steam pours from a pulp and paper mill that has spent more than nine million dollars to meet strict waste-control laws.

Willamette

By ETHEL A. STARBIRD

NATIONAL GEOGRAPHIC STAFF

Photographs by LOWELL J. GEORGIA

MY ARRIVAL in Oregon's capital last September coincided with the most unusual homecoming celebration I had ever seen. In Salem, bridges and banks along little Mill Creek brimmed with spectators, gathered to welcome a straggling parade of fall chinook salmon returning to their spawning grounds, 160 river miles from the sea.

Even Governor Tom McCall had deserted his desk; I found him a few blocks from the state capitol, stream-watching in his own backyard. I had come, I told him, to discuss Oregon's amazing achievements in water-pollution control.

"Well, that's one of them," he said, pointing to a pair of 20-pound fish scooping a gravel nest, or redd, in the shallows below. "Fall chinook never ventured into these waters until we cleaned up the Willamette River."

They couldn't. For the lower Willamette, which migrant fish must travel to reach their spawning areas, was so polluted less than a decade ago that even resident scavenger species perished. Spring chinook, riding a full

river, could survive the swim upstream, but fall chinook could not. By summer's end, running low and slow, the river was so clogged with agricultural, industrial, and human wastes that inbound salmon would have suffocated before they passed through Portland's harbor.

River Came Close to Strangling

The Willamette Valley, a strip of lush fields and forests, curls 187 miles into the foothills of western Oregon's Coast and Cascade Ranges. Return of the fall chinook to places where they were planted as fingerlings in the 1960's is a tribute to Oregonian tenacity in pushing through the most successful river-rejuvenation program in the country.

To see how well the program was working, I would spend three weeks on and along the Willamette, running all but the wilderness areas by canoe, jet boat, tug, and launch. But, first, I wanted to know how bad things really were at their worst.

The governor's able assistant for natural resources, Kessler Cannon, described the



depressing scene of the 1950's: "From Eugene to its confluence with the Columbia, the Willamette was the filthiest waterway in the Northwest and one of the most polluted in the Nation. Municipalities piped raw sewage into it. Pulp and paper mills added wood residues and strong chemicals. Food processors donated all their leftovers.*

"As the bacteria count rose, oxygen levels dropped—to near zero in some places," Kess Cannon continued. "Fish died. The threat of disease put a stop to safe swimming. Rafts of sunken sludge, surfacing in the heat of summer, discouraged water-skiing and took the pleasure out of boating."

The river is a resource the valley could ill afford to lose. It serves some 20 municipalities and 600 industrial plants; it irrigates thousands of acres of farmland and provides transportation for logs harvested on nearby hills. Millions of tons of gravel are mined from its bed and bars. And commercial and

*Earth's ecological crisis was described by Gordon Young in "Pollution, Threat to Man's Only Home," NATIONAL GEOGRAPHIC, December 1970.

sports fishermen on the Pacific Coast draw heavily on chinook and coho salmon produced in the Willamette and its tributaries.

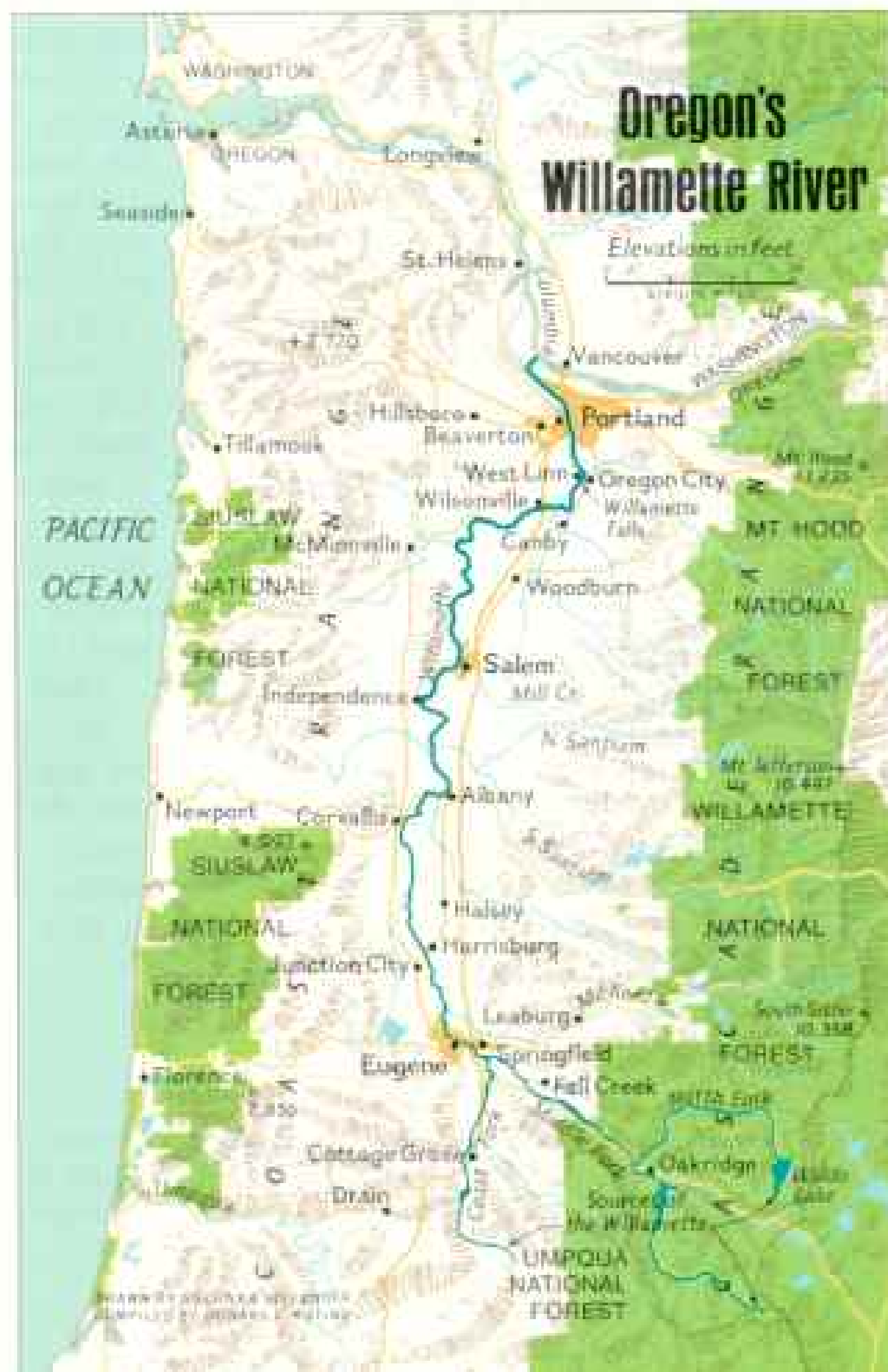
"Fishermen and conservationists were the first to call for reforms," Kess Cannon went on, "while polluters kept insisting the corrective costs were prohibitive. But the cleanup crusaders kept plugging away. Tom McCall, who was then a popular television newscaster, was one of them. In 1961, he made a real shocker of a documentary film that showed how rotten the river had become. Some polluters threatened to sue, but backed down. It's mighty hard to refute evidence everyone can see."

Protectionist sentiment snowballed. In 1966, both candidates for the governorship, which McCall won, campaigned vigorously for conservation and an end to pollution. Shortly thereafter, leadership and legislature kept their promise to the people by eliminating loopholes in existing laws and writing more-forceful ones.

What emerged was a reasonable and economically feasible program to improve

Pollution fighters gather beside the Willamette at West Linn. Oregon's Governor Tom McCall, left, explains his river-rejuvenation program to Laurance S. Rockefeller, center, and Charles A. Lindbergh. All are members of the national Citizens' Advisory Committee on Environmental Quality. Governor McCall's crusade to clean up the Willamette helped him win election in 1966 and reelection in 1970.

Lifeline of Oregon's economy, the Willamette (pronounced WIL-LAM-et) serves the recreational, industrial, and agricultural needs of 1.5 million people—70 percent of the state's population. Winning compliance to antipollution laws was simplified by the fact that the Willamette lies wholly within one state.



the Willamette which, in recent years, has:

- Reduced waste discharges into the river by some 90 percent.
- Boosted overall water quality to meet strict state and federal standards.
- Increased the number of migratory salmon, native trout, and other game fish.
- Made the river safe again for all water-contact sports, including swimming.

Surprisingly, the state—which pioneered and passed some of the toughest environmental legislation in the country—has not had to bring suit against a single violator. And only one small company chose to shut down rather than mend its ways.

Constant Watch Prevents Violations

For a close-up of the cleanup, I put into the Willamette's Middle Fork near Fall Creek for a 20-mile canoe trip downstream with slender, bearded Mel Jackson, outdoor and environmental coordinator for the Eugene Park and Recreation Department.

Though roiled by recent rains, the water seemed free of fouling as we slid past sand-spits and danced through rapids white-washed with foam. Only stilt-legged herons, posted like palace guards along the shoreline, noted our passing. The hand of man rests lightly on this region.

A riverside resident most of his life, 37-year-old Mel—who has more than 80 mountain and river rescue missions to his credit—spends some of his spare time as a self-appointed vigilante, searching the Middle Fork for signs of pollution.

"Sure, we've made progress," he conceded, as we shipped our paddles and let the lively current carry us along, "but the old abuses will come creeping back if we don't keep a careful, constant watch over these waters."

A few miles farther on, Mel proved his point; a dark stain was seeping into the stream from the east bank. Beaching the canoe, he struck inland and traced the trouble. Waste from a small mill, unattended on the weekend, spilled from a storage pond.

"There's not much traffic up this way," he said when he rejoined me. "The operators

probably gambled that no one would notice."

With Mel on the lookout, they had lost. On Monday, he reported his observations to environmental officials; on Tuesday, when he revisited the site, the ribbon of refuse had vanished. Obviously, citizen power is an effective force around these parts.

We landed, after four hours afloat, at Eugene, where the Willamette begins to feel the mounting pressures of population. Here the Coast Fork empties effluents from Cottage Grove and surrounding settlements into the main stem. A few miles away, the sprawling Weyerhaeuser pulp and paper mill at Springfield contributes waste waters by way of the McKenzie River.

Once the worst of the pollution began here. Now, with all municipalities on secondary sewage-treatment systems, waters reentering the river are about 90 percent pure, compared with the mere 35 percent achieved by primary plants of the past.

Fish Flourish on Sewage Pellets

Looking to the future, little Cottage Grove has installed the valley's first tertiary system. It removes 95 percent of all impurities and can accommodate twice its present load. So far, residual solids present no problem.

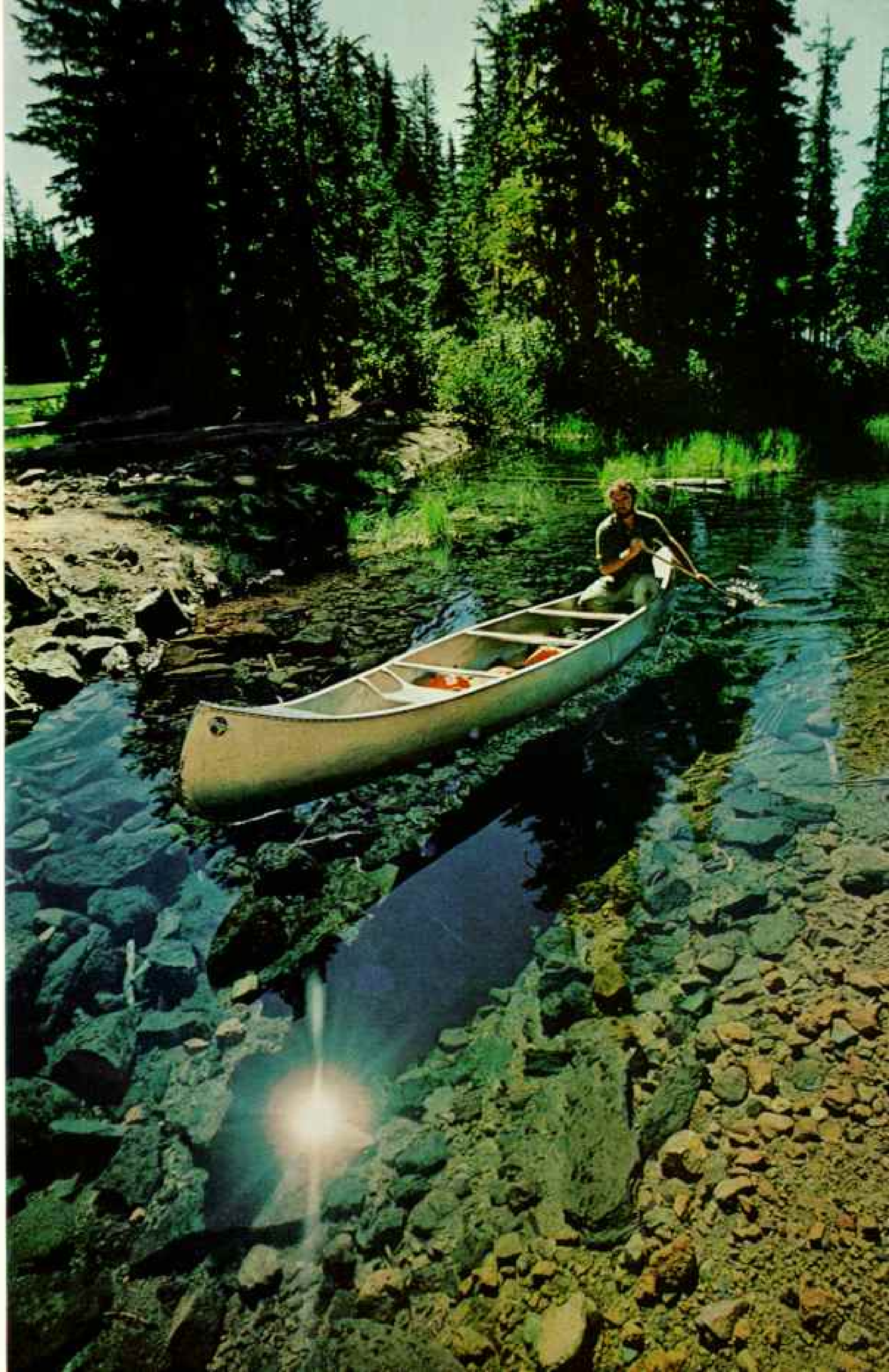
"Once they decompose and dry," supervisor Peter Horvath told me, "we have a free and odorless fertilizer local gardeners are eager to haul away [pages 822-3]."

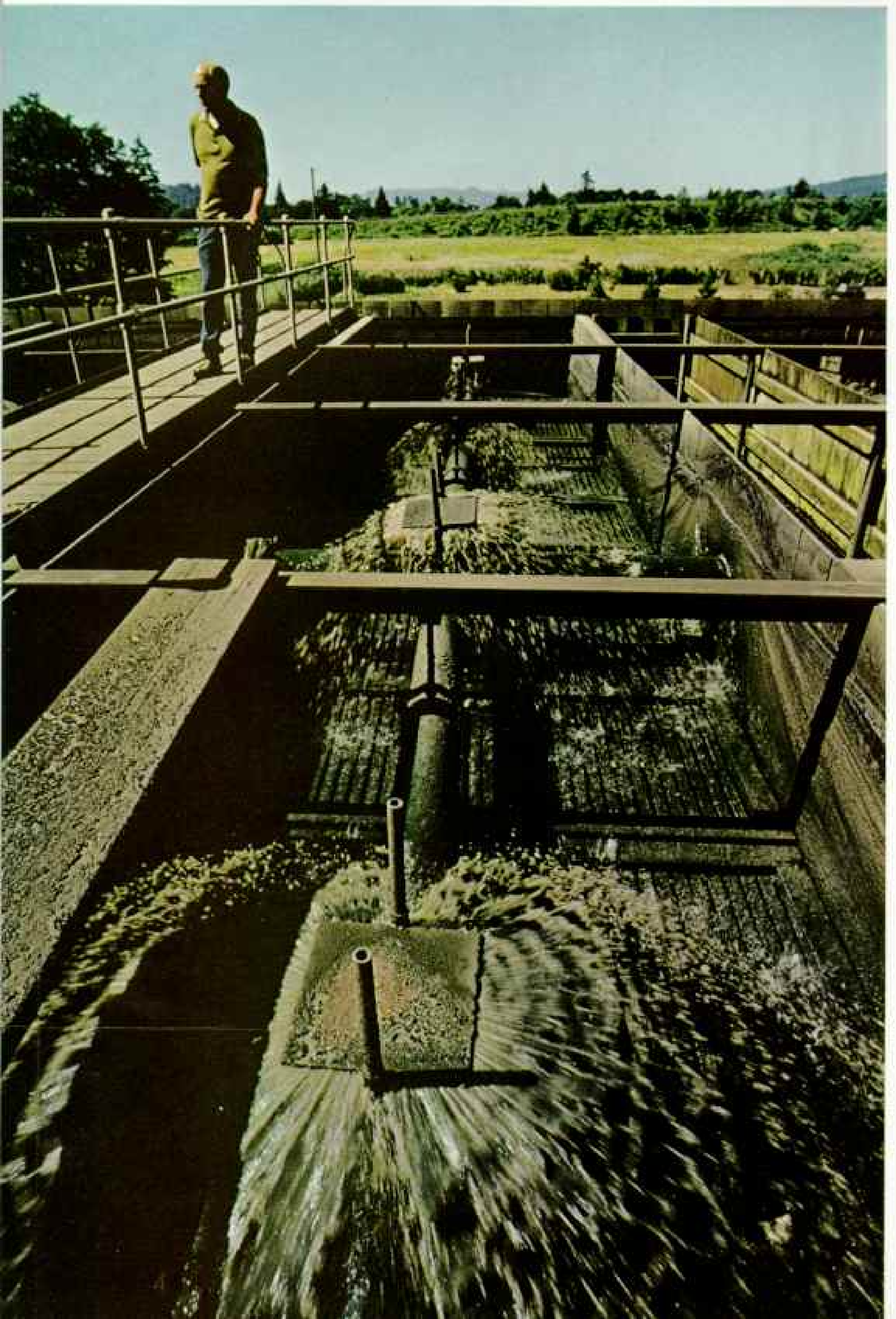
Inside his office, goldfish circled in a bowl and two trout stared from a tank. This, Peter explained, was his latest experiment in waste disposal. "We've kept these fellows healthy for a year on an exclusive diet of BB-size pellets pressed from sewage solids. Maybe pet shops and hatcheries will be our next customers."

