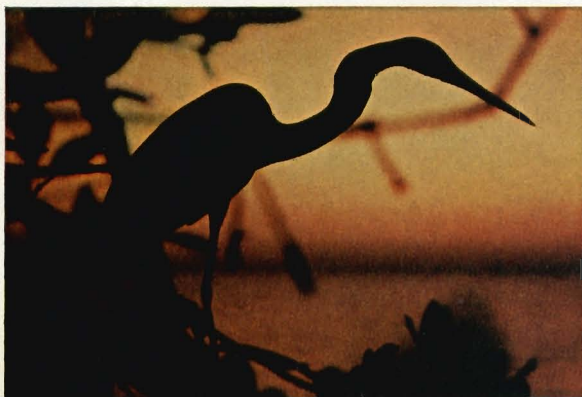




The Tree Nobody Liked

By RICK GORE Photographs by BIANCA LAVIES BOTH NATIONAL GEOGRAPHIC STAFF



Leapfrogging to a new foothold, a red mangrove reaches across a sandbar in Florida Bay. Once considered a nuisance by Floridians, the irrepressible tree is now esteemed as a nursery for marine life and a haven for water birds.

I STILL RECALL the dredges and the bulldozers working in the red mangrove swamps near my father's house. I never thought their destruction was much of a loss. Mangroves were scrub: junk trees. The peculiar aerial roots, which, like spidery legs, prop the mangroves up in the mud, made the swamps seem forbidding. Swarms of mosquitoes and clicking, crablike creatures lurked within. The mud often stank. "No one likes the mangroves," John Steinbeck once wrote. And in Florida, until very recently, he was right.

Few people complained as stands of mangroves along the state's southeast coast were replaced with sea-walled housing developments, hotels, and shopping plazas. Today most of Florida's red mangroves are part of a lush fringe extending along the southern Gulf Coast. They embrace the Ten Thousand Islands, wrap around Everglades National Park, and reach to the tip of the Florida Keys (map, facing page).

In the past few years the red mangrove has made a lot of friends. "It is the sacred tree of Florida," says Bill Merrihue of Naples, president of the Collier County Conservancy.

Sacred enough for a Miami federal judge to order a trailer-park developer in the keys to restore to its natural state a mangrove swamp he had dredged without proper permit. And at Marco Island, south of Naples, the U. S. Army Corps of Engineers recently denied the Deltona Corporation permission

to develop some 2,000 acres of mangrove wetlands it had already sold for luxury homesites. That decision, if upheld in the courts, could force Deltona to refund tens of millions of dollars or offer purchasers property of comparable value.

It was the work of two biologists at the University of Miami, Eric Heald and William Odum, in 1969, that inspired this renaissance of the red mangrove. Working in the heat and muck of the North River, in a remote part of the Everglades, the two men demonstrated that in estuaries the unloved red mangrove is actually the basis of an elegant food chain that supports much of south Florida's unique and wondrous animal life.

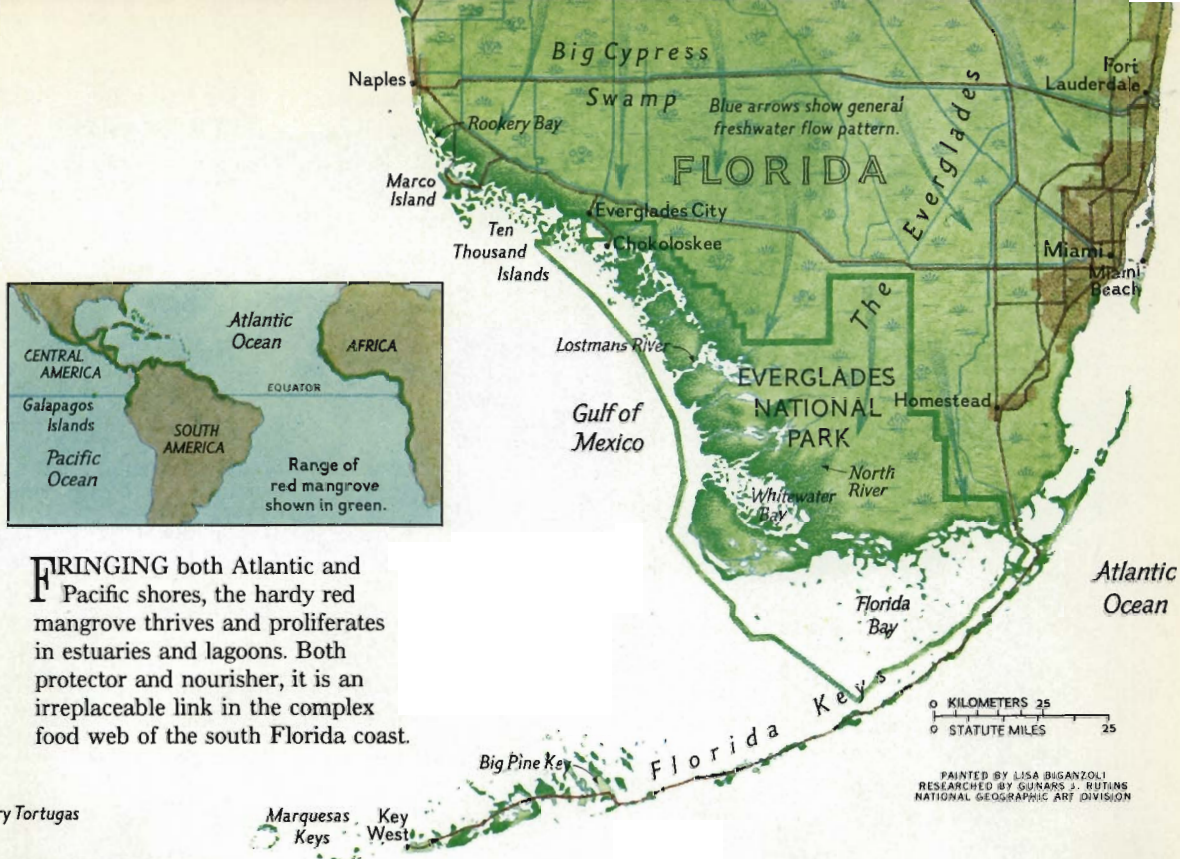
Red mangroves, they showed, shed more than three tons of leaves an acre each year. As these leaves decompose, they are eaten by the little crabs, worms, and other small creatures that form the lower links of the food chain. In some southwest Florida estuaries, mangrove leaves provide a large percentage of the diets of these animals. The little creatures in turn become prey for larger fish and many of Florida's tropical birds.

