WRECKING THE REEFS

Coral ecosystems are in desperate trouble all around the world—and guess who's to blame

By J. MADELEINE NASH PANAMA CITY

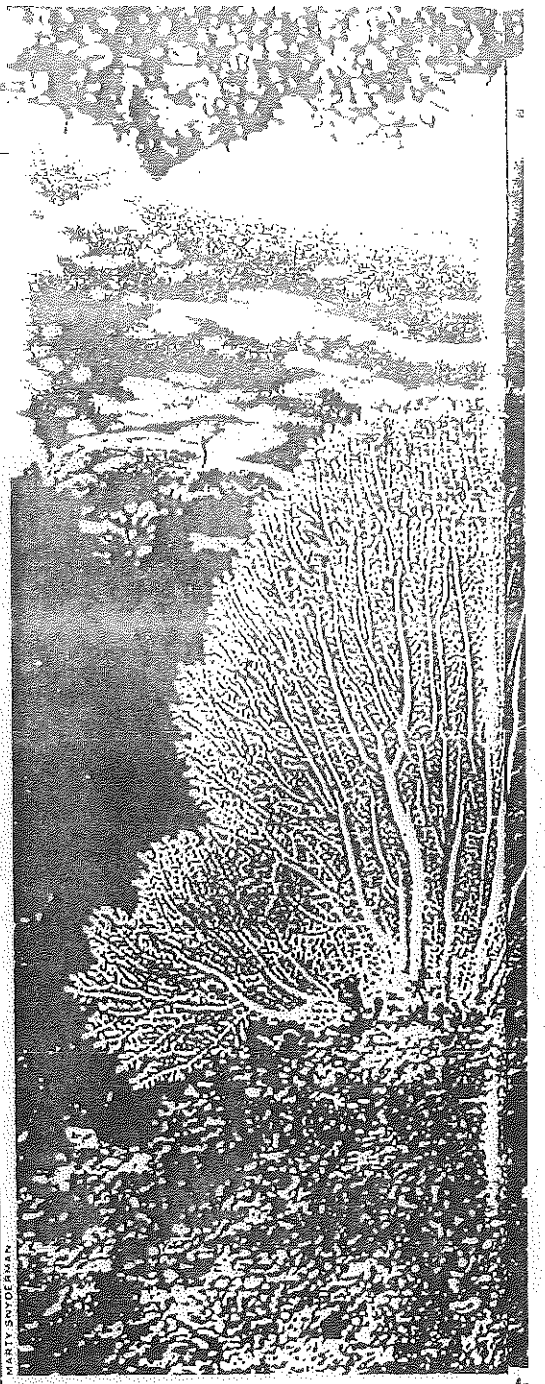
ONCE THE CORAL REEFS OF THE Caribbean all shimmered with life. Herds of iridescent parrotfish darted through forests of branching corals. Spiny lobsters lurked in crevices, while squid, spooked by shadows, dissolved into clouds of ink. But now many of these bustling underwater habitats are taking a beating—and the tropical storms that tore through the region in recent weeks are the least of their problems. "Reefs are tough," observes Clive Wilkinson, a biologist at the Australian Institute of Marine Science. "You can hammer them with cyclones, and they'll bounce right back. What they can't bounce back from is chronic, constant stress." The kind of stress, in other words, that is being applied by humans.

Across the globe, from the Gulf of Mexico to the South China Sea, people are killing coral reefs. Cyanide fishing, harbor dredging, coral mining, deforestation, coastal development, agricultural runoff, shipwrecks and careless divers are putting so much pressure on these extraordinary ecosystems that they may not survive beyond the next century. "You can never point to one thing and say it's this that's killing the reefs," Wilkinson observes, "because in reality it's almost everything."

While the evidence for the decline of reefs is based on observations of only a few hundred reefs out of uncounted thousands, scientists around the world are becoming increasingly alarmed. Already, some experts estimate, 10% of the earth's reefs have been mortally wounded. Thirty percent are in critical shape and may die within the next 10 to 20 years. And an additional 30% are coming under such sustained attack that they may perish by the year 2050. "I used to be reluctant to say the sky was falling," says paleobiologist Jeremy Jackson of the Smithsonian Tropical Research Institute near Panama City, Panama. "I'm not anymore. Today when I go for a swim on a reef in Panama, I cry."

BLEACHING The coral equivalent of a fever

Coral reefs are more than beautiful structures admired by snorkelers and scuba divers. Their stony ramparts serve as storm barriers that protect shorelines and provide ships with safe harbor. Their nooks and crannies accommodate fish and shellfish that are important sources of food and livelihood for millions of people. And like the tropical forests to which they are frequently compared, reefs are repositories of vast biological wealth as yet untapped for medicinal and industrial uses.