There is no doubt that restricting what the river may receive has greatly accelerated the search for ways to recycle solids and further purify pollutants. New disposal techniques must be developed, for Oregon law makes no allowances for additional wastes to flow into the river, even though valley

(Continued on page 826)

Water clear as sunlight buoys Mel Jackson of Eugene along the Willamette's North Fork, near its birthplace in the Cascades. He canoes on lake-fed headwaters free of any contamination introduced by man's industry or carelessness.





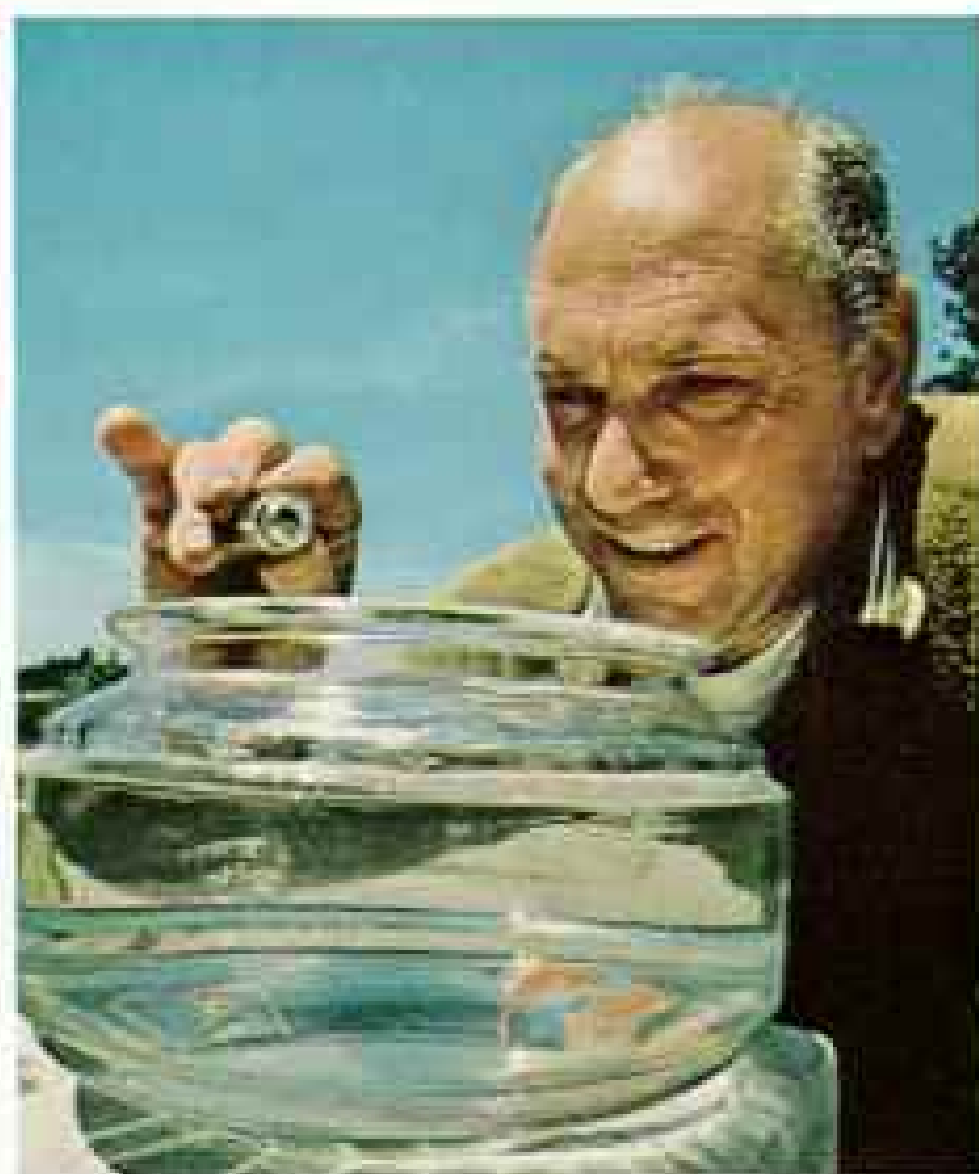
Laundering a city's sewage, a three-stage filtering system—the first in the Willamette region—processes wastes from Cottage Grove, Oregon. In the second stage (left), redwood baffles boost the absorption of oxygen, which speeds breakdown of solids by bacteria.



Beakers tell the story: Four samples proclaim results of the three-stage process. Darkest is untreated sewage. Hand-held jar holds the final result, cleansed of 95 percent of its impurities.

Fertilizer, anyone? Sun-dried sludge that settles out during the sewage-treatment process (upper right) becomes a free bounty for local gardeners, who haul it away by the truckload. Rich in nutrients, the odorless material makes an excellent soil builder.

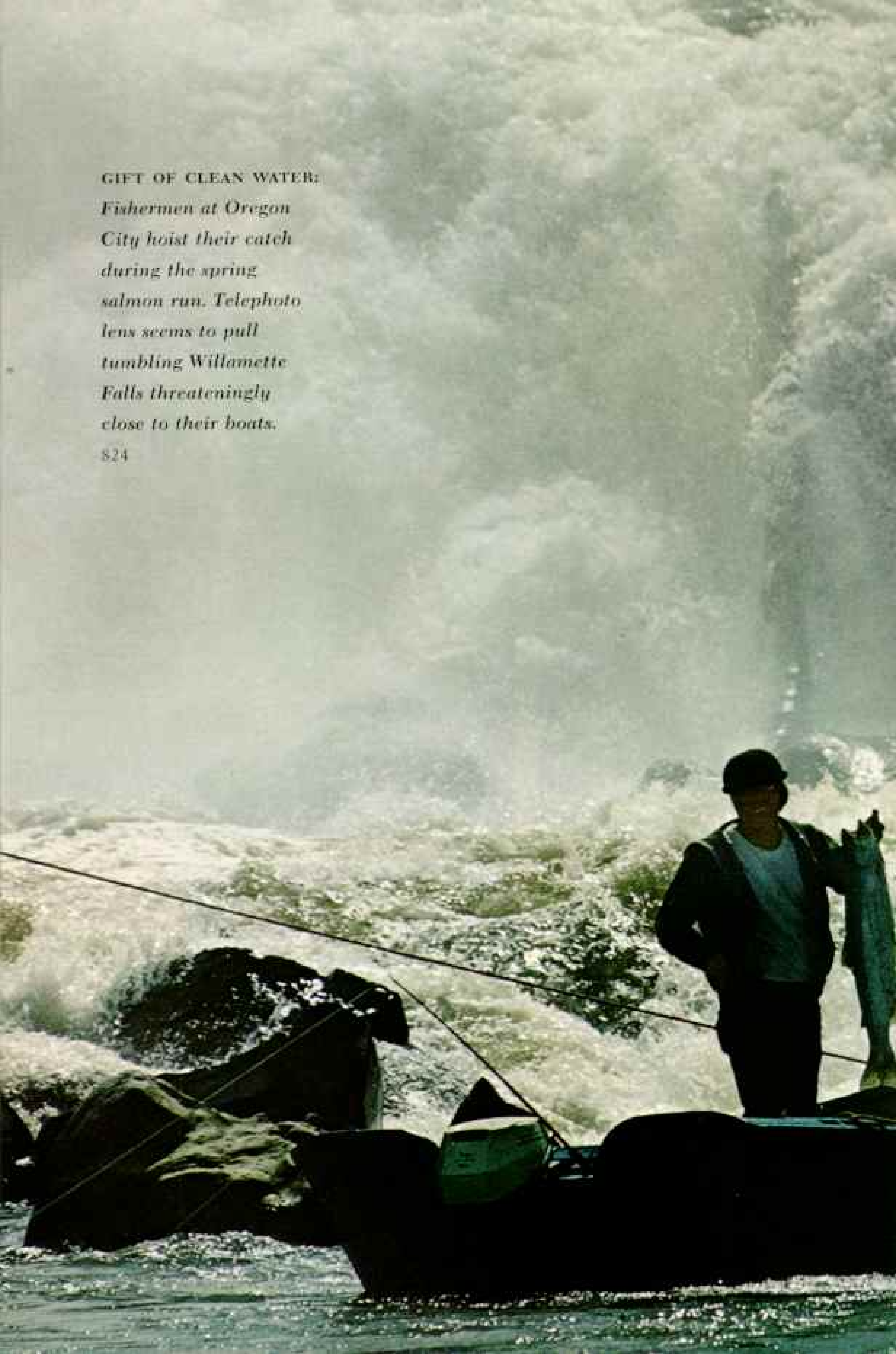
Fish gobble it up! Pellets pressed from sewage sludge keep goldfish thriving (right). Plant supervisor Peter Horvath looks to salmon hatcheries as possible large-scale users of this food made from recycled waste.



GIFT OF CLEAN WATER:

*Fishermen at Oregon
City hoist their catch
during the spring
salmon run. Telephoto
lens seems to pull
tumbling Willamette
Falls threateningly
close to their boats.*

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industrial production and population are bound to grow.

Demonstration projects have already proved that industrial discharges can be diverted to useful purposes. Hot waste water from Weyerhaeuser's Springfield plant has been sprayed on nearby orchards to keep fruit trees from freezing (page 828). Applied to vegetable fields, the water has made it possible to grow two crops in a single year.

Pulp- and papermakers, once the Willamette's worst polluters, must install chemical-recovery and secondary waste-treatment facilities by this summer. Most have already done so, at a combined cost of some 50 million dollars. To ease this financial strain, participating industries can deduct 5 percent of their costs from their state corporate taxes each year through 1977.

Mills and municipalities follow much the same formula for secondary treatment. Sewage is held until most solids settle out or are skimmed away. Bacteria break down residual waste, then mechanical agitation

beats air back into the river-bound discharge to restore the oxygen level. A state permit system sets quality standards for all liquid discharges and requires frequent testing of outflows. Infractions can result in revocation of this permit and, with it, the operator's dumping privilege.

An early leader in the war to clean up the Willamette, Portland attorney John D. Mosser calls the permit process "one of our most effective weapons."

"Should a company lose its river rights," Mr. Mosser said, "it would have to close or convert to a completely independent disposal system. Meeting permit standards is by far the easiest and least expensive choice."

Fortunately, Oregon's rigid rules were passed without the waivers and variances that have undermined similar efforts elsewhere—and with only slight resistance. A few lobbyists descended on the capitol to oppose the sweeping changes proposed for 1967, but most of the lawmakers listened, instead, to the public demand for action.



"After all," Mr. Mosser said, "politicians want to keep their constituents, and industry its good community relations. So we ended up working together to devise and enact legislation everyone could live with."

Battle Extends to Riverside Clutter

Riding a jet boat from Eugene to Corvallis, I found the results of this effort reassuring. Here, the river has regained its unspoiled charm. A lone osprey flapped overhead, clutching a whitefish in its claws. Two red-tailed hawks battled above the alders for possession of a small snake. Flocks of killdeer skittered along the shore, while mergansers, mallards, teals, and coots bobbed around us like bathtub toys.

Not a beer can marred the setting. Oregon, in another bold move, is choking off such clutter with a new law that requires a deposit on *all* beverage bottles and cans. Officials believe that if buyers don't bring them back for a refund, energetic collectors in search of easy cash will. The sale of pull-tab

containers in the state is totally forbidden.

Good companionship added to the delights of the trip. Skipper Wayne Gardner of Leaburg guides professionally on wilder rivers, but has run this one for years. Henry Stewart, civilian planning chief for the Portland District of the U. S. Army Corps of Engineers—and an active environmentalist—knows every sandbar and bend.

Not always compatible elsewhere, Corps and conservationists work remarkably well together in Oregon. "Even many of those opposed to any man-made control over natural resources," Henry said, "realize that restoring the Willamette to full vitality would have been far less feasible had there been no dams on its tributaries."

Planned primarily for flood control and water storage—though some produce hydroelectric power as well—the dams are also manipulated to improve water quality, for the benefit of fish and the pleasure of people.

"This drainage basin averages about nine rainy months a year and, from June to



Census of home-bound fish counts swimmers making their way up a new fish ladder at Willamette Falls. Television camera aimed at the underwater window videotapes passersby—here two steelhead trout.

Return of the natives: These anglers exult in a bonanza unmatched for decades as spawning salmon again return from the Pacific. Only 79 chinooks were counted in the fall-run of 1965; the 1971 tally exceeded 5,000.

September, three fairly dry ones," Wayne said. "Spring chinook get the breaks. They migrate from April to June, when the flow is cool and constant, then spend the summer and spawn high up on feeder streams, where the same favorable conditions prevail."

"No such luck for the fall chinook," Henry added. "Arriving this time of year, they'd meet sluggish, overheated waters heavily burdened with waste, if the Corps of Engineers didn't increase reservoir outflow to raise the river level and lower its temperature."

Decisions—for fish, farms, navigation, and recreation—are made in Portland. There the division engineer, Maj. Gen. Kenneth T. Sawyer, and his staff weigh water-release requests against weather predictions and river conditions and arrive, through the use of computers, at a daily rate of flow that satisfies the maximum number of valley needs.

Model Plant Steps Back From River

One of the Willamette's best customers, the American Can Company, completed its model pulp and paper plant three miles east of the river near Halsey in 1969. Four million dollars—10 percent of all construction costs—were spent on pollution controls (page 832). I asked why the mill, which uses 18 million gallons of river water a day, was so far removed from the source.

"We intended to locate much closer," plant manager Thomas W. Orr told me. "But when state officials explained their long-range plans for a park along both banks, their need for the site seemed greater than ours."

In this way, American Can has already shown its support for the highly ambitious Greenway program, which proposes eventually to edge the river with a nearly continuous strip of recreational land for public use.

Below Halsey, our jet boat passed shovels scooping away bars and islands, satisfying a growing need for gravel to make concrete. To prevent destruction of spawning areas and silting that kills fish eggs, the law insists that a berm—a protective strip—be left around all excavations. As a further precaution, stone crushing and washing operations ashore must return only unclouded water to the Willamette.

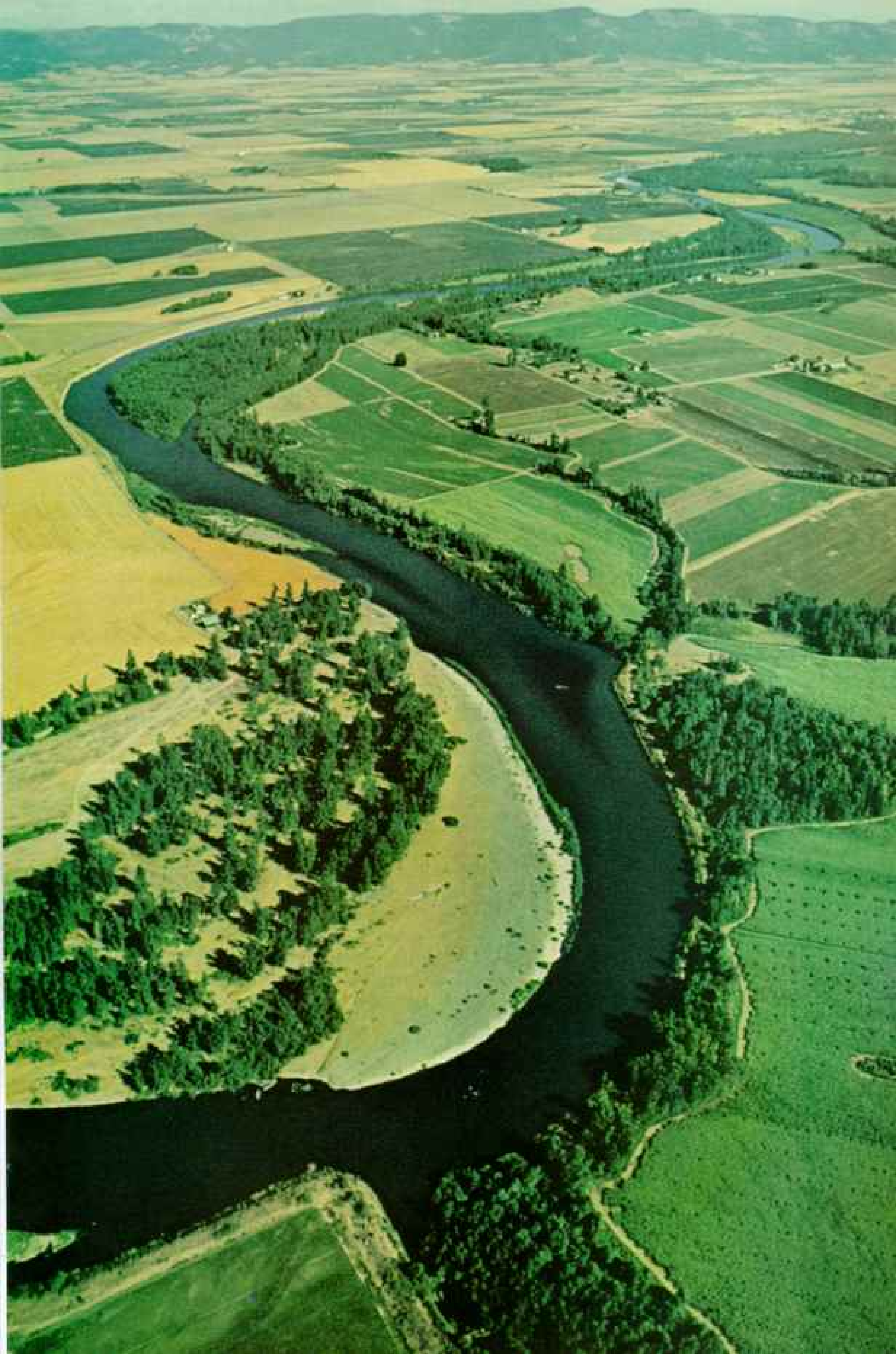
A brown streak off our starboard side hinted at another infraction. How well do citizen complaints really work? When I telephoned from Corvallis, I learned that ten other river-watchers had already reported the matter and remedial action had begun.