Red mangroves offer more than food. They provide a safe, irreplaceable wildlife habitat, both on land and, around their roots, in the water. Moreover, they break up storm waves, and their spidery roots stabilize land vulnerable to the sea. Old-timers say the mangroves are one of the safest refuges in a hurricane.

Rediscovering *(Continued on page 675)*



Stemming the tide of Florida's land development, the U. S. Army Corps of Engineers recently called a halt to further mangrove destruction at Marco Island (left). At stake, said conservationists, was the future of the area's fragile ecosystem. Though the landmark decision is being appealed in court, few now deny the importance of the red mangrove to Florida's commercial- and sport-fishing industries.



FFRINGING both Atlantic and Pacific shores, the hardy red mangrove thrives and proliferates in estuaries and lagoons. Both protector and nourisher, it is an irreplaceable link in the complex food web of the south Florida coast.

The red mangrove, vital habitat for wildlife

SALT-TOLERANT mangroves thrive in environments ill suited to other plants; tide-borne debris often collects among the roots to form new land.

SEEDLINGS DROP and take root nearby or travel by sea to other shallows.

FRESH WATER from seasonal runoffs reduces salinity to levels more productive of marine life.

LEAVES FALL to start formation of nutrient-rich detritus.



LARGE FISH, crabs, birds, and animals continue the food chain, which may culminate with man himself.



SMALL FISH eat crustaceans and worms, as well as detritus.



FUNGI AND BACTERIA begin organic breakdown of fallen leaves. Microscopic crustaceans and worms eat and excrete particles, furthering protein enrichment.

Dry Tortugas

Marquesas Keys Key West

Big Pine Key

Florida Keys

0 KILOMETERS 25
0 STATUTE MILES 25

PAINTED BY LISA BIGANZOLI
RESEARCHED BY GUNARS J. RUTINS
NATIONAL GEOGRAPHIC ART DIVISION



A pandemonium of fish—big mangrove snappers and others—gathers amid tangled prop roots at high tide to dine in one of the world's richest marine environments.



As the tide recedes, it carries detritus and microorganisms to nearby shallows that become nurseries for many of southern Florida's commercial fish and shrimp.



(Continued from page 670) the red mangrove, *Rhizophora mangle*, became an excursion of surprise. As I expected, mosquitoes still abound in the mangrove swamps, along with clouds of Florida sand flies, or midges, which Dr. Eric Heald describes as "all jaws; a set of teeth with wings." But the mangroves also host a panoply of life that I had grown up never knowing.

Aquarium of Life Surrounds Roots

With Billy Schwicker, a young jack-of-all-trades and mangrove enthusiast, I put on snorkel and mask off a mangrove island near Big Pine Key to explore from below the tangle of prop roots that make the mangroves look as if they are walking on the water.

It is like diving into an aquarium. Schools of rainbow-colored fish, jellyfish, translucent minnows, and little yellow-and-black-striped sergeant majors glide about the mangrove roots. Dozens of immature mangrove snappers peer out at us from their refuge in the roots. In shallower waters clusters of sea anemones and tiny fish are attracted to the food and protection within the mangrove stilts. Hermit crabs (page 680) scavenge along the bottom for organic debris that has washed from the island.

Since there is a breeze to keep the mosquitoes bearable, we trudge ashore through knee-deep muck. We contort our way through a jungle gym of roots to a small sand ridge at the island's center. It is teeming with life. Thousands of tiny shrimplike amphipods leap and burrow about in the sand.

There is a flap of big wings overhead as a breathtaking great white heron takes off. Florida's magnificent four-foot-tall great whites nest in these fertile mangroves of the keys.

As we pole our boat between islands, I notice many six- to twelve-inch-long green pod-like objects bobbing in the water. I have seen them many times before, stranded with seaweed on beaches and well out at sea—the seedlings of the red mangrove tree.