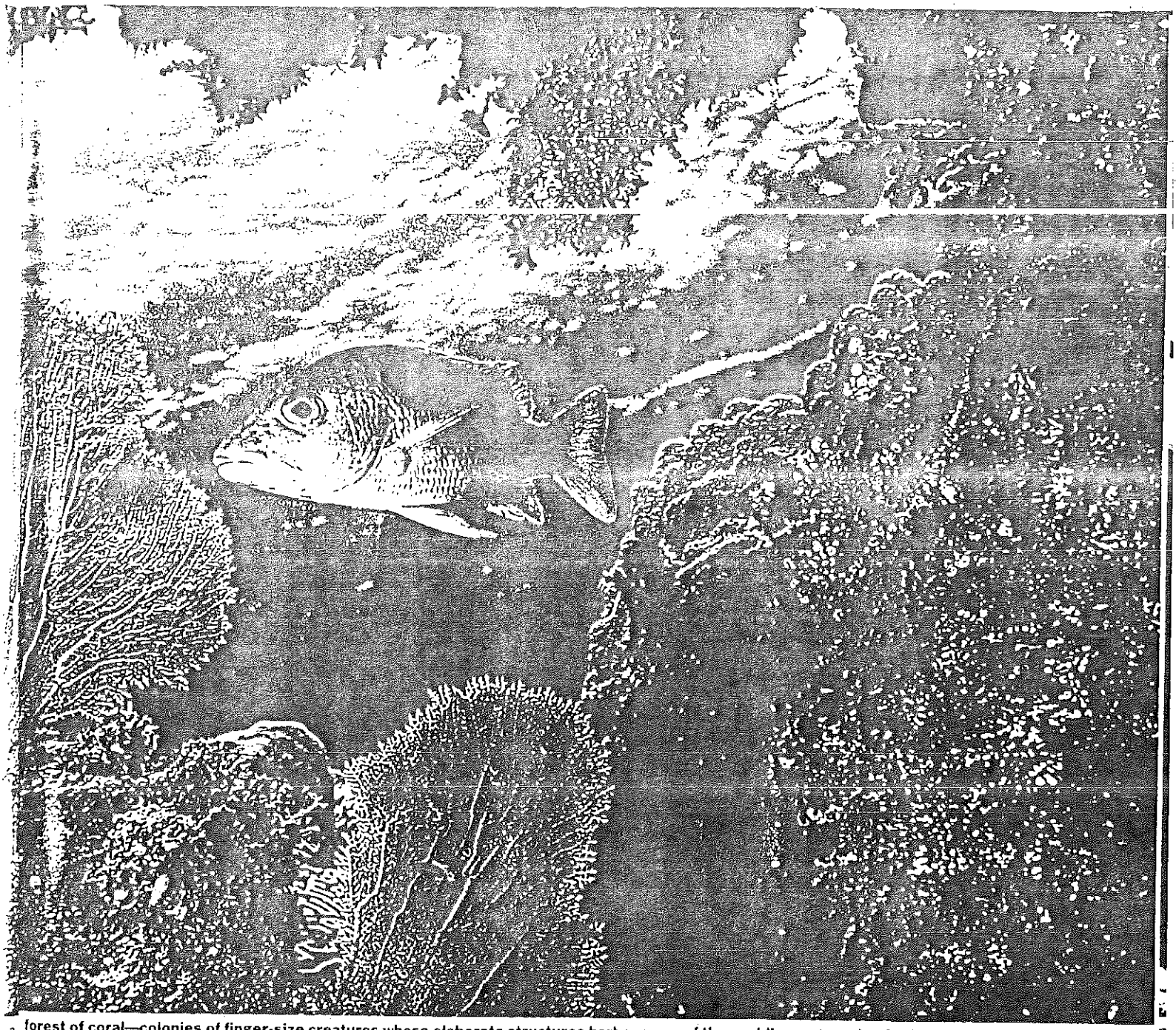


MARTY SNYDERMAN

UNDERSEA WONDERLAND A snapper swims in a fo

To rouse public concern, marine scientists and environmental activists have proclaimed 1997 the International Year of the Reef. They have persuaded the U.S. and other major countries to support a conservation offensive called the International Coral Reef Initiative. And perhaps most important, they have launched an ambitious project called the Global Coral Reef Monitoring Network, which will conduct the first surveys of the earth's estimated 400,000 sq. mi. of reef, including remote atolls no scientist has ever seen.

The underwater structures at the center of this concern are, in fact, built by live animals. Corals—fingertip- to hand-size



a forest of coral—colonies of finger-size creatures whose elaborate structures harbor some of the world's most productive habitats

creatures that stick together to form large colonies—use the carbon and calcium in seawater to build their hard, exterior skeletons. Over time, the stony material accumulates, giving colonies of coral their signature shapes. Some corals, for example, form big round heads that resemble a giant cauliflower, while others assume elongate shapes reminiscent of skyscrapers. As impressive as cities, mature reefs may be thousands of years old, extend for hundreds of miles and shelter thousands upon thousands of species—making them one of the most genetically diverse ecosystems on sea or land.