RICHARD TITTON

"Warm ice" may save fruit buds from frost damage. Hot waste water from the Weyerhaeuser pulp and paper plant at Springfield has been experimentally sprayed on trees in nearby orchards. Sheathing the branches with a coating of ice, the technique keeps delicate buds insulated at about 30.5° F., even when the air temperature plummets as low as 15° F.

Lazy-looping river meanders through lush farm country near Eugene. Fertile bottomlands, saved from flooding by upstream dams, make the Willamette Valley one of the most productive in the United States. The ambitious Greenway plan calls for eventually bordering the river with an almost continuous belt of parkland for recreational use.



"Hand-in-hand with nature"—theme of the ambitious Greenway program designed to border the river with parkland—inspired the official flag (below) of Wilsonville, a new town 20 miles south of Portland. A Wilsonville youth (bottom) helps clean up riverside property bought by townsfolk for the project.



At Corvallis, Henry and I transferred to the tug *Maria*. With towing business seriously curtailed by a shipping strike, owner Bill Bernert had agreed to a charter that would carry us downstream to Portland at a leisurely pace.

Occasional openings in the bank cover of cottonwoods and willows revealed the empty lines and vines of hopyards, cornfields bannered with silk, dark green carpets of growing mint, stake-sided trailers heaped with the last of the beet harvest.

Bisecting one of the Nation's most productive food-growing valleys, the Willamette has long carried away most of the refuse attendant upon a rich agricultural community. But those days and ways are dying. Animal wastes may no longer accumulate on cattle feedlots to be washed into the river by heavy rains. And canneries and food-freezing companies must tie into municipal sewage systems—if facilities permit—or develop waste-treatment plants of their own.

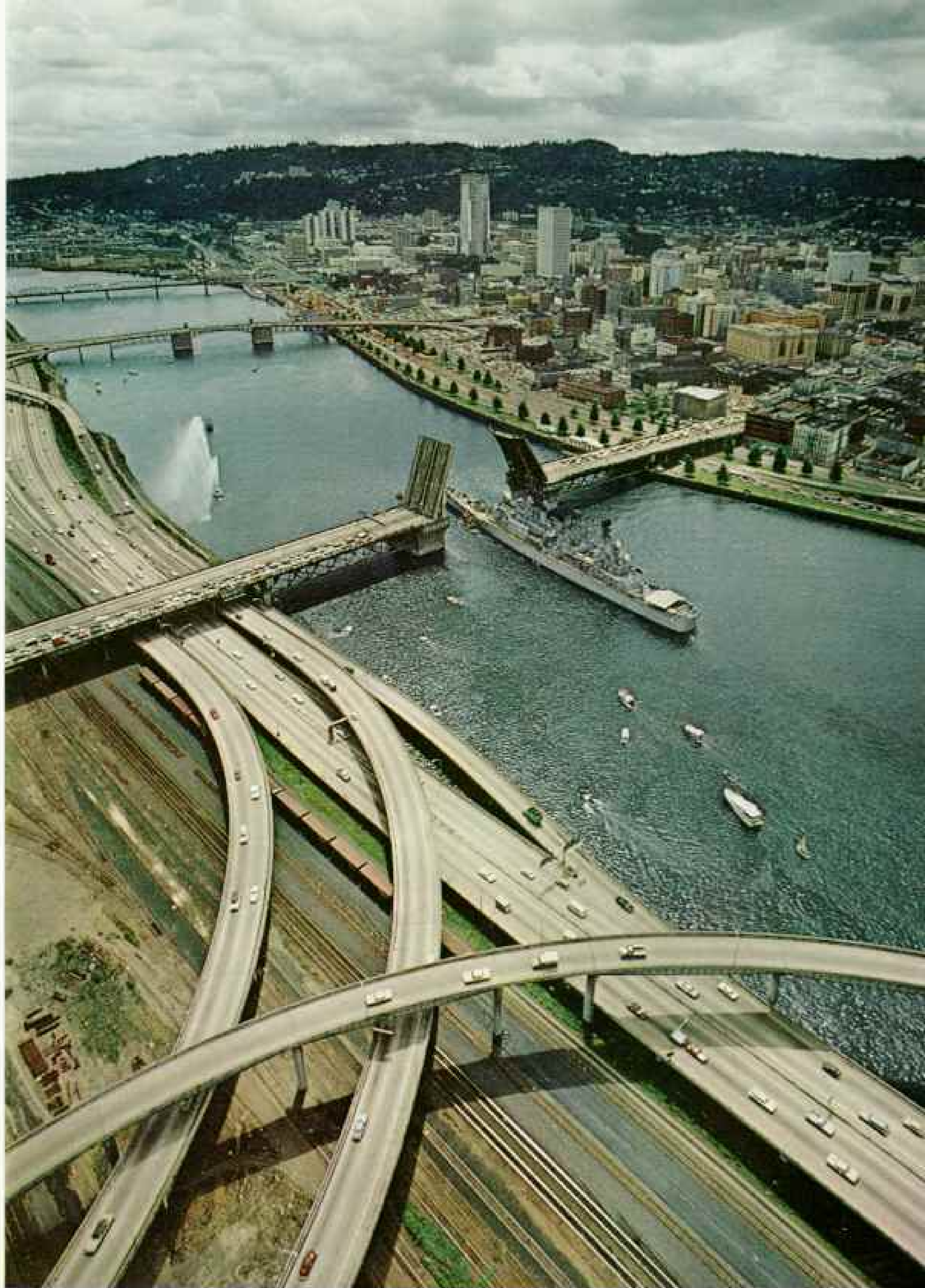
Some nutritious effluent from food canneries and feedlots, diluted to safe strengths, pours back onto fields, reducing the need for stronger fertilizers. As urbanization nibbles away at farmlands, however, cultivation will become more intensive. Then residents along the Willamette will have to worry about runoff of chemical fertilizers that, so far, have presented no problem.

Waterborne Seeds Yield Bumper Crops

Approaching Salem, the region's largest food-processing center, we drifted under a half-toppled apple tree and sampled its ripening fruit. Bill later butted the tough little tug into a bank where we gathered windfall filberts from the river's edge.

"A few years back," he said, "I could have picked you the makings of a full meal without ever leaving the river. All legal, you understand. A lot of seeds from cannery garbage caught on the shore and sprouted. Why, I've collected a couple of bushels of prime tomatoes on that bar right over there."

Bill and the *Maria* generally work the Willamette—navigable from Corvallis to the Columbia—towing rafts of logs from upland forests to wood-products plants along the river or into Portland for relay shipment. Newly cut timber, just passing through, adds no pollutants, but storing logs in the water does. Some rafts, moored along the banks



Fireboat sends up twin plumes as it welcomes the cruiser *U.S.S. Providence* to Portland for the city's annual Rose Festival. The busy harbor, once a festering sinkhole for all the Willamette's ills, now ranks among the cleanest in the Nation.



near Canby, have been afloat so long they've grown a thatch of weeds and bushes.

"Authorities are working on ways to reduce that problem, too," Henry said. "Tree bark soon flakes off and sinks to the bottom. Decaying there, it uses up a lot of oxygen. Possible solutions include requiring lumber industries to stack their logs on land or hold them in man-made lagoons."

Proscriptions placed on river use have cut into Bill's business, but he takes his losses philosophically. "After all," he said, "these waters are everybody's business. I'd far rather see them enjoyed than destroyed."

The enjoyment that people find along their rejuvenated river becomes fully evident in the last ten miles above the twin towns of West Linn and Oregon City. Here boathouses and sleek cruisers nestle beneath the bluffs. Fishermen crowd the current, trolling effortlessly downstream. Water-skiers perform their aquabatics, while 20th-century Tom Sawyers pole makeshift rafts along the shoreline. Commercial craft like Bill's creep slowly by, leaving such pleasures undisturbed.

Fish Climb a Watery Ladder

Industrial activity returns to the river at West Linn, where the Willamette cascades over a cliff 30 feet high and sluices past a power plant and two paper mills (pages 816-17). A new fish ladder now climbs the face of the falls, long an impassable obstacle for many salmon and steelhead trout trying to reach spawning beds upstream. Although the ladder cost some 3.7 million dollars, experts expect it to pay for itself by boosting the river's fish population by about 350 percent. To assure the venture's success, one good corporate neighbor—the Portland General Electric Company—donated more than half a million dollars.

Squeezed onto small rockbound sites on opposite sides of the falls, with little space for waste-treatment installations, Publishers Paper Company and the Crown Zellerbach plant are paying a high price for pollution controls. And rather than run its own hydroelectric turbines, which might injure young salmon as they head toward the ocean, Crown Zellerbach has agreed to shut them down and purchase commercial power during periods of fish migration.

A few miles downriver, Sellwood Bridge arches above some forty handsome houseboats, bright with potted plants and blossom-filled window boxes. Their owners, too, have



Unceasing vigilance keeps the river from reverting to its old untidy ways. A government official on pollution patrol checks wastes from a chemical plant. Rather than face court action, offenders have been quick to correct mistakes.

Whipped to a froth by rotors, effluent from American Can Company's pulp mill near Halsey (opposite) undergoes aeration to renew the oxygen content and speed the growth of bacteria that break down wastes. Despite the cost of such processes, only one small firm chose to close down rather than comply with tough regulations.

cooperated with the antipollution campaign by piping their sewage into the municipal system ashore, as the law now requires. Since the cleanup, demand for floating homes has skyrocketed, and even residents who were once indifferent to the Willamette's welfare are now its watchful guardians.

I found Frank Peters on the front deck of his houseboat, tossing bread crumbs to a greedy Canada goose. "You can really get hooked on this river living," he said. "Why, I catch trout and salmon from this very spot, swim when I please, and—if it gets real hot—paddle around on an inner tube, keeping cool and at the same time calling on my neighbors. No mowing or sowing for my yard, just a little litter prevention keeps it neat. All of us snag out debris and report drifting refuse we can't handle. And we don't toss so much as a matchstick overboard."

"A lot of little efforts," the governor had said, "make the big difference between success and failure." From Mel Jackson to Frank Peters—almost the river's length apart—thousands of Oregonians now live by this creed. Flotsam that finds its way into the water seldom stays there long.

Oregon Plans the Willamette's Future

"What's next for the Willamette?" I asked L. B. Day, Director of the state's Department of Environmental Quality.

"Our eventual aim is to divert *all* wastes from the river," he answered. "And I'm convinced it can be done. Maybe not tomorrow, but we're moving in on the problem."

For, to Oregon, the future is worth planning today. The Greenway program, which may not reach fruition for many years, typifies the state's farsighted attitude.

"The river itself is now relatively clean," State Parks Superintendent David G. Talbot said, "but much of its beauty lies along the banks. We are determined not to let the setting deteriorate the way the water did."

"It will take time and many millions of dollars to acquire a protective strip of parkland," he continued. "If the Greenway doesn't

prevail over development of the fringe property, we'll all be the losers."

With strong support from government officials and civic groups, the Greenway is gaining ground. Although state and local public lands presently preserve only 60 of 510 riverbank miles, another 156 miles will soon be purchased with state and federal matching funds. In January, the Department of the Interior awarded a grant of \$5,000,000; Oregon's \$5,000,000 already is allotted.

There has been such a citizen surge in preservation planning that last year the state passed 37 separate pieces of environmental legislation, much of it relating to the river. One bill directs state, counties, and cities to spend 1 percent of their highway funds for bicycle and foot trails along developing roads and in park recreation areas. It is hoped that the allocation, which will amount to about three million dollars this year, will include acquisition of pathway property to support the Greenway concept.

Pacesetting Project Wins National Praise

By passing progressive antipollution legislation, Oregon has produced a highly imaginative, innovative cleanup program that could well serve as a pattern for other states.

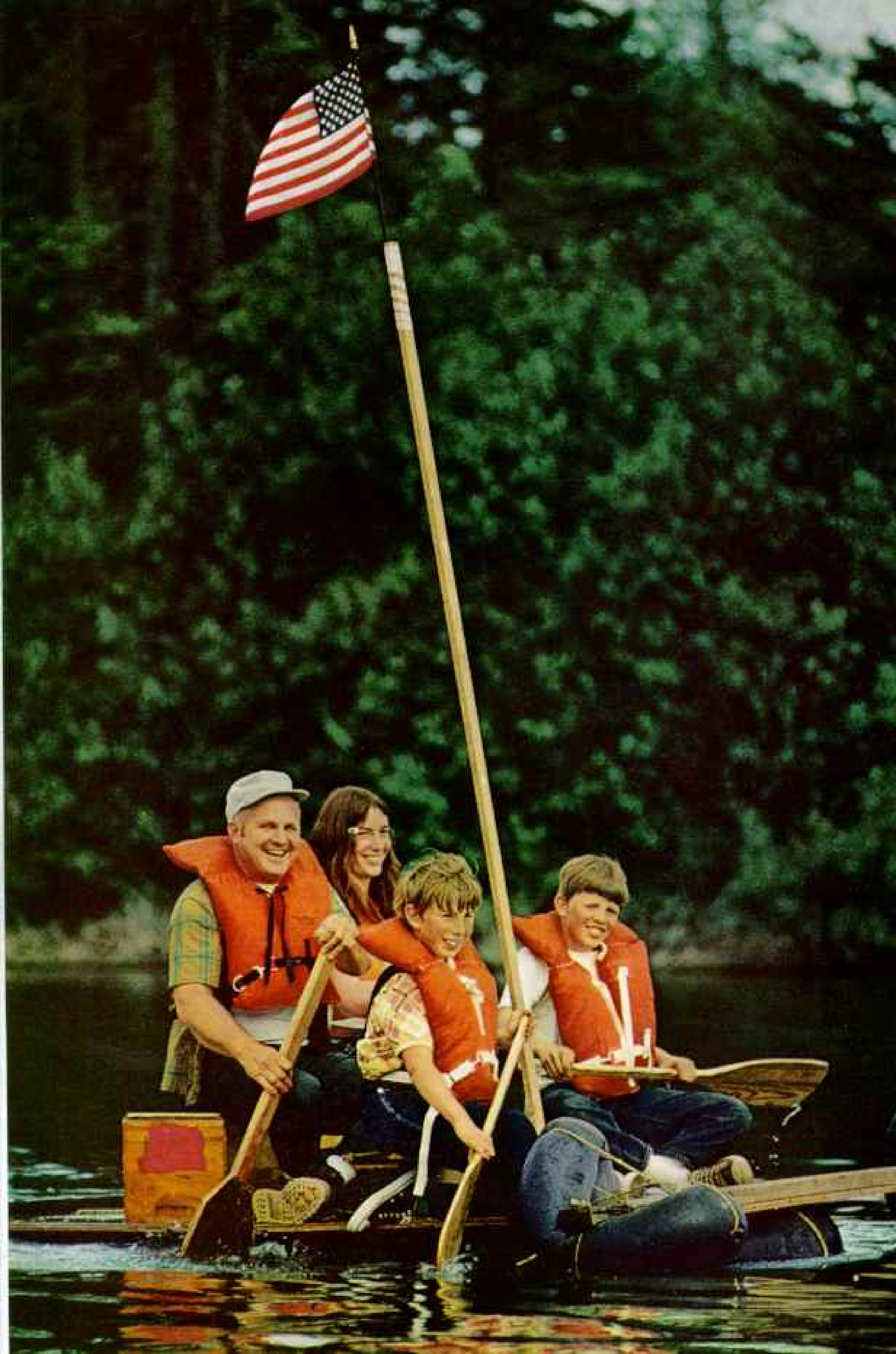
"Possibly for the whole country," commented Chairman Laurance S. Rockefeller (page 818), when I met him in Portland at the fall meeting of the Citizens' Advisory Committee on Environmental Quality. "We intend to recommend parts of the program to the President for national consideration."

"The success on the Willamette teaches a simple lesson," added fellow member Frank Borman, the former astronaut. "If people want action, they carry the clout to get it."

Recognizing the ecological ills infecting other states, Oregon acted before time ran out. Now chinook spawn even below once-deadly outfalls. Little untreated waste ever enters the stream. Transgressors have learned that the laws won't bend.

Obviously, man and nature have come to terms along the Willamette. □

A river for everybody: With Old Glory at the masthead, a foursome competes in a Fourth of July raft race near Independence. Today, the entire length of the Willamette to Portland provides a safe playground for water sports, including swimming. Perhaps even more important, Oregon's accomplishment instills a valuable environmental awareness in the state's young people, heirs to the river of tomorrow.