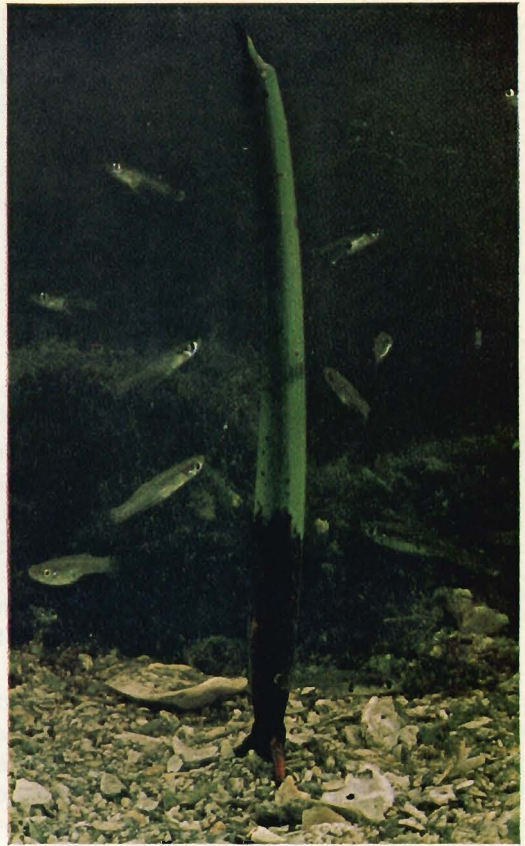
These ready travelers are one of nature's more remarkable seedlings; they give the red mangrove its extensive range: along the west coast of Africa, from northern Brazil through Central America to the southern coasts of Florida, and on the Pacific coast from Ecuador to Baja California.

In the spring the red mangroves blossom



Shapers of new islands, oyster bars at Rookery Bay provided both foundation and design for homesteading red mangrove trees (facing page). Getting their nutrients from water, these trees can root on convenient intertidal surfaces—oyster beds, sandbars, even coral reefs. Conversely, a cluster of coral has attached itself to a root (above).





Aggressive colonizers, red mangroves owe their far-flung presence to seagoing seeds that germinate while still on the tree. The flowers (**left**) bloom for a few weeks in the spring and then fall, making way for a fruit (**top**) that harbors a single seed embryo. A seedling shoot soon sprouts from each fruit (**above**) and grows to a length of six to twelve inches before dropping from the tree. Falling on land, it may put down roots immediately; otherwise, it will float with the current in a horizontal

position. Gradually the root tip becomes waterlogged, causing the seedling to shift upright.

In this manner it may drift for many months before going aground in shallow water, where it can take root (**above**). Borne on equatorial currents, seedlings have even crossed the Atlantic. As the tree matures (**below**), its prop roots take in oxygen, and transmit moisture and nutrients to the trunk and branches. They may also trap silt and debris that aid in stabilizing the shoreline.



with yellow flowers that produce more than three hundred seeds per tree during the summer. As the seedlings ripen, they drop, some like darts into the mud below, where they may take root.

But more end up in the water, where they sometimes drift horizontally for hundreds of miles, remaining alive as long as a year. Gradually their root ends begin to absorb water, and the bottom-heavy seedlings turn upright. Roots and top growth may even shoot out while the seedlings are still adrift.

Eventually the pioneering seedlings beach, often on a sandbar or oyster bar. If the landing site proves suitable, roots soon anchor them to the ground, and rapid growth—as much as two feet in the first year—begins.

By about the third year a young tree starts to sprout its own forest of arching prop roots. Red mangroves often root in mud lacking in oxygen, so aerial roots allow the exchange of gases needed for respiration.

Gradually the young tree forms its own seeds, and in about ten years the bar becomes a thriving colony of red mangroves. The roots catch silt and debris, and land forms in the center of the colony. Here, on these higher locations, other types of mangroves, such as the black, *Avicennia germinans*, the white, *Laguncularia racemosa*, and the buttonwood, *Conocarpus erectus*, may begin to take over from the reds. But the reds continue to spread outward, colonizing and often stimulating the growth of new land at the sea's edge.

Coastal Groves Form Murky Jungles

The great coastal red mangrove belt at the lower tip of the Florida peninsula differs dramatically from the mangrove islands I saw with Billy in the keys. In the keys the islands sit scattered amid clear green sea. But along the coast the mangroves look like a primeval jungle that has been cut into a maze of small, closely connected islands by endless, twisting channels of murky water, stained a rust brown by tannins in the mangrove bark and leaves. Here, where the Everglades meet the sea, the mangrove ecology becomes estuarine rather than oceanic.

The view from the air is striking. To the north, mangrove-fringed estuaries reach like green fingers into the distant yellow saw-grass plains of the Everglades. Mangroves here may grow 80 feet tall. Below, when the tide is

out, hundreds of white ibises and other wading birds speckle the glistening, fecund black mud, stalking its overlaid cache of crustaceans and other marine life.

Mangroves are what botanists call halophytes, plants that thrive in salty conditions.

"It is not so much that mangroves need salt water," explained Dr. Heald. "The salty soil keeps out other plants that would be more efficient competitors. The mangrove is no wonder tree in the amount of leaf material it produces. Its value is that it grows where no other tree can."

Fallen Leaves Colonized by Fungi

Bacteria and fungi begin to colonize the red mangrove leaves even before they fall. But the work of marine microbes is most important. The leaf has a waxy outer layer, or cuticle, which, as an adaptation to its hot, salty environment, keeps it from transpiring too much water. The microbes invade through tiny cracks in this cuticle. They usually attack a leaf within 24 hours after it falls.

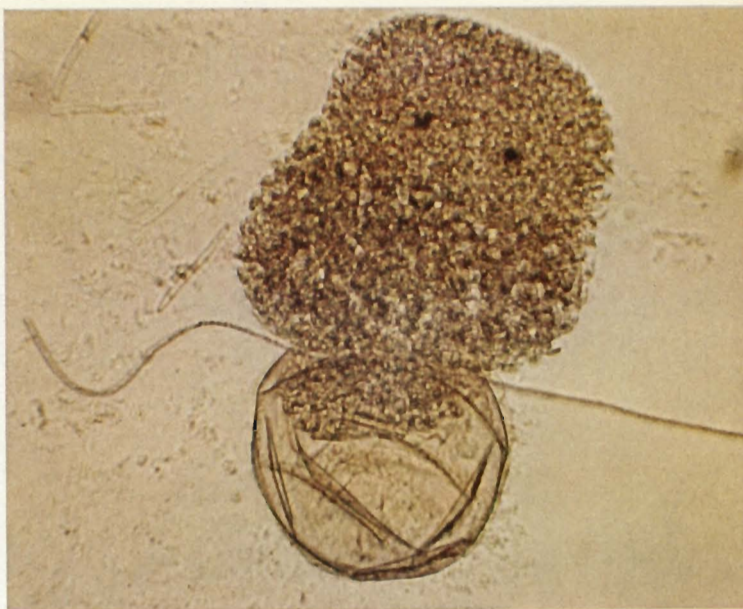
"These are among the first marine colonizers," said University of Miami biologist Manny Master, showing me a picture of a fungus named *Phytophthora vesicula*. Master and others in Dr. Jack Fell's laboratory at the university's Rosenstiel School of Marine and Atmospheric Science are studying the gradual breakdown of the red mangrove leaf.

"Different fungi live on the leaf at different times," Master said. "These phycomycetes have spores that swim like sperm right to the leaf's stomata, or pores. There they grow filaments called hyphae that bore through the cell wall to reach the carbohydrates inside."

Phycomycetes stay on the leaf for two or three weeks until the particular cellular nutrients they thrive on are exhausted. They coexist with and are succeeded by protozoa, bacteria, and some hundred other fungi, about fifteen of which are of major importance in degrading the leaf. Most of these fungi, unlike the phycomycetes, are immobile. They float and attach to the leaf by chance.

The bacteria and fungi look to the naked eye like a slimy brown film on the leaf. This film attracts a hungry host of tiny animals, mostly nematodes and other little marine worms, as well as microscopic crustaceans called copepods. Biologist Rose Cefalu Hendrix in Dr. Fell's laboratory scraped the slime

Climbing out of its egg sac, a baby turbellarian, or flatworm, looks for its first meal. It is one of the first carnivores in the mangrove food chain. Often less than 1/25th of an inch long when full grown, these voracious creatures inhabit the film of fungi and bacteria that forms on dead mangrove leaves during organic breakdown. Comprised almost entirely of digestive sac, flatworms swallow animals up to half their own size, such as nematodes and copepods. Their two eyespots probably can detect light.



MAGNIFIED 250 TIMES

off a leaf and put it under a microscope for me.

She pointed out a hard-to-detect, transparent flatworm called a turbellarian (above). "Its two little eyespots are about all you can notice. It changes shape as it swims. It is all stomach inside. It just opens its mouth and sucks in prey."

Small crabs and amphipods soon begin to gnaw at the leaf, both consuming it and breaking it down. Gradually the leaf falls apart, and its **particles** drift about. These particles, called detritus, are by then rich morsels for a wide variety of marine life.

"As the leaf particle becomes more and more infested with microbial life, it becomes richer in protein," explained Dr. Heald. "Take two particles of identical size, one six months old and one twelve. The shrimp that picks up the older one would get better nutrition."

Mullet "Graze" on Bits of Leaves

The particles may be eaten and excreted and eaten again many times by different animals: sea worms, little mollusks, shrimp, crabs, and more crustaceans than I dreamed exist. These animals become prey for small fish, like grunts, pinfish, and snappers, that are later eaten by larger fish.

Some larger fish, notably the commercially important striped mullet, feed on mangrove detritus directly. They scour the bay bottoms in schools, taking in mouthfuls of mud and

filtering out the enriched mangrove particles.

These grazing mullet are primarily what keep food in Sonny Strickland's mouth. Sonny is one of a handful of full-time mullet fishermen who work the glaring waters around the Ten Thousand Islands, a no-man's-land of mangrove-jungled sand keys and oyster bars.

The ancient Calusa Indians first lived in this labyrinth of islands. Long after the Calusas vanished, hardy white settlers established a few outposts, like the colorful fishing village of Chokoloskee. The mangroves also attracted outlaws. Murderers and thieves could hide out in these islands for years, confident that the law would never even try to track them through the maze of blind creeks and impenetrable mangrove roots.

Sonny, it is said, knows these islands better than anyone.

"This boat ain't built for guidin'. This here's a workin' boat," he apologizes as we set off toward Lostmans River. His boat is five years old and looks fifty.

Fishing has been miserable lately, Sonny complains, eyeing the horizon for a muddy patch of water that would indicate a school of feeding mullet. He also keeps an eye on the birds.