The World of My Apple Tree

By **ROBERT F. SISSON**

NATIONAL GEOGRAPHIC PHOTOGRAPHER



APRIL 30 The morning sun comes skipping down the mountainside, pushing light and warmth into Harmony Hollow. Father Robin perches on a nest in my York Imperial apple tree, waiting for his mate to swoop in with breakfast for two greedy babies.

The old tree, on its Virginia hillside overlooking the barnyard, is a bit slow in dressing up. But after 70 years, being a little out of style is forgivable. Just today does she begin to blossom.

I come by my love for the tree in many ways. We both sit on the hill and watch. I watch the animals and birds that visit or live in the tree, and she watches over them for me.

I have another connection. My fourth great-uncle—so my grandmother said—was John Chapman, better known as Johnny Appleseed.



MAY 5 I climb the tree late this afternoon and relax, my back against a foot-wide limb. A pink-and-white blossom proclaims the tree's survival through one more winter.

My tree dresses for each season. Only a few weeks ago she held up bare branches like the fingers

of a skeleton. Beneath, black shapes stood like undefined wraiths. When the fog began to lift, they turned into an Angus cow and her calves.

In the clear light of summer the mystique is gone, and the tree is again a proud, prim lady in green. Sudden storms rush down the



hollow with a sound like a great freight train, and I wish I could protect the old girl from the lash of the wind.

An early snowfall gowns her in white lace. And because she's not young, I give her branches a shake now and then to lighten their burden.



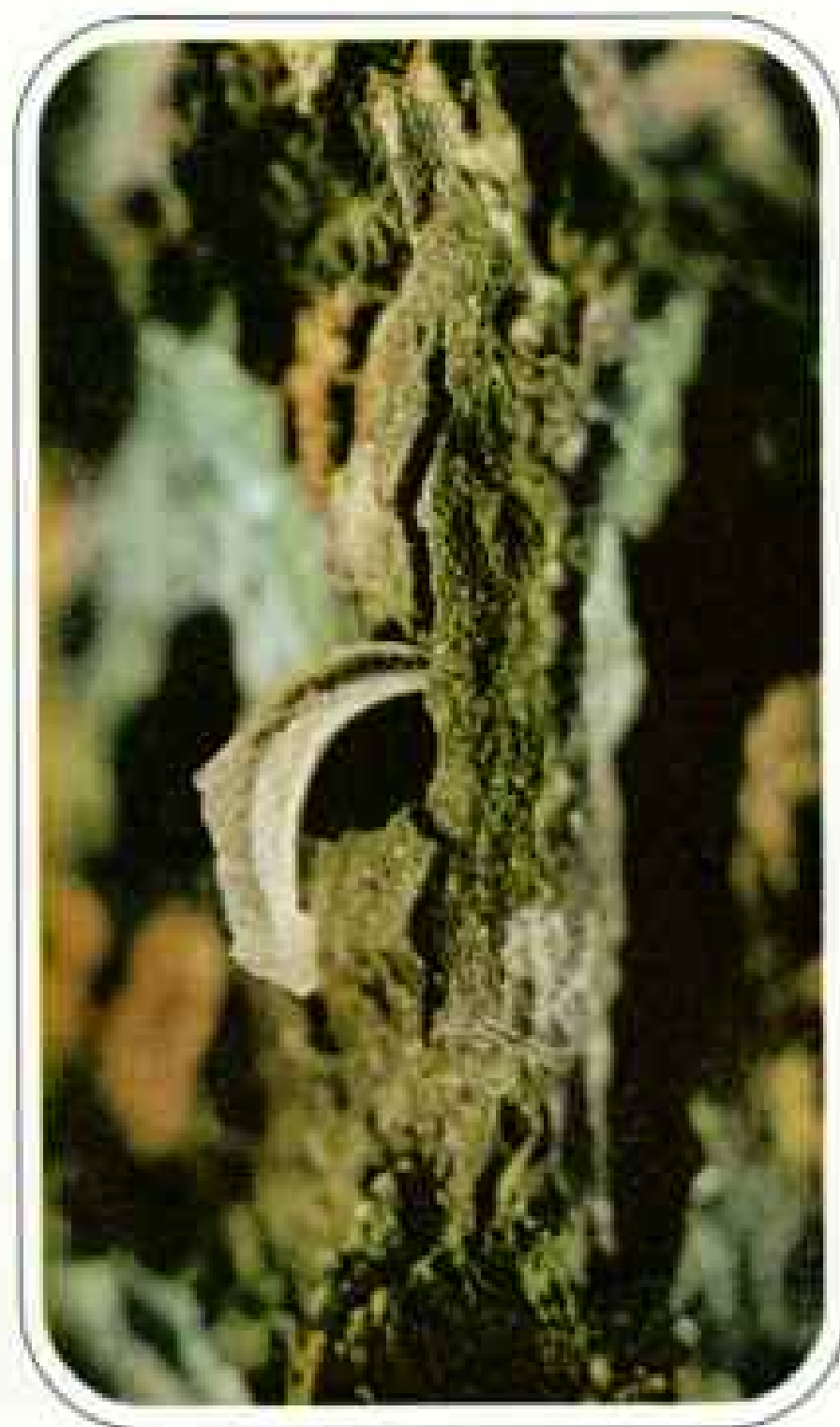




JULY 20 Standing beneath the tree this morning, I look up at all those holes marching around and up the trunk, the signature of a yellow-bellied sapsucker. Since December, when the leaves had gone and I could get a better view, I have watched the bird busily drilling holes into the tree.

About 10 a.m., she comes again and begins to work her way around the tree, probing for sap and insects. As I set up my camera, something bumps my leg. I look down. It's one of the barn cats. The cat sees the bird and is off, running low and fast. The bird sees her coming and leaves. I hate cats! I throw a rock, but just in front of her, for I really don't hate them enough to hurt them.

Some days later, as I examine the trunk for insects, I see something sticking out of the bark. At first I think it is a fungus. Gently I touch it with my tweezers. It has a firm body, and is almost clear. I look again. It's the sheath of a cat's claw. A barn cat again!



SEPTEMBER 7 Under my tree is a rock; under the rock is a hole. Here lives what must be one of the fattest groundhogs in all Virginia. ▶

Today, as I go through the barnyard to feed the pigs, I glance up the hill. Sure enough, there is Mr. Groundhog, sitting up under the tree eating a bright red apple (*following pages*).

Two of the tree's main branches are so positioned that any apple that falls will roll right up to or into the doorway of the groundhog's house. He obviously chose this location with an eye not only to the view, but also to a goodly supply of food.







AUGUST 23 As I sit in the tree this afternoon enjoying the breeze and the quiet, a thistle blows by and sticks on a limb just above my head. A hackberry butterfly drifts in and sits on the branch in front of me. So quietly does it come and go that only the wind and I know it has been there.

The butterfly reminds me of the tent caterpillars, now moths, that in the spring spun their gauzelike communes between branches. Other multilegged creatures meander about the tree in search of greenery.

Just the other day a slight motion attracted my attention to a great hairy apparition, a pale tussock caterpillar (*right*) chewing on an apple leaf. Mr. Tufts, as I called him, went right to work. In 15 minutes he had eaten from the leaf a curved section about half an inch long and half an inch deep. Not only did I see his voracity, I heard it. My wife, son, and a friend listened to him with me.

"He sounds," my wife said, "like a midget eating celery."







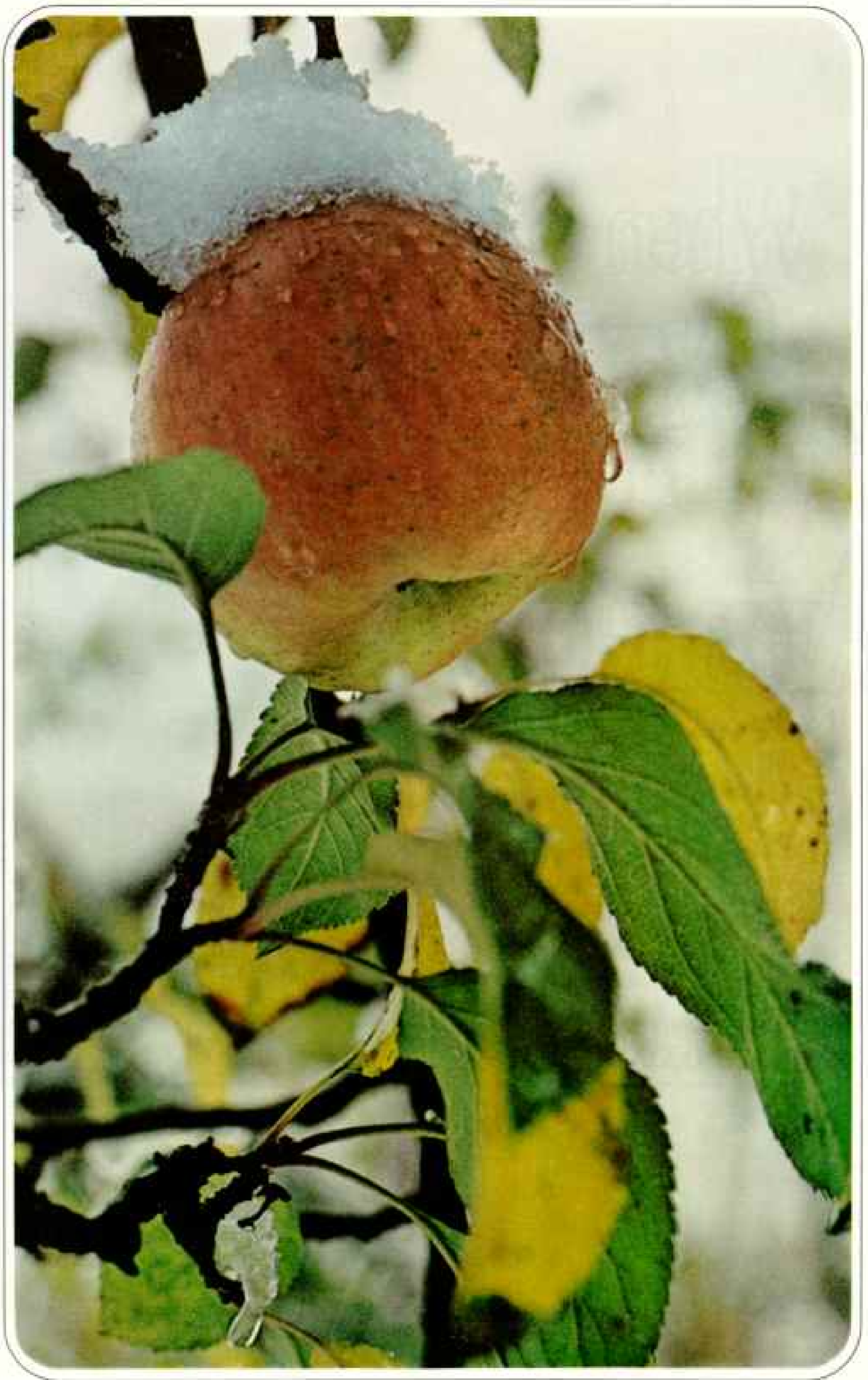
A sow just plowed her way past the tree like a big tank, looking for fallen apples. Only a few hardy ones are left on the limbs, as if each is trying to be the last one.

I shake wet snow from some of the branches before they

NOVEMBER 10 It has snowed all night. The ground is covered with about a foot of wet snow. The apple tree bows beneath the heavy white blanket. Here and there a red-faced York peers through. One large apple wears a cap of melting snow, and drops of water trickle down its sides.

break, then head homeward for a good hot cup of tea. The old tree once again has come through a storm safely. But how many more can she ride out? Sleet coats her to the breaking point, summer sun bakes her, drying her to the roots. In spite of it all, she stands there on the hill, shelter and food to all. Good luck, old girl. □





When Gypsies Gather at Appleby Fair

PHOTOGRAPHS BY
BRUCE DALE

NATIONAL GEOGRAPHIC PHOTOGRAPHER



STUBBORN INHERITORS of a vanishing life-style, British Gypsies keep a rendezvous with the past. Each June, as they have for more than two centuries, Gypsies, Irish tinkers, and itinerant potters come together at Appleby, a little gray-stone town in the north of England. Along



highroads and byways, for days and weeks, they have moved toward their destination: Appleby Fair.

The pace is slow for those who walk alongside horse-drawn *vardos*. On a good day they may cover 20 miles. On a good night, by the grace of a hospitable farmer, they may camp in a grassy pasture or at

the edge of a wood. But they often come to grief amid the congestion of heavy truck traffic or from police insistence that they keep moving or use official campsites. Convenient as such parks may be, they deprive the Gypsy of the very thing he values most—the right to choose his own way, to control his own destiny.





AN OPEN FIELD their hearth,
a row of bow-top
wagons their shield,
Gypsies draw strength from
camaraderie and the common
memory of a turbulent past.
Their ancestors came out of
India about ten centuries ago
to wander across western
Asia and Europe to the British
Isles. Here, as everywhere
they traveled, they hit a hard
wall of hostility.

"Outlandyshe People callynge
themselles Egyptians,"
railed King Henry VIII. His
daughter, Queen Mary, tried
to expel them from England
because of "their old accustomed
devilish and naughty Practices."
But royal disapproval eventually
eased, and Gypsies were allowed
to take part in the Appleby
New Fair, established in 1750 for
the trade of horses, sheep, and
cattle. Over the years the
Gypsies have made it their own.

A measure of hostility endures.
The misleading sign below was
put up by a farmer to frighten
away the visiting wanderers.





THE REUNION: Crowning Fair Hill outside Appleby town, 800 wagons, campers, trailers, and motor homes cluster together. The 32-acre campsite commands a view of the distant hills of Cumberland.

Disdaining the restrictions of the camp community, other Gypsies park along the neighborhood's narrow roads, choking traffic. A few years ago such defiance of police regulations triggered a move to close down the fair. The Gypsies promised to keep better order. But for a people forever on the move, constraints come hard, and the fair is once again endangered.

Yet little dampens the Gypsy spirit. Young Stephen (right), who came to Appleby with his family to sell *grais* (horses), smiles impishly at photographer Bruce Dale while a playmate puts a toad in a camera case behind Dale's back.



• APPLEBY, ENGLAND







83 **W**ILD OUTCASTS OF SOCIETY," poet William Wordsworth called them. Even today the untrammelled ways of Gypsy children may seem bizarre to more settled folk. In fact the Romanies, as Gypsies call themselves, are bound by strong family



ties and learn responsibility early. This trio fetches a can of water while tending baby sister.

Daughters taught by Gypsy matriarchs become in turn the guardians of Romany customs. Boys aspire to follow in the footsteps of their elders and deal in horses.

Nobody knows how many Gypsy children there are in Britain, or, for that matter, how many Gypsies. Estimates for the total population run to about 15,000. Most children miss regular classes. "We may not read many books," said one girl at Appleby, "but we learn a lot about life."



PASSION FOR COLOR and design decorates every part of a wagon, including the brake shoes (below). With attention thus captured, advertising takes over. Horses on the vardos broadcast the news that dealers are at hand, though the one at left is momentarily at rest. C. Rushbrooke & Son even supply a telephone number.

Superb horse breeders and traders, Gypsies suffered a blow with the coming of the automobile and the farm tractor. Finding fewer customers for their animals, many turned to buying up scrap metal.



Such trade on a large scale demands a storage area, so the big dealers are forced to settle down.

Wagons are symbols of pride and status but, at Appleby Fair, they are often for sale. Gypsies joke that a true Romany will sell anything he owns.



“Oy, oy, oy,” cry Gypsies to clear the road as they trot their horses through the heart of the crowd. Horse trading at Appleby Fair has changed little over the centuries. A country lane, once a Roman road, still serves as marketplace. After a dealer “runs off” his horse to show its merits, buyers gather round to bargain. The buyer slaps the palm of the dealer’s hand with each bid. On accepting a bid, the dealer then slaps the bidder’s hand with the finality of an auctioneer’s hammer.

Cash must be paid on the spot, and thereafter the seller may convert his pounds to gold. The Romanies love flashy sovereigns, even though the coins are no longer in circulation. Knowing this, coin dealers frequent the fairs where Gypsies gather.

Happily, the horse traders detect a rising demand for draft animals from English farmers, and small tradesmen in country towns are going back to economical horse-drawn carts. At Appleby exceptional horses bring as much as \$1,000. Donkeys sell for as little as \$100.









NEW LOOK in Gypsy living, a luxurious motor home gleams under the ministrations of its owner. In a nearby camper, a freshly polished cut-glass window shows off its pattern. Britain's Gypsy women are zealous about cleanliness, especially in their homes. The Romanies pay little attention, however, to litter around their vehicles, perhaps because they are always moving on. The mess they leave does not endear them to environment-conscious Britons.

Throughout the year, Gypsy families continually pull up stakes whenever they hear the call of the road. Gypsy men usually choose a trade that lets them travel. From April to October many families journey from farm to farm doing odd jobs. During the winter months they turn to dealing in scrap, rag collecting, making baskets, grinding knives, and other casual occupations.

COLORFUL as its horse-drawn predecessor, this Gypsy motor home plays a dual role—living quarters for the family of Mena Lee and display case for choice possessions.

Rather than use banks, most Gypsy women invest their money in gold, jewelry, cut glass, and expensive china figurines like the horse and carriage in the window. Easy to pawn, the valuables sometimes serve as “traveler’s checks.”



Trailer manufacturers often install cupboard doors of glass instead of wood for customers who want to show off their treasures while camped. Experience has taught Gypsy women to pack their breakables quickly and well before taking to the road.