"Them ole pelicans," he says, pointing to a couple. "I watch them a lot to guide me to the fish."



To eat and be eaten: a sober fact of wildlife in the mangroves. An injured killifish, itself grown fat on detritus-nourished amphipods, falls prey to a scavenging blue crab (above). The crab in turn is a toothsome favorite of man—as a hard-shell delicacy or in its soft-shell stage after molting.

Stoking up on a pink shrimp, a hermit crab (left) protects its soft abdomen by residing in a discarded mollusk shell. Nearby cruises a mangrove snapper (right), much prized by Florida fishermen.

Down the hatch of a young pink shrimp goes a tiny mosquito fish—an unusual meal for these small crustaceans that support Florida's multimillion-dollar shrimping industry. Born off the Dry Tortugas, the light-shunning creatures—then only speck-size—migrate a hundred miles to mainland mangrove estuaries, where they reach adolescence. Returning to the Tortugas, they spawn and begin the cycle anew.



Marine eccentrics: Sea horses, like this one that has tethered itself to a stem in Rookery Bay (**below**), are hatched by their fathers, who carry eggs deposited in their brood pouches by females. Like chameleons, these fish can change color to suit their surroundings. Shrimp larvae and other plankton are sucked in through their tubelike mouths. Two decorator crabs (**facing page**) camouflage themselves in hydrozoans—plantlike animals—snipped off with scissor-like claws.



When Sonny finally spots a school, he drops one end of a 425-yard-long net into the water and runs the boat wide open in a broad circle that he hopes will ensnare the fish. As he hauls in the net, a scowl forms on his face.

"Little bitty rascals," he grumbles. We watch the few small mullet in the net slip through the mesh as he pulls in. "This is what I call a water haul. Nothin'!" The next try turns out only a bit better. "Fish are as scarce as I ever seen 'em."

Sonny expects the fishing to improve once the rainy season gets started upland in Big Cypress Swamp. "Fishin' here is like farmin'. You need rain for both."

Sonny was right about the rains. The annual slow overflow of Big Cypress rainwater into these islands flushes mangrove detritus out of the backwaters. It also freshens the bays and estuaries, creating a desirable salinity for the migrating young of many marine creatures. This salinity level chemically encourages mangrove particles to clump and settle rather than wash out to sea.

The mangrove wetlands thus become vast, bountiful nurseries. And when the little creatures arrive to feed and grow bigger, larger predators, including such sport fish as snook, tarpon, and snapper, soon follow.

The fabled fishing in these waters has indeed been off for the past five or six years.

During that same period, nearby drainage canals built by land developers have short-circuited much of the overflow out of the Big Cypress.* The canals deliver poor-quality water in sudden bursts that shock the estuaries, shorten the period of freshwater inflow, and reduce their capacity to support life.

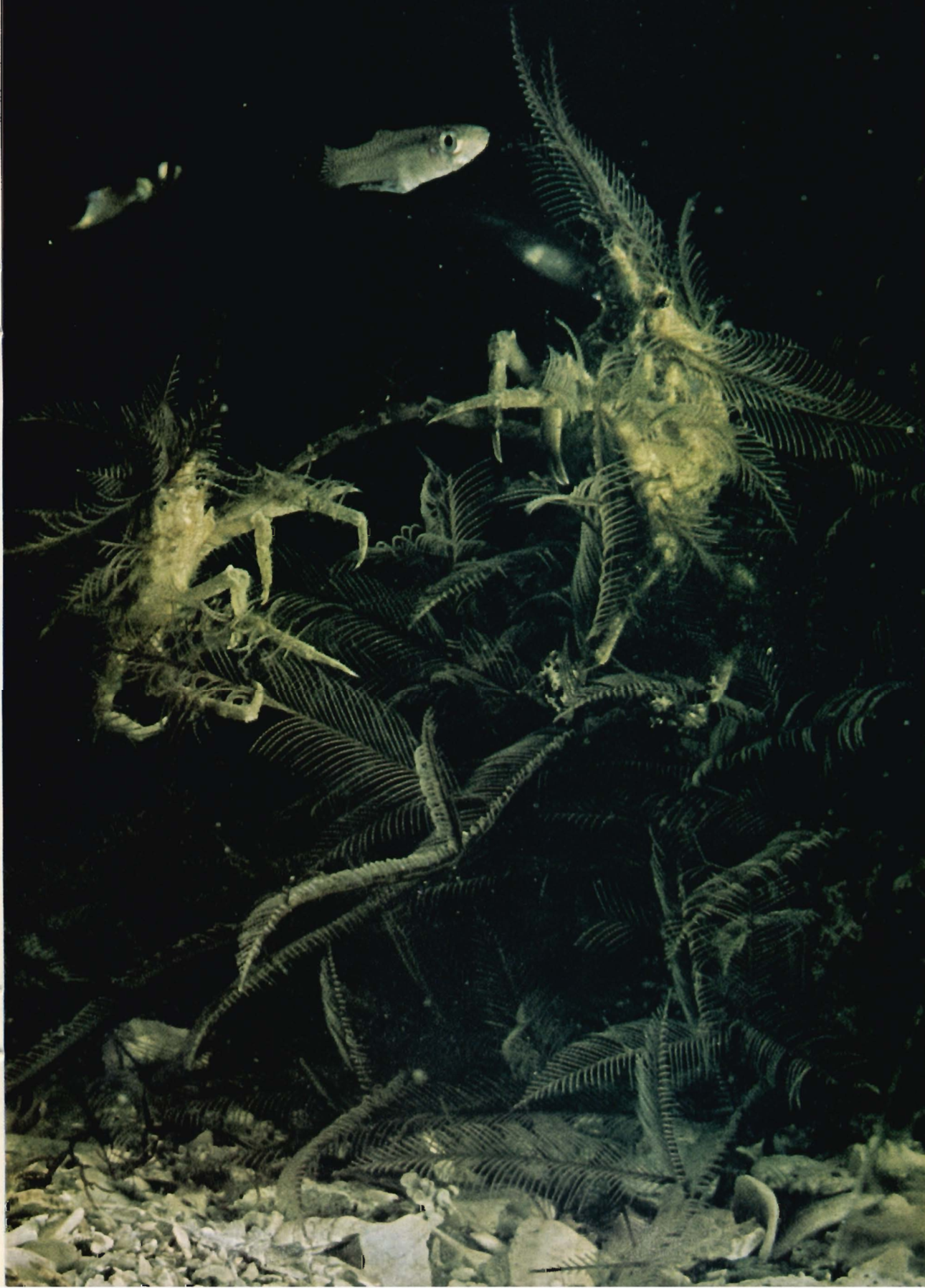
No one can prove that these changes have decreased the amount of estuarine life, but most biologists I talked with believe that the correlation is more than coincidence.

Marco Island Ruling a Legal Milestone

Just north of the Ten Thousand Islands lies Marco Island, the resort and retirement-home community where mangroves have won their most significant victory to date. Marco, once fringed by mangrove swamp, is today a tidy network of sea-walled canals and beautifully landscaped modern homes.

The Army Corps (*Continued on page 686*)

*See "Twilight Hope for Big Cypress," by the author, NATIONAL GEOGRAPHIC, August 1976.





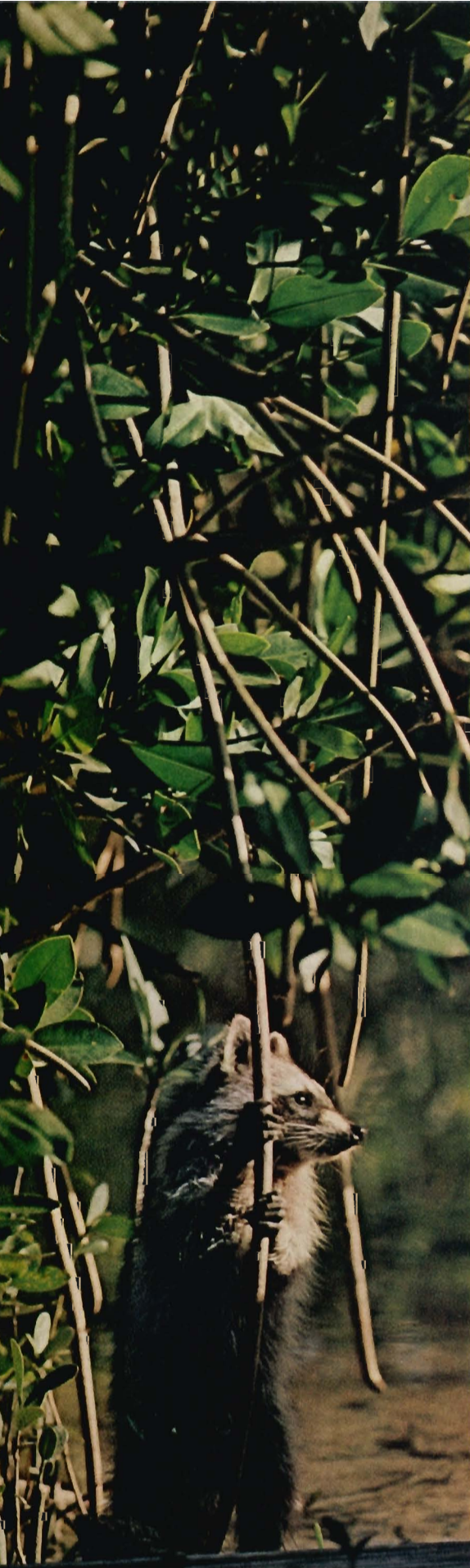
“I was here first!” Attracted by the area’s abundant fish, white ibises dispute the ownership of a branch (**above**) on a mangrove island in Rookery Bay, where, at sunset, thousands of water birds contend for space (**below**). Big birds roost on the top canopy, while smaller ones settle for the underbrush. A plentiful food supply, coupled with the efforts of conservation groups—the Audubon societies in particular—have kept southern Florida a birdwatchers’

paradise. Many species, such as the reddish egret and the roseate spoonbill, almost vanished around the turn of the century when their plumes were prized as adornments for ladies’ hats.

In the Marquesas Keys a downy young frigatebird (**right**) will mature to become an aerial pirate, snatching food from boobies and terns. Also known as the man-o’-war bird, the species established its first U.S. nesting grounds here in the late 1960’s.







of Engineers' controversial decision to halt further development and thereby save two big mangrove tracts on Marco is a milestone for all this country's wetlands. The corps essentially ruled that wetlands are too valuable a public resource to be squandered for developments that are not clearly in the public interest. (The value of Florida's mangrove wetlands for fishing, tourism, and recreation has been estimated at about \$4,000 per acre per year.) Owners of wetlands, it would now appear, can no longer do whatever they want with their property.