To supply the demand for china and bric-a-brac, salesmen flock to Fair Hill and carefully cruise between the lines of trailers, with their fragile

wares balanced precariously on car roofs.

Here Mrs. Lee entertains her kinsman Clifford Lee, being served in the rear of the caravan. In 1969 Clifford, his wife, and National Geographic's Bart McDowell and Bruce Dale followed the Gypsies' trail from England to their original homeland in India. Their story is told in a National Geographic book: *Gypsies, Wanderers of the World*.





TEA can be elaborate or spartan. The roomy trailer above offers space for a linen-covered table set with Royal Crown Derby plates of a pattern long favored by Gypsies. Cramped quarters of a vardo (right) send another Appleby visitor outside to enjoy her cup.

The fair gives Gypsy women a chance to gossip with friends, as well as to follow traditional moneymaking

pursuits—hawking combs, lace, artificial flowers, or clothespins whittled by the men.

Their most famous profession—*dukking*, or telling fortunes—has drawn a romantic cloak of mystery about the Romanies. For such is their theatrical skill and intuition that tales of uncanny precognition abound—tales recounted most vividly by the Gypsies themselves.



FAIR TIME transforms Appleby, a shopping and business center for a widespread farm region, from everyday primness to once-a-year frivolity. Each morning pony carts rattle into town from Fair Hill to collect bread, milk, and canned food. By early afternoon the pub crowd overflows into the street, where the Gypsy men (right) challenge other travelers, townsmen, and farmers to games of chance.

Once such young men would have found their fun in the encampment

among their own kind. Then, as they sat around a campfire, the music of a fiddler or an accordionist would stir a man to show off his nimbleness in steps so light that he might be said to "dance on eggs."

Now, in the evening, more and more Gypsy youths break with tradition and join young *gorgias*—as they call non-Gypsies—at town dances.









NO MAN HIS MASTER, a Gypsy rides through Appleby on a piebald, favorite mount of the Romanies. "A Gypsy without a horse is no genuine Gypsy," goes an old saying.

For centuries the Gypsy has survived—and often thrived—by guile and wit. Secretive and sagacious, he considers any gorgio fair game. He has been known to doctor an old horse to make it seem young by dyeing its coat or perhaps by feeding it stimulants. But then, as one Gypsy says, "It's no worse than the used-car trade."

These people, who gave the word "pal" to the English language, hold to warm friendship and square dealing among themselves. Tenets of their philosophy: "Always help brothers; never harm brothers; always pay when you owe, although not necessarily money; and never be afraid."

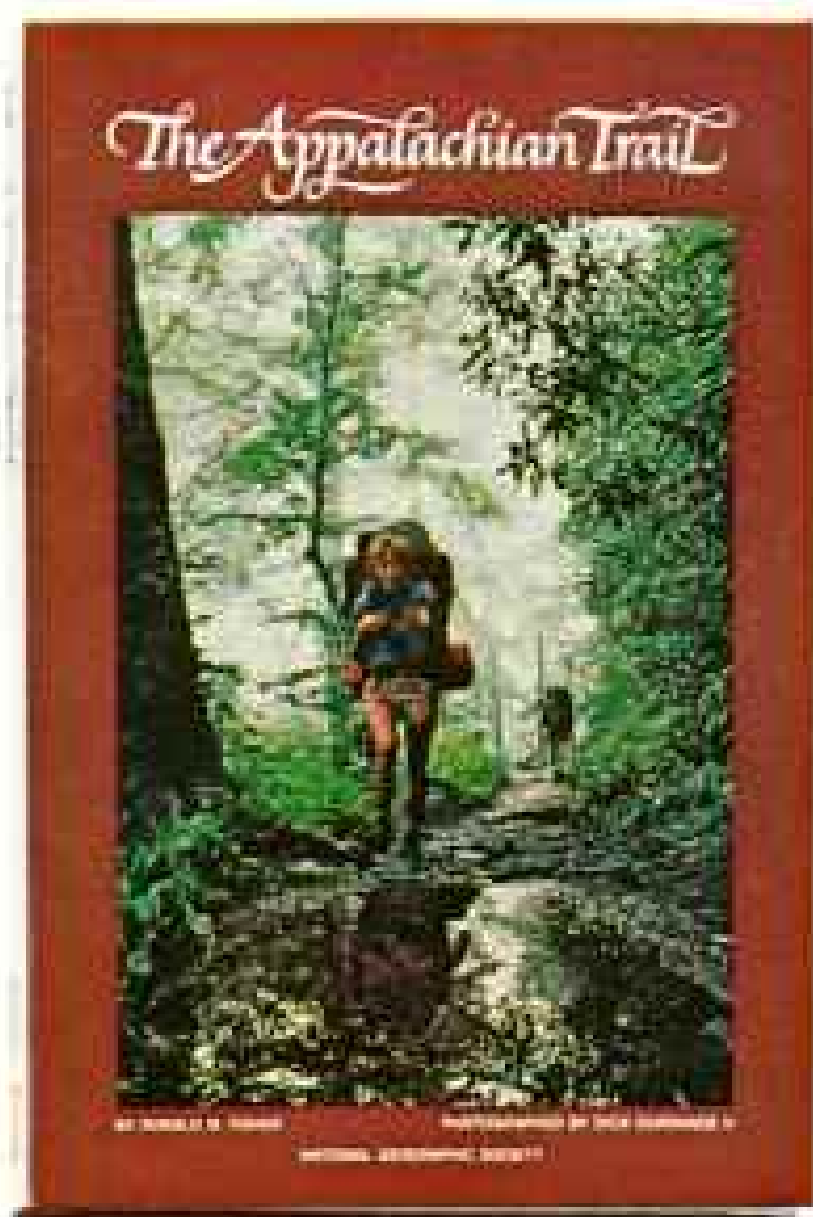
If fear is little known, unease is not. Should the Appleby Fair close down, a cornerstone would be knocked from the foundation of the Gypsy year. It is at horse fairs like Appleby that the wandering people find mutual support for their traditional way of life—a way increasingly threatened by the pressure to conform and the difficulty of earning a living in a mechanized society.

Each year the road is less open, the heath less free. □

Four new books
for 1972-73

From the Appalachians to the Alps

By GILBERT M. GROSVENOR
EDITOR, NATIONAL GEOGRAPHIC



Footpath to a new life: A section of the Appalachian Trail in Connecticut (right) becomes a wedding aisle for a couple marching beneath an arch of ice axes. Hiking the 2,000-mile route, you will meet its mountain folk and discover its animal and plant life. This first of four new Special Publications is available from your Society now.

BY DICK DURRANCE II (RIGHT)

"IN ALL YOUR TRAVELS," a friend asked me recently, "which country did you find the most interesting?"

"The United States," I replied.

Many people share that opinion. More members of the National Geographic Society ask for articles and books about this land than about any other.

For example, across my desk two years ago came a suggestion from James R. Wolf, an attorney in Pittsburgh, Pennsylvania. He wrote, "I have been studying the Appalachian Trail for the past several months, in the hopes of hiking the entire length. . . ." He had found reference books inadequate, so he proposed that the Society publish "a volume which deals with the natural history of the Appalachian Trail . . . and which aims at illustrating the impact of man on the trail and vice versa."

Mr. Wolf's letter was only one among many that suggested a book about the Appalachian Trail. Other ideas, too, were pouring in.

"How about a book on the deserts of the western United States?" wrote a member from California.

Our editors sifted the suggestions down to a stack only four inches high, and we set to work selecting the subjects for the Society's next four Special Publications. At least two, we felt, should be aimed at meeting the demand for Americana so apparent in letters from our members.

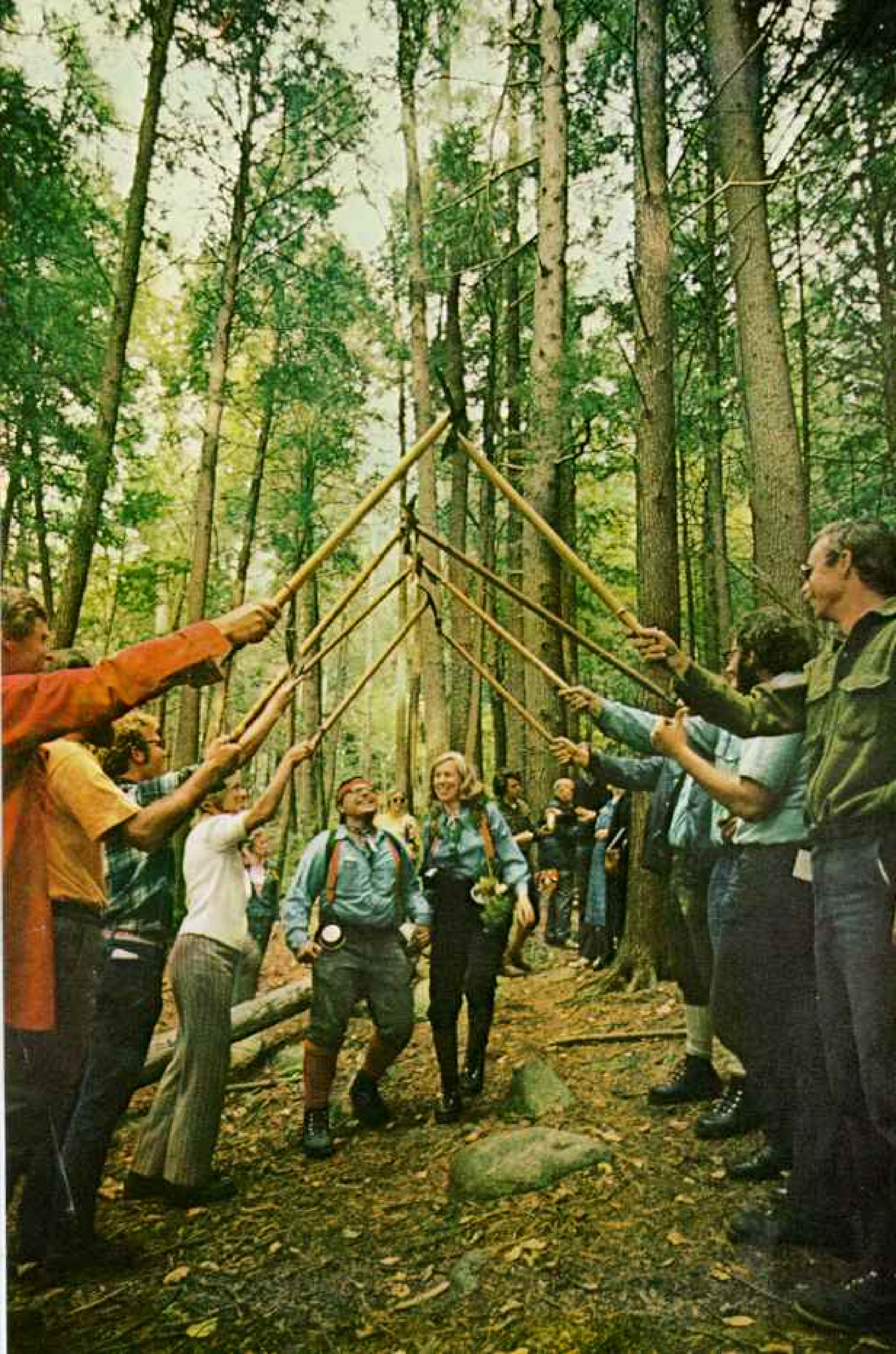
Not long ago, when I reviewed the text and photographs for *The Appalachian Trail*, I thought again of Mr. Wolf. I am sure he will delight, as I did, in the rich variety of material author Ron Fisher of our Special Publications staff brought back from his 14-state hike. For instance, there are the people he met: lumberjacks, dairy farmers, a lady prospector panning for gold, mountain climbers, and—appropriately—a moonshiner.

And there is Ron's sensitivity to the moods of Appalachia. We are with him as he picks breakfast blueberries in Shenandoah National Park while a deer eyes him curiously; as he waits out storms in the Great Smokies; as he slips along a treacherous ice sheath on Mount Washington in 70-mile-an-hour gusts.

The Appalachian Trail glows with the work of staff photographer Dick Durrance II, who portrays birds, wild flowers, and sensational scenery—along with the weathered faces of hardy Americans. I find this book physically beautiful, immensely informative, and as personal as hometown gossip.

The second in this four-book series is *Great American Deserts*, written by Rowe Findley of the Geographic's Senior Editorial Staff, and illustrated with the photographs of veteran staff man Walter Meyers Edwards. It will be ready this summer.

Some who have driven across western North America have rejoiced that they had no need to



AMERICAN DESERTS



Furnace by day, freezer by night, the desert evokes images of moonlike sterility. Actually, these stark wastelands are vibrantly alive with beautiful and bizarre plants and animals.

An osprey of the coastal desert nests in a towering cactus (left); tumbleweed bounds across the empty land (below). From Oregon into Mexico, a colorful procession of Indians, prospectors, bandits, and cattlemen have left in fact and legend the story of their struggle to survive.



WALTER NERTZKE EDWARDS

linger in its vast parched spaces. But those who have paused there have become enchanted by the country's haunting beauty, surprised by its contradictions. I recall my own shock on an archeological dig in the Mojave Desert. I was expecting a searing sun—and we had snow.

"The desert scared me at first," Eldon H. Anderson, a California member, said recently. "That was eight years ago. Now I live near Thermal, California."

"I, too, have felt awed," says author Findley. His enthusiasm led him to study

fantastic wildlife, like the desert cockroach that absorbs life-sustaining moisture from the air, and marvelously adapted plants, like the giant saguaro cactus that can soak up a ton of water in a single, short rainy season.

Rowe Findley also enthusiastically collected the folklore of the people who have lived here—tales of sudden riches and lost mines, of lonely deaths and heroic survival. I am sure that this book will change many readers' concepts of deserts and desert life.

The third book, available in the fall, takes us away from the American scene to chill



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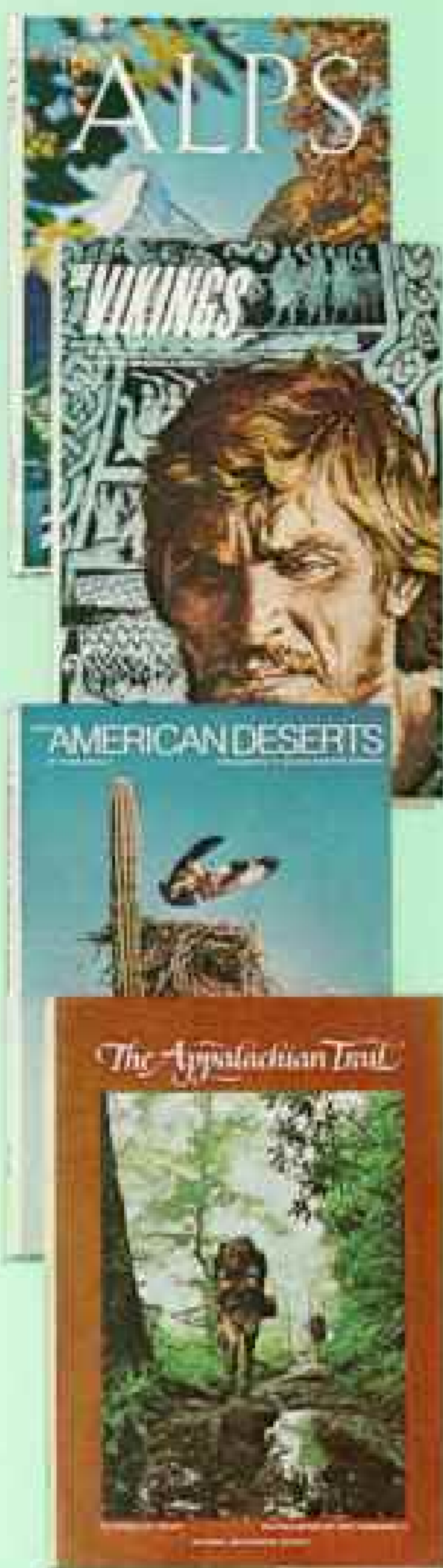
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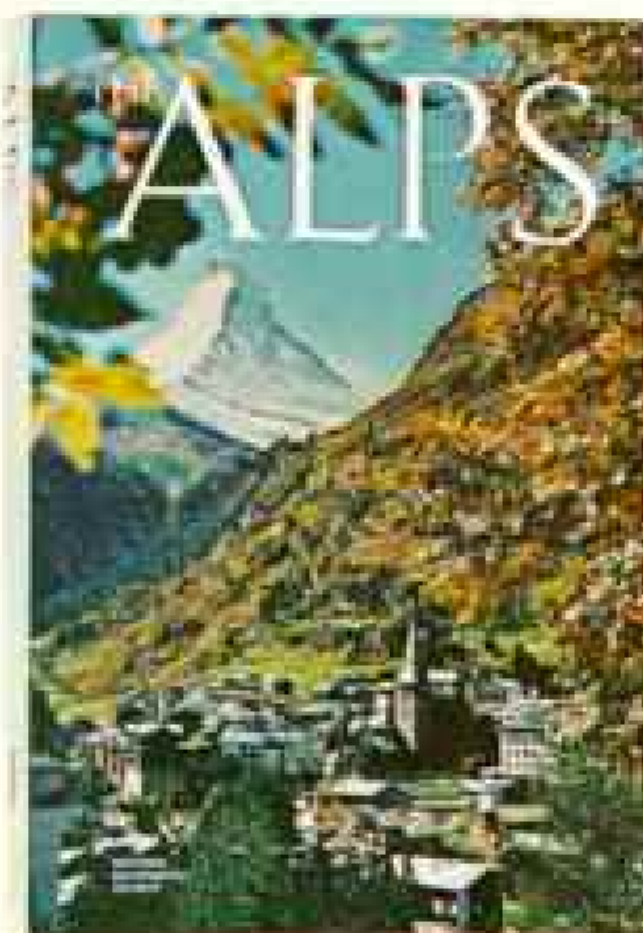
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A great deal of that feeling comes from what we call "The Thunderbird Ride."