Mangrove Nurseries Yield Shrimp

Few people are as pleased by the corps' decision as biologist Bernie Yokel, director of the Rookery Bay Marine Research Station, tucked into the 5,500-acre Rookery Bay Sanctuary, a splendid preserve of mangrove coast and islands just a short boat ride north of Marco Island. Bernie, a jovial, outspoken defender of mangrove purity, has no use for new neighbors. He understands too well the importance of the mangroves.

"Almost all the game fish and commercial species in the Florida mangroves go back to the open sea to spawn," he explained.

The most commercially important of these are the pink shrimp, which, as adults, support at least an 18-million-dollar-a-year industry. Hatched in the Dry Tortugas, nearly a hundred miles away, these shrimp mature in the mangrove estuaries of Florida Bay and Everglades National Park. The juveniles migrate back to the Tortugas, where shrimpers scoop up some 16 million pounds each year as the adults spawn. Nearly 75 percent of this country's pink shrimp grow up in these mangrove nurseries.

"One female pink shrimp may produce 500,000 or more eggs," said Bernie. "Spawning occurs all year, but the bulk of the larvae are produced in late spring and early summer as specks you can hardly see. Those specks make this incredible migration back

Perfect cover for tricky raccoons, the gnarled roots of a coastal mangrove swamp foil the most dauntless of coonhounds. At low tide, thousands of coon oysters—one of the predator's favorite foods—can be found clinging to mangrove prop roots.

to the estuarine nurseries. They come in by the hundreds of millions. In the fall, if you take a light out at night, it's just fantastic to watch the juveniles swimming back to sea with the tide."

Mangrove-leaf detritus is a major part of the juvenile pink shrimp's diet. One of Bernie's favorite game fish, the redfish, or channel bass, in turn relishes pink shrimp. Bernie explained the redfish's shrimp-hunting technique. "These shrimp are nocturnal; they bury up in the mud during the day. The redfish angles its body along the bay bottom at about a 35-degree angle. It has little sensing filaments at the ends of its pectoral fins that help orient it in water that is often turbid. It extends the fins downward, and when the sensors touch bottom, the redfish knows it's at the right angle. It moves its lower jaw back and forth on the bottom until it senses a crustacean. Then the fish snaps it up, crushes the shrimp in the back of its mouth, and swallows."

One of my most common catches as a boy was the sheepshead, so named because it eats with sheeplike teeth, cropping little crustaceans off the mangrove roots.

Birds Included in the Food Chain

In all, Bernie estimated that some 75 percent of the game fish and 90 percent of the commercial species in this part of Florida depend on the mangrove system. And the food chain does not end in the water. Cruising the channels of Rookery Bay, Bernie showed me many of the birds that rely on mangrove-fed prey. Along one shore was a roseate spoonbill, whose striking pink coloring comes from a carotenoid, a chemical in shrimp and other crustaceans it eats. The bird was weaving its spoon-shaped bill back and forth, stirring its dinner up out of the mud.

A little snowy egret sat on a log, peering into the water and occasionally making a jab. "They are great ambushers," said Bernie. "They rely mostly on little filter-feeding fish—sardines, herrings, and anchovies."

Near extinction in 1947, when numbers shrank to 50, the tiny Key deer has made a comeback. More than 600 now feed in mangrove thickets in a 7,000-acre refuge. Throughout the mangroves, rat snakes (upper) keep alert for birds and rodents.



The mangroves are also the only trees around that these birds can roost in.

With Ted Below, a Naples man intrigued by brown pelican research, I visited a little mangrove island that seems to be the most popular roost. The branches were dotted by doleful-eyed pelicans staring out at us, now and then stretching their beaks upward to clean out their pouches.

"At night there are fifteen thousand birds on these islands," Ted said. "Nine species nest in there. The big birds, like the cormorants and the pelicans, use the top of the canopy; they need it as a platform from which to take off. Smaller birds can scuttle about the brush inside. The obvious advantage of a roost like this is that only one bird has to take alarm and the whole island gets excited."

Most of the birds this morning were out feeding. Only those pelicans that were full from a previous day's meal were at home. As Ted explained, a well-fed pelican can sit in the mangroves and watch the boats go by several days before hunger strikes again.

Natural Enemies Still Invade

In many roosting islands like these, a persistent spoiler of the red mangrove food chain has recently been observed. Along Rookery Bay the roots of some mangroves were dangling above the water as if they had been cut off. Bernie peeled open one of these roots and pulled out a little crustacean that looked something like a pill bug.

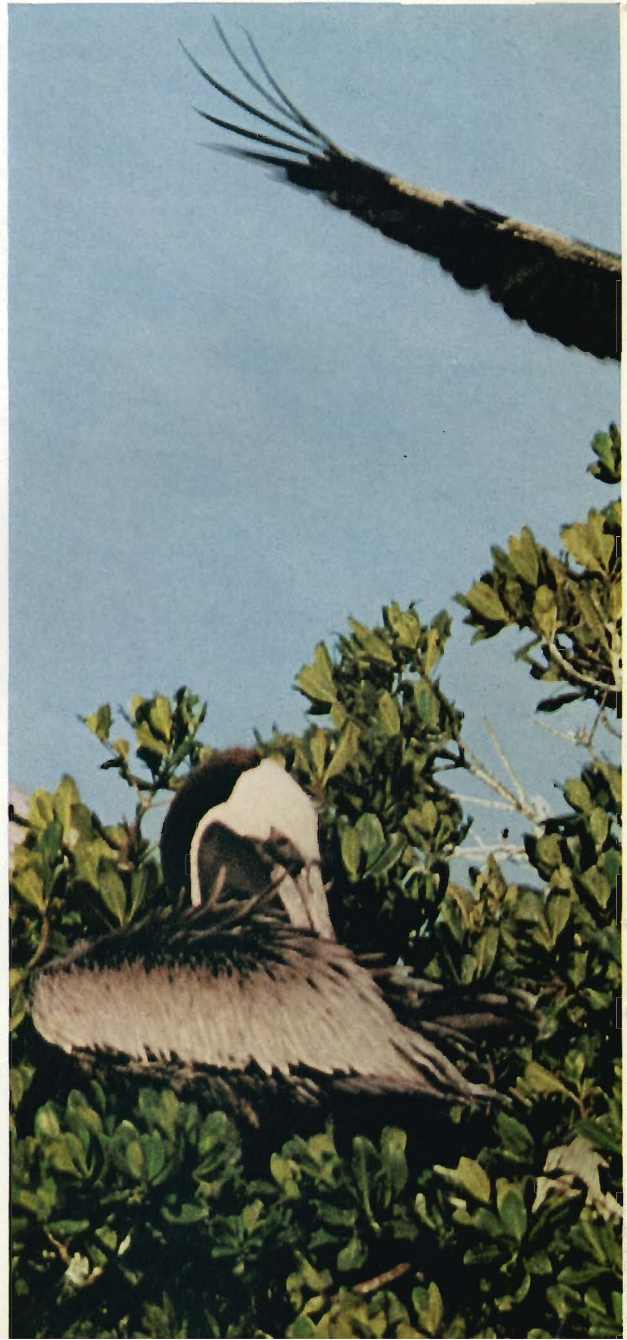
"This fellow is a wood-boring isopod called *Sphaeroma terebrans*," he said. "It eats into the ends of the prop roots. That can keep roots from growing and therefore keep the mangroves from marching on into the water."

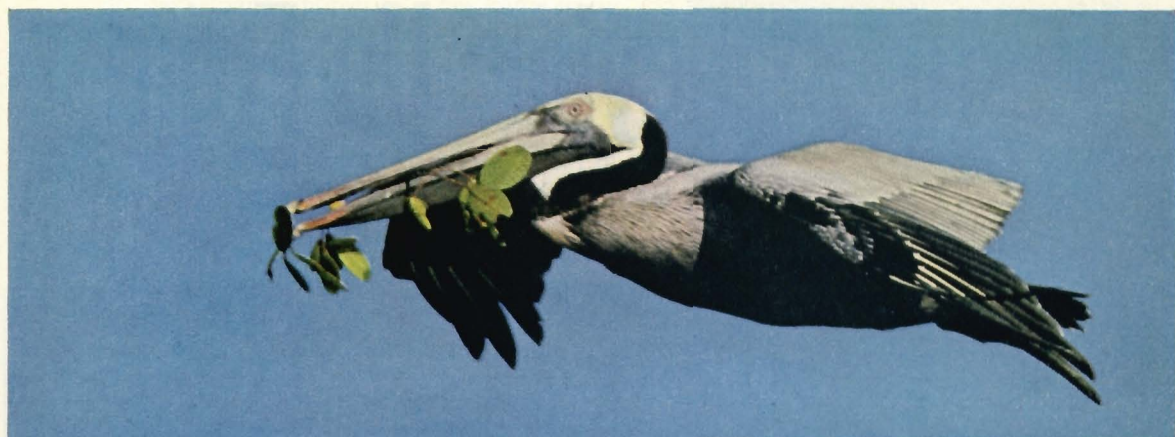
The isopod itself does not kill the tree, but sometimes, without the support of its prop roots, a red mangrove topples into the water during storms.

The isopod has been a problem on the southwest Florida coast for several decades, but not yet in the keys. It is ironic that this pest, one of several that plague the trees, should be gaining ground just when the last of Florida's red mangroves finally seem to be safe from the dredges and bulldozers.

But for the red mangrove's newfound friends there is some consolation. At least from now on, the mangroves will only have to cope with natural enemies. □

Padding their nests with mangrove leaves flown in from another island, a colony of brown pelicans spares the foliage from its own trees. Situated safely off shore, their island rookery offers a measure of protection against egg-robbing raccoons and rodents—and from man himself. These and many other imperiled tropical water birds find one of their most secure U.S. sanctuaries among Florida's remarkable mangroves.





VOL. 151, NO. 5

MAY 1977

NATIONAL GEOGRAPHIC



**WILD NURSERY
OF THE MANGROVES** 668

**THE CELTS
EUROPE'S FOUNDERS** 582

MALAYSIA: YOUTHFUL NATION WITH GROWING PAINS 635

ICELANDIC VILLAGE REBORN FROM FIRE AND ASH 690

NEW YORK'S NATURE-BLESSED FINGER LAKES 702