The ride comes from Thunderbird's new body/frame construction that helps absorb road shock and vibration. And a new suspension that's electronically tuned to the steel-belted radial tires for quiet, smooth road performance.

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Options shown: glamour paint; vinyl roof; body side protection molding; power antenna; leather and vinyl individually adjustable seats.

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THE TIMEX® QUARTZ WATCH \$125.

A micro-computer with over 300 transistors controls its accuracy to within 15 seconds a month.*

Only Timex makes a watch this accurate and dependable at this price.

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Quartz is a mineral with unique properties. When it's used in an electronic circuit, quartz will oscillate at a constant rate. This stable quality of oscillation is what makes quartz so special.

There's a quartz crystal in the official time system at the U.S. Naval Observatory.

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It splits each second into 49,152 equal parts, enabling the watch to maintain superior accuracy.

How the micro-computer system helps to maintain accuracy.

The quartz crystal is an integral part of a micro-computer system inside the TIMEX Quartz Watch.

This micro-computer system senses any variation in the accuracy of the watch. If the accuracy should vary, the micro-computer system restores the watch to its programmed accuracy.

Why the TIMEX Quartz Watch is so dependable.

The watch is engineered to be as rugged and dependable as you expect a TIMEX to be. And its water-resistant case keeps it protected from moisture, grit and dust.

The TIMEX price.

All quartz watches are more expensive than ours. Their prices range from about \$250 to over \$2000.

The price of the TIMEX Quartz Watch is \$125.

It has always been our tradition to give you the best possible watch for the money. We feel the TIMEX Quartz Watch is a milestone in that tradition.

**THE
TIMEX®
QUARTZ
WATCH**



Tracking the first men in the Grand Canyon



EARL VERMEIJER ABOVE AND LEFT



NATIONAL GEOGRAPHIC PHOTOGRAPHER VICTOR R. BIRRELL, JR.

AN AWESOME CHASM HIS LABORATORY, archeologist Dr. Douglas W. Schwartz (holding map, top), Director of the School of American Research at Santa Fe, searches the Grand Canyon for clues to its prehistoric inhabitants. In high cliff caves he has found traces of the earliest known human visitors—willow-twig figurines of animals pursued by nomadic hunters 4,000 years ago. About A.D. 900, Indians known as the Anasazi came to the North Rim to farm, and built simple pueblos like this one on the Walhalla Plateau (left). After some 300 years these “Old Ones” vanished—driven away, Dr. Schwartz’s findings indicate, by a change of climate that brought droughts and failing crops. Your Society dues help support such rewarding research. Let friends participate, too, by nominating them for membership.

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Washington, D. C. 20036

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Why you need a

The picture on the far right was taken by the only camera of its kind in the world.

Most camera owners cannot get close-up portraits at all. And those that can need expensive cameras or expensive accessories to do so.

The Big Shot gets them. In 60 seconds. For \$19.95.*

Portraits—the kind of pictures you want most. The Polaroid Big Shot Land camera is for close-up color portraits only. That's why it looks unusual—its length gives you the same kind of pictures as studio portrait cameras, or expensive cameras with complicated lenses and attachments.

These are the kind of pictures you want most—not only close-ups, but close-ups with rich portrait-like colors and lighting.

Portraits that are hard to mess up. Forget words like “focus settings” and “exposure.” This is the



Most cameras can't get close-up portraits.

simplest of all systems. To focus, just walk toward your subject until the two faces in the window are one—and press the button.

Do not worry about lighting. It is the same, indoors or out. A light transmission panel in front of the flashcube eliminates harsh “flash” contrasts and gives you soft portrait lighting for every shot. There is not even a battery to worry about.

second camera.



The Big Shot does (in 60 seconds).

The built-in timer tells you when your picture is developed and ready to see—and that's it. It's so easy anybody can take *your* portrait.

How can we make this camera for \$19.95? The secret is simplicity. The design that makes the Big Shot so easy to use also makes it

amazingly inexpensive.

The Big Shot takes every picture the same way—and simply eliminates all the adjustable devices on costly cameras.

For instance, the distance for your pictures is always the same and the focus is set for this. The shutter speed is always the same and the lighting is always the same.

If you never took a picture before, you can now have beautiful color portraits of Dad, Mom and the kids just 60 seconds after you press the button.

And if a second camera sounds extravagant, just look at the price again. \$19.95.



Polaroid's \$19.95 Big Shot

*Suggested list price

You can get one for the price of a Toyota.

At first glance, the Toyota Celica ST might come off as a rich man's sports car.

That's the nice thing about it.

However, in real life, it's an economy car.

That's the nice thing about it.

The Celica ST has hood vents and rally stripes. Standard.

It comes with a four-speed synchromesh transmission and radial tires. Standard.

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The New Adventurers

Why do they search for oil and gas offshore?

What are the risks they take?

Do they pollute our coastal waters?



**Standard Oil Company
(New Jersey)**



(Left) Helicopters carry small equipment and men to the rigs. (Right) To replace a worn bit, the entire drill pipe is taken apart, stacked in the derrick, and then reassembled. Drillers call this "making a roundtrip."

The New Adventurers. They search beneath the sea for new supplies of oil and gas.

A hundred miles out from the Louisiana coast over the sea, the big helicopter flies on and on. Suddenly, there appears on the far horizon a massive steel structure that seems almost delicate with its lattice of metalwork—yet with sturdy legs that fix it firmly to the floor of the ocean more than 200 feet below the waves.

This is an offshore oil well drilling platform in the Gulf of Mexico. Hundreds more like it are here in the Gulf, off the coast of California, in Alaska's Cook Inlet, the North Sea, offshore Indonesia, Africa, Australia, and in other waters around the world. Every one of them is working around the clock, seven days a week, searching for, or producing, the world's most vital sources of energy—oil and natural gas.

A career for a lifetime.

The crew is likely to be a small cross-section of America. The cook might be a Louisianan, the drillers from Texas or Montana, the geologist a New Yorker, the rough-necks from California or Oklahoma. But almost to a man, they share an interest and enthusiasm for their task, and the ability to do a job that is physically demanding. The pay is good, and the men get seven days off after every seven days on board. Offshore drilling is a special calling with a special lure. The same men return again and again. Most of them make it a lifetime career.

In a real sense, the men who go to sea today in search of oil or gas are the "New Adventurers," the descendants of the fishermen,

traders and explorers who centuries ago ventured upon the unknown for daily sustenance, wealth, or from sheer curiosity. The modern searchers on the sea also live with danger. A severe storm can force them to seek safety on shore. An oil or gas blowout can in seconds create an inferno of fire. Such disasters are infrequent but they happen—even though the most stringent safeguards are taken to avoid them.

Drilling rigs with libraries.

The living quarters on an offshore drilling platform resemble those on a modern tanker or freighter. Spotless corridors, air-conditioned staterooms and offices, a recreation room complete with a library and TV, a dining room that serves king-sized meals, where snacks and hot coffee are available at all hours. But on the working deck, it's something else: a maze of complex machinery, hoses, chains, pipes and cables. The focal point is the tall derrick ceaselessly guiding long lengths of pipe into the ocean floor.

A 19th century beginning.

Many people probably think of offshore drilling as a fairly recent development—especially since the 1969 blowout in the Santa Barbara Channel focused public attention so dramatically on the environmental aspects of these operations. Actually, producing oil from coastal water dates all the way back to 1894. It began from piers built in that same Santa Barbara Channel. But it wasn't until 1947 that the first true offshore platform was built in fifty feet of water off the Louisiana coast. Since then, some 20,000 wells have been drilled off the coasts of 70 countries, and one-sixth of the world's oil is now being



Our continental shelf. There may be more oil and gas here than has ever been found onshore in the history of the U.S. Prospects look especially good for discoveries of large volumes of urgently needed natural gas.

produced from offshore fields.

Exploring for, and producing, oil and gas offshore is expensive. It costs about four times as much to drill an exploratory well offshore as a similar one on land, and operations in deeper waters will cost even more. Why then does the petroleum industry persist in its underwater search?

First of all, there's the matter of supply and demand. Beyond that are vital considerations of continued economic growth and security of supply. Right now, oil and gas provide three-quarters of America's energy requirements. Meanwhile, the demand for energy continues to increase.

Every day, the United States consumes

650 million gallons of petroleum and over 50 billion cubic feet of natural gas. This consumption is growing so fast, that the United States is expected to use as much petroleum and natural gas in the next fifteen years as it has during the entire 113 years of the oil industry's existence.

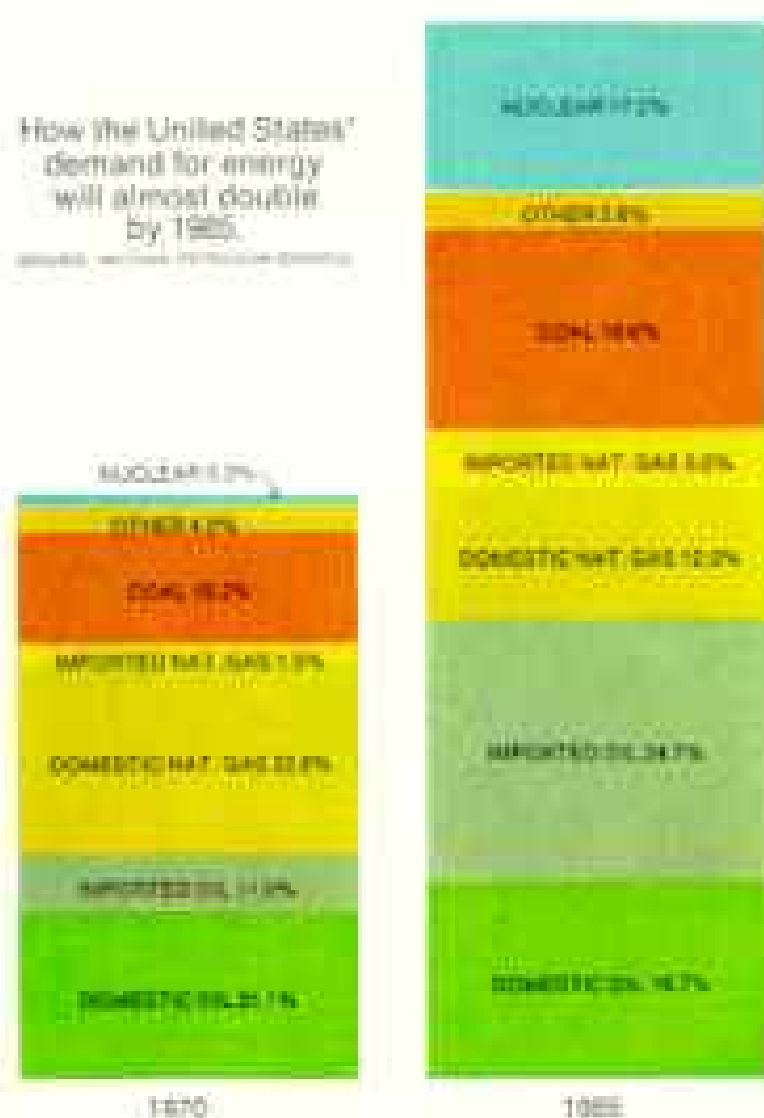
In the case of natural gas, this estimate is conservative—only because supplies are severely limited. Gas is such a clean, convenient fuel that its use would grow much faster if it were readily available. Here in the U.S., we are increasingly dependent on offshore areas for natural gas—a fuel which is becoming critically scarce. Overseas imports are not the entire answer, since gas is difficult and expensive to transport in anything other than pipelines.

The offshore potential.

If the U.S. is to minimize dependence on foreign energy sources, as much of our oil and gas as possible must come from domestic supplies. But it is increasingly more difficult to find oil and gas reserves on land.

That leaves the offshore areas, where the prospects for finding additional oil and gas deposits are quite encouraging. Geologists estimate the recoverable reserves of oil underlying our continental shelf may be more than the U.S. has consumed in its history. The outlook for natural gas also appears excellent, particularly in undrilled areas along the East Coast.

Today, as domestic reserves of oil and gas dwindle in relation to consumption, the offshore search is more urgent than ever. The new adventurers are embarked on a sea venture that can have far-reaching significance for our country and our people.



This is one appraisal of how the U.S. may meet its future energy needs. It assumes coal users will meet air pollution regulations, construction of nuclear plants will accelerate rapidly, and availability of synthetic fuels (e.g., oil from shale) will be limited. Problem areas may be large oil imports and reduced domestic natural gas supplies.

More than \$800 million in offshore royalties and lease bonuses has been paid annually to state and federal treasuries.

To look for oil and gas at sea, our explorers use modifications of the tools they use for the search on shore.

If early reconnaissance is encouraging, the search advances to seismic surveys. Shock waves are generated which travel downward, striking successive rock formations beneath the surface of the sea. These waves are reflected back to the surface where detecting devices record the impulses. By measuring the time intervals of the waves, a geophysicist can tell the general characteristics of the formations that lie below the ocean floor. But he can't tell if the rocks contain oil and gas. Only a drill can do that.

Our sleeve exploder.

A few years ago, Esso Production Research, a Jersey Standard affiliate, invented a device to replace the use of dynamite in offshore seismic work. It explodes a small gas charge in a heavy rubber sleeve, inflating it like an instant balloon and producing a seismic echo. It provides more data in less time. It's a lot less expensive than dynamite. And it won't kill the fish.

Bids in the \$millions.

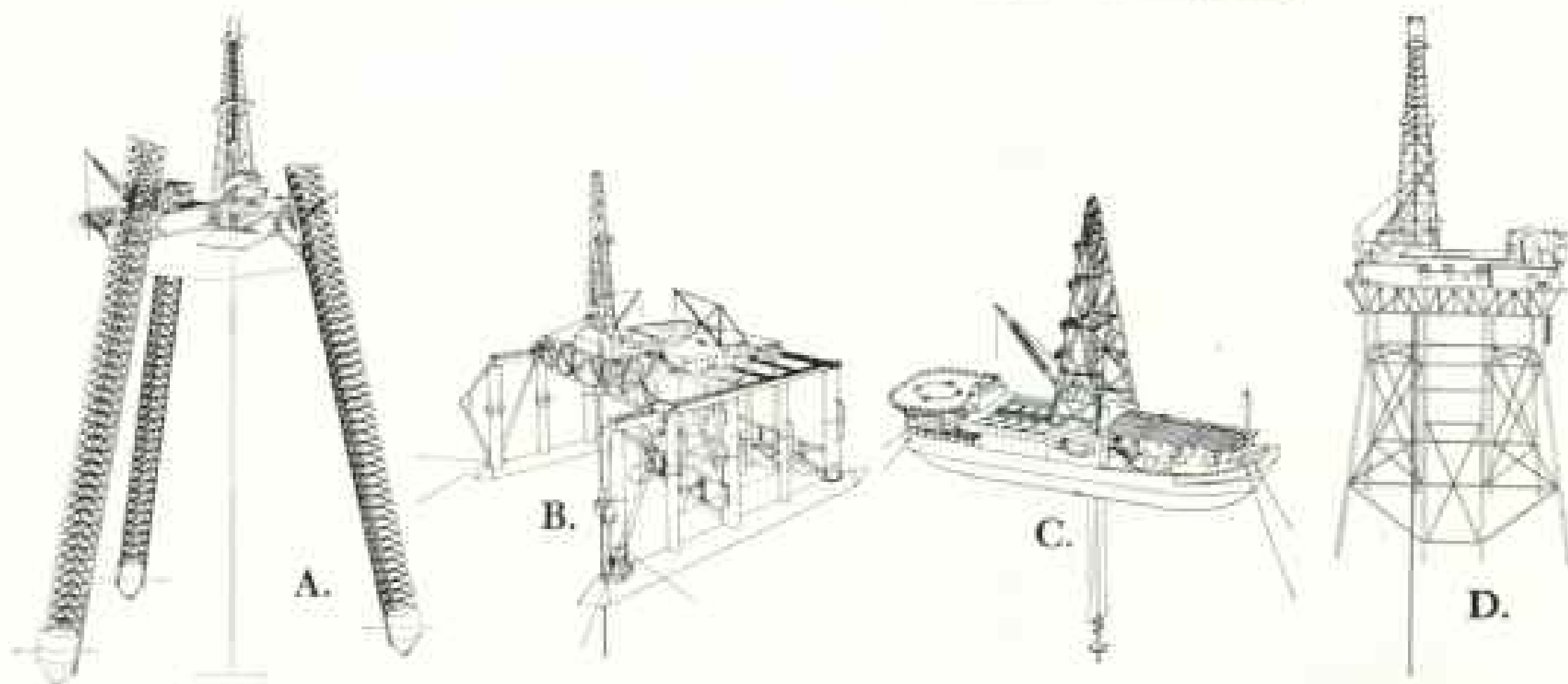
Even if our geophysical and geological findings indicate a good chance of oil or natural gas under the ocean floor, drilling is still a long way off.

Next, we must obtain the right to drill. There may be long public hearings or government studies prior to bidding for leases.

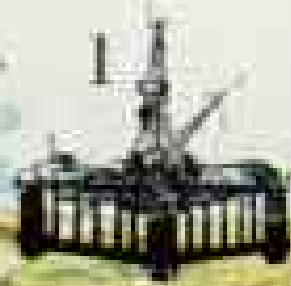
In areas considered highly prospective, competitors for the leases can put hundreds of millions of dollars into public coffers. Oil companies must also pay royalties on every barrel of oil and every cubic foot of gas produced. In recent years, offshore lease bonuses and royalties paid to state and federal treasuries have averaged over \$800 million per year.

Once a lease is granted, exploratory drilling can begin. But the odds are still against us. For every *fifty* wildcat wells drilled on land in the U.S., only *one* finds a field that will turn a profit. Because offshore areas are relatively unexplored, the odds of finding oil or gas at sea are better—but it's still a real long shot.

If exploratory drilling finds oil or gas, fixed platforms to develop a field of wells are then put in place. They contain living quarters for the work crew, a helicopter landing pad, storage space for supplies, and room for all the complicated drilling and production equipment. From these "islands," up to thirty wells can be drilled directionally to locations as far as a mile away.



In the search for oil and gas at sea, we use three basic types of mobile drilling rigs. A) This self-elevating rig is towed to a site where its legs are lowered to the sea bed, and its platform "jacked up" above the water. Jack-up rigs are limited to waters up to 300 feet deep. Beyond this depth, floating rigs must be used. B) Semi-submersible rigs are supported by gigantic buoyant chambers, which are ballasted with sea water and submerged. The drilling platform stays safely above the waves' reach. C) In very deep water, ships with large holes midship for drilling are used. D) After a discovery, fixed platforms are built to drill development wells and handle production.



1. Drilling rig.

This semi-submersible rig cost about \$30 million to build, and is leased to us on a daily basis. The upper deck is 200 feet square, and from the bottom of the vessel to the top of the rig is almost 300 feet.

2. Anchors.

Eight mooring lines extend as far as one mile from the rig. At the end of each is a 30,000-lb. anchor.

4. Underwater eyes.

A television camera is lowered to the ocean floor to check equipment. It sends back pictures of every joint, every bolt, every valve within its sight.

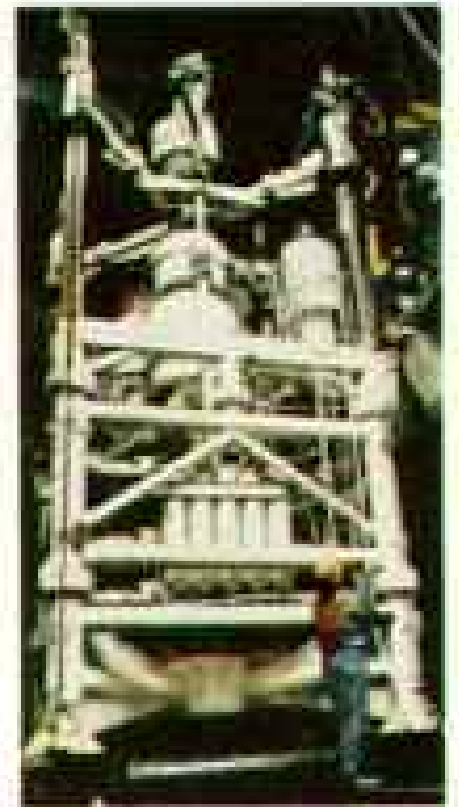


3. Drilling pipe and riser.

The drill pipe, a string of 30-foot pipe lengths with the drilling bit attached, runs through the riser. The riser, a 2-foot-diameter casing extending from the rig to the wellhead, guides the drill pipe into the hole. Together, they also circulate the specially compounded drilling fluid called "mud."

5. Blowout preventer.

It is attached firmly to the wellhead on the ocean floor when drilling starts. This one, built specifically for use in deep waters, is 30 feet high and weighs 40 tons. It is operated by hydraulic lines running to the surface. If unexpected pressures are encountered, it is designed to control them until normal drilling can be resumed.



6. Underground casing.

As the bit drills deeper, the hole is periodically lined with steel and cement. This prevents caving and seals off high pressures.

7. Drilling bit.

In hard rock, a bit may drill only a few feet before it gets dull. In soft shale, it can cut through 100 feet an hour, and last a day or more.



8. Core sample.

Oil and natural gas are produced from sedimentary rocks, like this 4-inch-diameter sandstone core cut by a special bit. Underground "pools" of oil exist only in the imagination.





Today, hundreds of producing platforms rise from the Gulf of Mexico. And fish thrive in great abundance and variety among the platform legs, which act as artificial reefs. Both sport and commercial fishermen agree the fishing is better than ever.

***"No Pollution—Not Any."
This order is posted
throughout our drilling rigs.***

The design and construction of offshore structures is an essential part of the petroleum industry's efforts to protect the ocean environment. To insure that platforms can withstand the elements, extensive research has been done on the effects of wind and wave forces that develop at sea, on water depths, currents, and sea floor conditions. By reducing the risk of damage to these installations, the possibility of pollution-causing accidents is reduced.

Built to last.

Structures are designed for local conditions. In the Gulf of Mexico, platforms have endured full hurricane winds, and in the North Sea, the violent storms that whip down from the Arctic. A special challenge is withstood by platforms in the Cook Inlet of Alaska: ice floes four feet thick. During the winter these are carried in and out of the inlet by swift currents and thirty-foot tides.

You might think that offshore oil operations would have a harmful effect on traditional fishing grounds. Just the opposite has happened. In a few months, a new platform becomes an artificial reef with tiny marine life clinging to the underwater structures. Small fish feed on these and, in turn, attract larger fish, which attract sport fishermen. And drilling doesn't seem to have harmed commercial fishing. In fact, Gulf Coast fleets now haul in four times the weight of fish they caught before the drilling started.

Drilling an offshore well is an around-

the-clock operation—one that must be closely supervised at all times. Many mechanical and electronic devices log the progress of the drilling, and keep a continuous check on conditions in the well.

"Mud" is more than mud.

During the drilling process a special fluid called "mud" (a mixture of water, clay, and mineral additives) is pumped down the drill pipe under carefully controlled pressure. When the "mud" reaches the bottom of the hole, it is forced out through the drilling bit and returns to the surface between the drill pipe and the walls of the hole.

This constantly circulating fluid has several functions. It cools and lubricates the drill bit. It flushes from the well the cuttings left by the bit. It cakes and stabilizes the sides of the hole, preventing cave-ins. And it acts as a safety device, chiefly by its weight, to contain underground pressures. High-pressure zones are counteracted by increasing the weight of the "mud."

As a standard pollution-control practice, any drilling "mud" which could damage the environment is sent ashore for disposal. The same applies to test samples such as cores and fluids—and to all wastes generated by the drilling crews. One of our rules—strictly enforced—is that not so much as a paper cup should go over the side.

Like mud, "casing" serves multiple roles in drilling operations. Casing consists of long lengths of steel pipe which are set in the drill hole. It helps maintain good circulation of the mud, prevent erosion of the walls of the hole, protect fresh water strata, and shut off high-pressure zones. Once casing is set in the hole, it is sealed securely in place. This

is done by pumping a cement slurry, or mixture, down the inside of the casing. It is forced out through the bottom, and rises to fill the space between the outside of the casing and the walls of the drill hole.

After the first "string" of casing is set, "blowout preventers" are installed on the well. These highly important safety devices can close off the space between the drill pipe and the casing in a matter of seconds if unexpectedly high pressures are met, and contain these pressures until normal drilling can be resumed. When the well is ready for production, a system of high-pressure surface valves, called a Christmas tree, is installed on top to control the well flow. Or, if the well does not flow naturally, a pump can be added. On the platform, the oil and gas are separated and sent to shore through pipelines.

Onshore and offshore, between thirty and forty thousand oil and gas wells are drilled around the world every year. Yet, only a handful result in those violent eruptions called "blowouts"—but the possibility is still there.

A prevention paradox.

Prevention is the most effective way to deal with the problem of blowouts. To that end, Jersey has established training facilities in the U.S. and abroad for drilling superintendents and contract crews from our affiliates all over the world.

Our main school is centered around a mile-deep well on the King Ranch in Texas. This practice well is the real thing. It has storage tanks, a pump, control manifold, a full array of pressure gauges and controls—all the diverse equipment that is used in the field to prevent a blowout.

Oddly, all this training represents something of a paradox, set up mainly because there are so few blowouts. Since drillers may never experience a runaway well, the schools give them an opportunity to improve their skills in control and prevention.

Four times deeper.

As the demand for energy grows steadily, the search for new sources of oil and gas has moved ever farther offshore and into deeper waters. This has necessitated refinement and extension of the methods used for

In deeper water, we'll need platforms as tall as skyscrapers.

many years in shallower waters.

Recently, Humble has devised a system that will make possible the development and production of oil and gas in waters ranging from 700 to 1500 feet deep. This is from two to four times as deep as any offshore fields now producing.

A basic component in the Humble deep-water system will be, of course, drilling platforms. The first one will be a real giant. Plans call for a huge four-legged structure in nearly 800 feet of water, and weighing more than 20,000 tons. As many as sixty wells can



This is a sixteen-foot model of what someday may be the tallest offshore platform. It will be nearly as tall as the Empire State Building, but only the tip will rise above water.

be drilled directionally from its 150-foot-square deck. Each of the giant's four legs will be seventeen feet in diameter, and they will straddle more than an acre of the ocean floor.

The SPS.

The second part of the project—for the deepest waters—will be Submerged Production Systems, secured to the bottom of the sea. Each SPS will include a cluster of wells drilled directionally from floating rigs.

The whole underwater operation involves advanced technology, with electronics to monitor and "instruct" each unit, hydraulics to open and close valves, and safety devices that will automatically close off any part of the system that malfunctions.

Oil and gas from each SPS will flow through pipelines to points on centrally located platforms, and from there to shore.



The Santa Barbara Channel today. In 1969, a blowout caused a terrible, but temporary, blight. Since the clean-up, scientists have found no evidence of lasting damage.

The Santa Barbara blowout taught us all a painful lesson.

The tragic Santa Barbara blowout wasn't at one of our wells. But that's beside the point; we do drill there. That blowout caused the death of about four thousand birds; and a terrible, but temporary, blight to a beautiful shoreline. The entire oil industry is paying for this accident—in millions of dollars' worth of drilling delays, and a lot more in reputation.

Our industry's excellent safety record has been marred severely by that one event.

We aren't trying to make excuses for what occurred, but some of the after-effects seem to have been exaggerated. A research team from the University of Southern California confirmed there was no apparent lasting damage to sea growth, marine life, or beaches as a result of the spill.

Some lasting benefits.

To a lot of people, the blowout ushered in the age of ecology. It also made the oil industry and the Government take a good hard look at operating procedures. And some lasting benefits are evolving.

Both private industry and the U.S. Coast Guard are now working on a large variety of oil containment and recovery systems to minimize the damage caused by blowouts or spills. Where containment and recovery are impractical, research has developed nontoxic dispersants and biodegrading agents to assist in cleaning up.

Also, extensive research is being done on keeping our beaches clean. Surprisingly, most authorities agree ordinary, plentiful

straw is still one of the most effective ways to absorb oil.

One significant development has been the creation of Clean Seas Inc. It was set up and financed by Humble and 14 other oil companies operating in the Santa Barbara Channel. Its purpose is to provide immediate equipment, materials, manpower and know-how to handle spills of all types. Clean Seas is just one of 70 organizations around the country set up to meet such emergencies in coastal areas.

We work with people and machinery and there is always the possibility of an accident. Yet in completing over 1500 wells in U.S. waters over the years, Humble has had only three blowouts. All were controlled without polluting the water or the shore line.

We can't promise we'll never have a damaging accident. But we can promise that as long as we work offshore we'll operate in the most responsible way we know how.

A last word.

The United States is no longer in an era of abundant energy. Our needs for the future are critical. But not everyone agrees where the energy should come from. Decisions for or against offshore development, or any other source of energy, are too important to be made by less than an informed public. In these pages, we have presented the case for offshore development as we see it. If you would like additional copies of this report, write to "The New Adventurers," Standard Oil Company (New Jersey), 1251 Avenue of the Americas, New York, N.Y. 10020.

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**Golden
Guides**



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The beginning of a water shortage.

Not all phases of a water shortage wear the familiar face of parched, sun-bleached land.

One phase looks like a flood.

Because too much water and too little water are really different sides of the same problem:

Poor water management.

In droughts, there's no reserve water available until it rains again. When the heavy rains do come, there are no ways to capture and control them. Good water management includes saving in times of plenty for use in times of need.

As our nation grows, as our world grows, our water needs will also grow. Water for new communities, industry, recreation and agriculture. Yet all the water we have today is all the water we will ever get.

That's why it's so important to get every drop of use out of every drop of water.

For help in getting your community started on a water management program, talk to your local Caterpillar Dealer. Or write: Caterpillar Tractor Co., 100 N. E. Adams Street, Peoria, Illinois 61602 for the booklet "It's Time We Face America's Water Crisis."

It won't be an easy job to tackle. But it can be done.

Because it must.



We can make the world a better place to live in. Caterpillar machines will help.



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3. **Right amount:** Squeeze handle, spray's on. Release, it's off. Spray just to the point of runoff. Coat the plant, don't drench it.
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We helped set up Jim Collier so he could develop a profit.

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But Jim needed more money. To compete in this highly competitive field, he had to have the kind of expensive photographic equipment that would allow him to take on a variety of jobs.

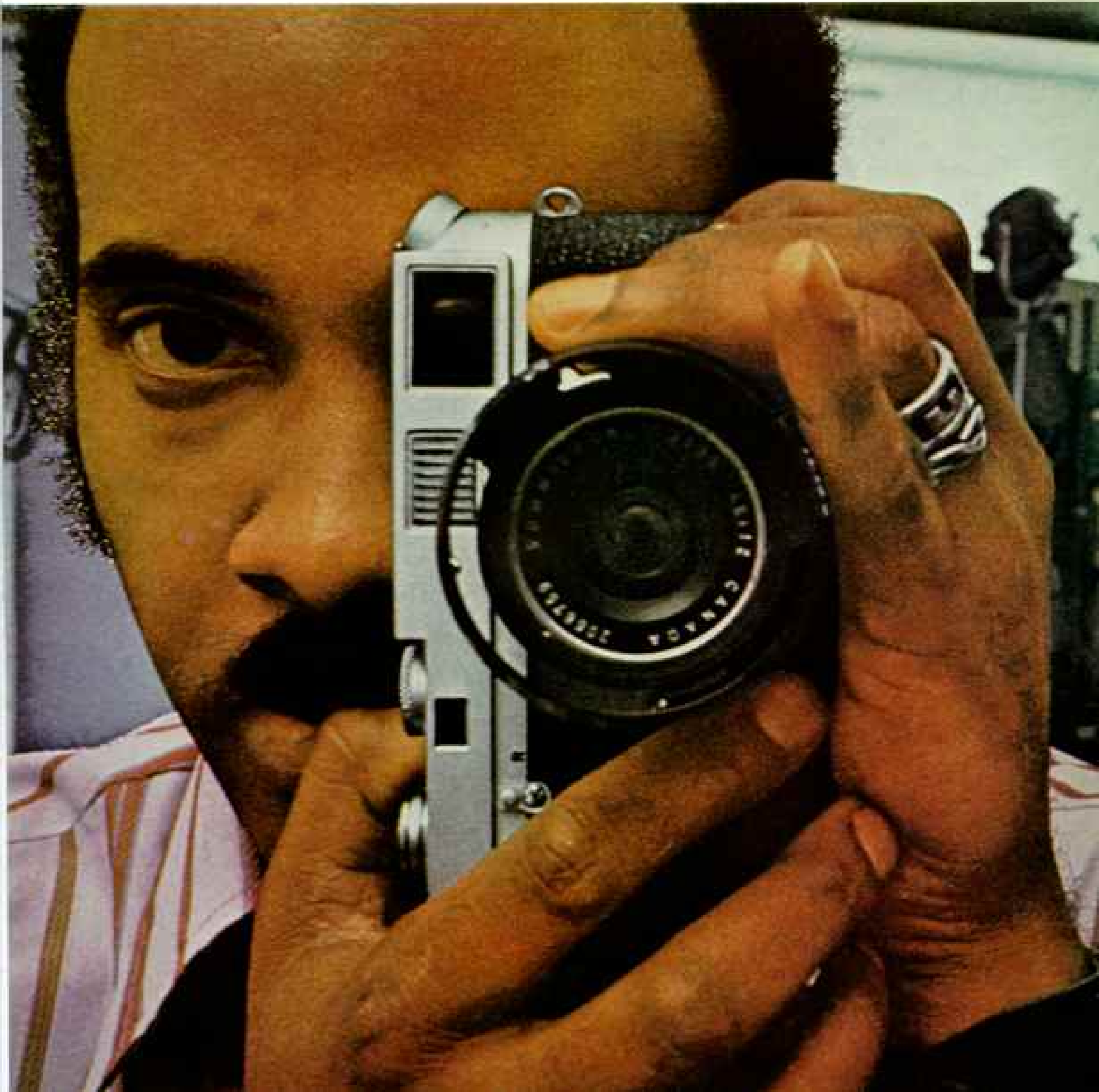
So he came to Chase. With the money we lent him, he was able to acquire the necessary equipment. And we've continued to stand by with whatever financial advice he needs.

Jim Collier is now busy doing work for many of the nation's largest advertising agencies. And he has developed a great reputation as a photographer. And we're both developing a profit.

A good motive for change is the profit motive.

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looks exactly like these postcards.
Oddly enough it's where we
took the pictures.

These pictures were not retouched, so when you come to Bermuda you will not be disappointed. We can promise you countless scenes like these, because, in reality, Bermuda is a 21-square-mile picture postcard. You'll enjoy everything here including some of the nicest people you've ever met—Bermudians. Bermuda is only 90 minutes away from the U.S. coast. See your travel agent. Or write Bermuda: 610 Fifth Ave., N.Y., N.Y. 10020—6 N. Michigan Ave., Chicago, Ill. 60602.

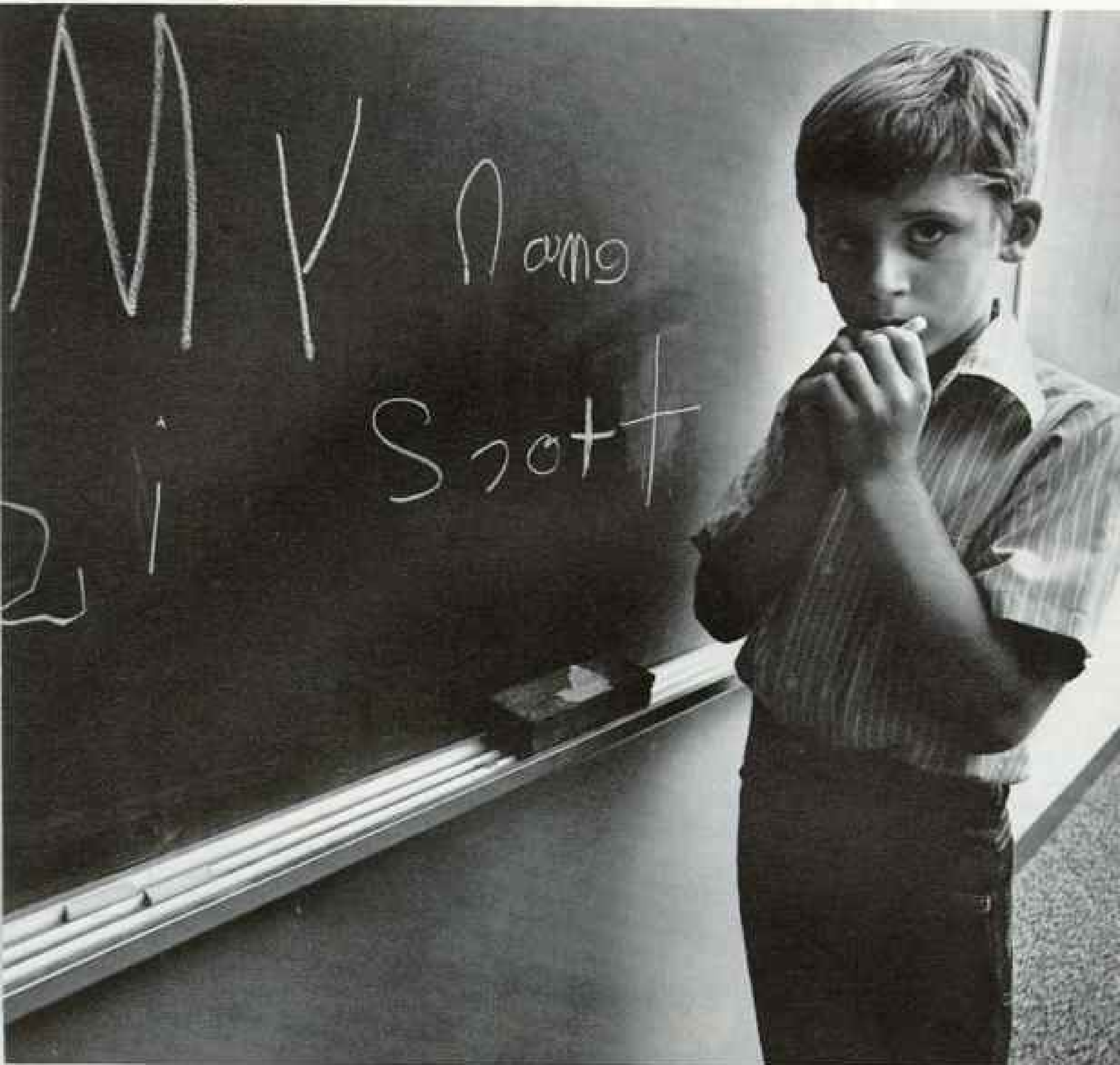


Bermuda

Wish you were here.



Scott isn't stupid. But it took a smart teacher to recognize it.



What's wrong with Scott is what's wrong with at least one kid in almost every classroom.

Scott has a learning disability. A perceptual problem.

When he writes, the letters are mostly illegible shapes. When he does his arithmetic, the answers are usually incorrect.

If you wanted to guess how many kids have ever had a problem similar to Scott's, you could start by counting many of the kids who've dropped out of school.

The sad part is:

You can correct the problem

if you spot it soon enough. Before a child has failed and been frustrated and lost his self-confidence.

So in 1969, Metropolitan Life began showing teachers and parents how to spot early signs of physical disorders that can interfere with a child's learning.

We produced a film called "Looking at Children," and a companion booklet.

Very often, they're the first time a child's teachers or parents ever see "backwardness" as a disability that many times can be corrected.

We'll send the film to your com-

munity or school group.

Write "Children," Metropolitan Life, 1 Madison Avenue, New York, N.Y. 10010.

You may have to wait, even with hundreds of prints of the film in constant circulation.

But the wait is worth it.

To keep a child's learning disability from becoming a life-long handicap.



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We sell life insurance.
But our business is life.

In 1918 we made the only Frigidaire refrigerator.



We still do.

When we introduced the Frigidaire refrigerator 54 years ago, everybody was happy about our invention, including the iceman's wife.

Needless to say, the iceman wasn't delirious.

We, who made the Frigidaire, became a little unhappy as years went by. Why? Because some people called just any refrigerator a Frigidaire.

We didn't think that was right, because even though many manufacturers made refrigerators, we didn't believe anybody made one with our same, high quality standards.

To this day, nobody's changed our minds. We think you'll feel the same way that we feel about



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We believe you will be happier with Frigidaire appliances than any others, not only when you buy them, but many, many years after they've lived with you in your home.

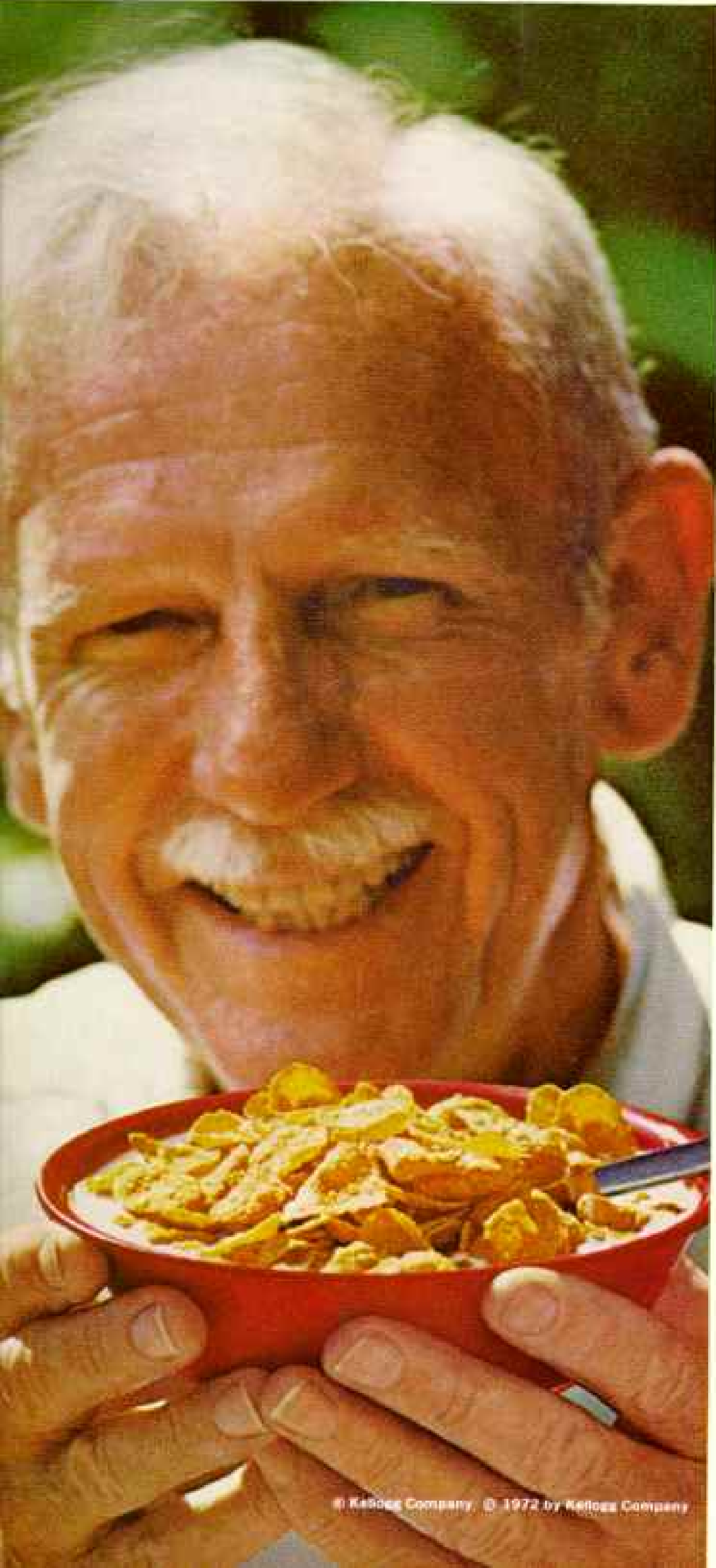
Antique Frigidaire refrigerators from decades ago can still be found in a number of homes. And they're not standing there as nostalgic memories.

They're working away still keeping the milk and the soda and the butter and the eggs fresh while turning out the ice cubes.

We built them to last. We still do, so that they'll always be healthy, hearty and strong members of your family.

Every refrigerator is not a Frigidaire.

"The best to you each morning"



They say the world has only two kinds of people: those who can get up smiling with the early morning sun, and those who take a little longer.

Whichever kind you are, a breakfast built around Kellogg's Product 19 and milk is a mighty nice way to say Good Morning to yourself. A breakfast loaded with vitamins and iron helps get you off and running.

And who ever thought so much nutrition could have such a great Good Morning taste?

NUTRITIONAL FACTS

One ounce of Kellogg's Product 19 provides these percentages of an adult's officially established minimum daily requirements (MDR):

NUTRIENT	Product 19 1 oz (1 cup)	Product 19 with 1/2 cup Whole Milk*
VITAMIN A	100%	104%
VITAMIN D	100%	112%**
VITAMIN C	100%	104%
NIACIN	100%	101%
THIAMINE (B ₁)	100%	104%
RIBOFLAVIN (B ₂)	100%	117%
IRON	100%	100%
CALCIUM	10%	29%
PHOSPHORUS	8%	23%
***VITAMIN E ₁	1.0 mg	1.08 mg
***VITAMIN B ₆	2.5 mcg	3.0 mcg
***MAGNESIUM	15.0 mg	30.5 mg

TYPICAL NUTRITIONAL COMPOSITION

	% of Total Weight	Amount in 1 oz	Product 19 with 1/2 cup Whole Milk*
Protein	8.5%	7.4 gm	6.7 gm
Fat	1.2%	0.3 gm	4.6 gm
Carbohydrates	81.0%	21.0 gm	29.0 gm
Calories		104 calories	184 calories

*Whole milk values derived from USDA Handbook No. 8 and USDA Report No. 36.

**Vitamin D fortified milk at 400 USP units/quart.

***Minimum daily adult requirements have not been established.

Kellogg's

PRODUCT 19



HAVE YOU BEEN LIVING ON BORROWED TIME?



With a dishonest watch you go around begging people for the time.

Trying to spot a clock.

And getting dirty looks from the lady sitting next to you, when you were only trying to see her wrist.

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It has a tuning fork movement that's guaranteed honest to within a minute a month.*

So never again will you have to beg anyone for the time.

Or try to spot any clocks.

And though you may still get dirty looks from the lady sitting next to you, it won't be for staring at her wrist.

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Shown: Accutron™ 2631. Combination brushed and polished stainless steel case. Applied silver markers. Sunray silver dial. Grey napped strap with silver lame inserts. \$125. Ask your dealer to show you the many other styles from \$110.

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Most cameras won't let you move fast enough. When you look away to adjust the camera, you lose your bug and a great shot.

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the shot, without looking away from the viewfinder.

Minolta SR-T 101, from about \$300. The Minolta SR-T 100, about \$250. For literature, write Minolta Corp., 200 Park Ave. So., N.Y., N.Y. 10003.

In Canada: Anglophoto Ltd., P.O.

Minolta

When identified by a factory-sealed "M" tag, Minolta 35mm reflex cameras are warranted by Minolta Corporation against defects in workmanship and materials for two years from date of purchase, excluding user-inflicted damage. The camera will be serviced at no charge provided it is returned within the warranty period, postpaid, securely packaged and including \$2.00 for mailing, handling and insurance.



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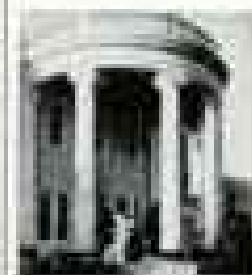
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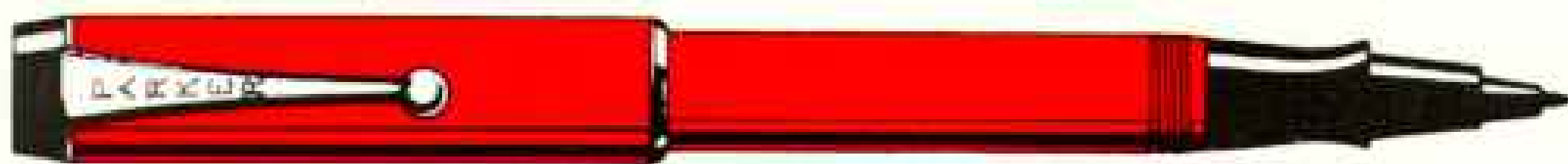
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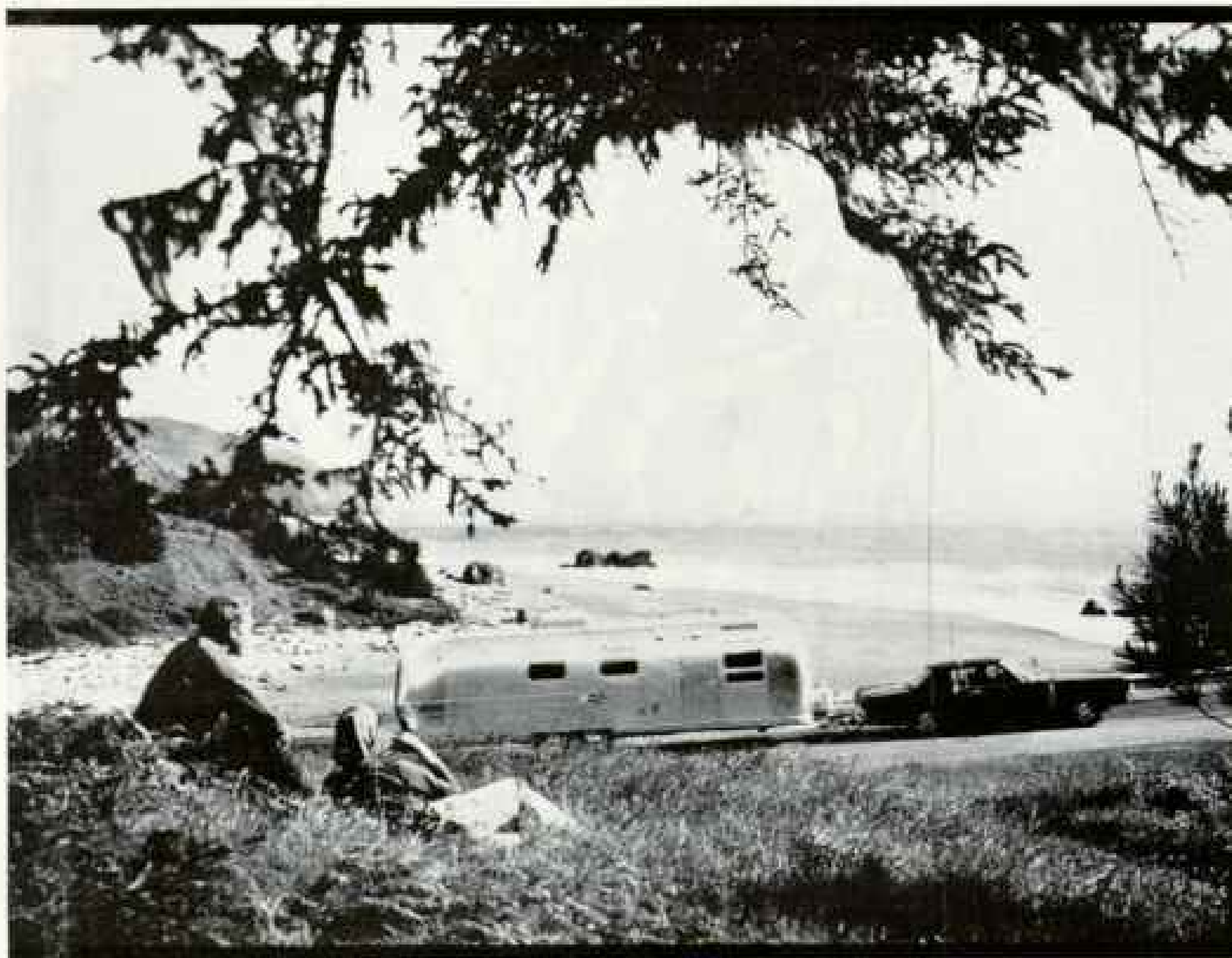
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