Modern reef-building corals are descendants of organisms that first appeared in the fossil record 225 million years ago. These ancient carnivores, cousins of sea anemones and jellyfish, boast stinging cells and tentacles for stunning and capturing prey. But while corals have survived the onset of major ice ages and variations in sea level of hundreds of feet, there are limits to the conditions they can tolerate. For example, they cannot build reefs in water colder than 60° F or in murky depths. They live in symbiotic relationships with colonies of tiny algae called zooxanthellae that depend on the sun for photosynthesis. Unfortunately, the fact that they gravitate toward sunlit shallows has made reefs easy targets for plunder.

Nowhere in the world have they been subject to more abuse than in the Philippines, says University of the Philippines marine scientist Edgardo Gomez. According to environmentalists, a staggering 90% of the archipelago's 13,000 sq. mi. of reef is dead or deteriorating. Among other things, Philippine reefs are being buried by tons of soil that washes from deforested tracts of land. They are also being damaged by pollution that seeps from factories, farm fields and sewers. But above all they are being destroyed by too much fishing.

The destructive cycle of overfishing began when coastal villagers started stripping nearshore reefs of giant clams, groupers and other large fish. Then the fishermen upped their productivity by a novel but frighteningly destructive practice: blasting the reefs with dynamite and scooping up the dead fish. Now they have adopted what

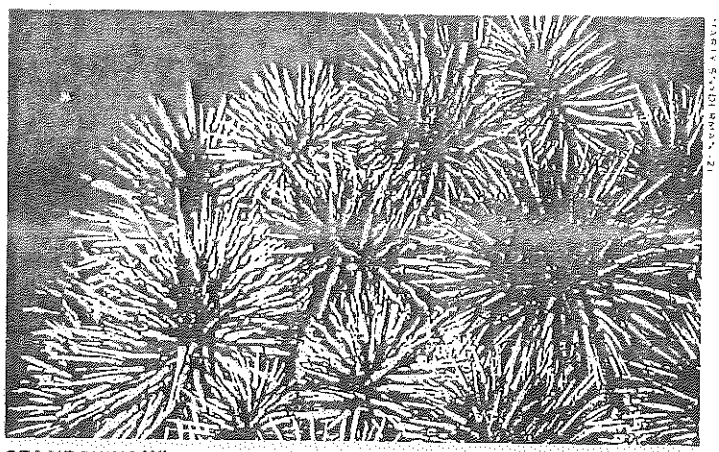
may be the most insidious fishing method of all. Sustained by hoselike "hookahs" and portable air compressors, Philippine divers are hunting down big reef fish, stunning them with cyanide and hauling them to the surface alive. The practice allows traders to supply Chinese restaurants with the live fish their affluent customers covet. Meanwhile, the 330,000 lbs. of cyanide the divers dump onto living corals each year is poisoning the reefs.

The good news is that the Philippine government has started to crack down on dynamite and cyanide fishing. The bad news is that those destructive practices are just the latest in a string of insults to reefs, and not necessarily the most serious. Far more troubling to biologists is the fact that groupers and other valuable reef fish are being harvested at a critical point in their reproductive cycle. With satellite navigation systems to guide them, fishing boats are homing in on areas where large numbers of the fish have gathered to spawn. Already, says University of Hong Kong fish biologist Yvonne Sadovy, fishermen have eradicated entire groups of sexually mature adults, which jeopardizes the future of the fish and also the future of the reef.

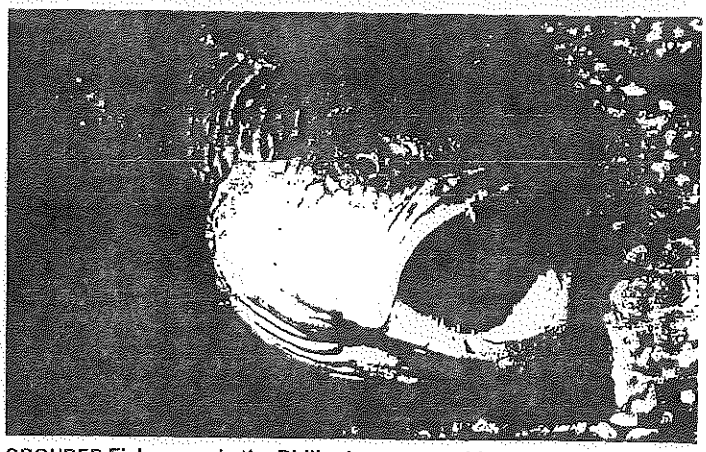
Large fish, it turns out, are among the most critical of all reef inhabitants, especially herbivores like parrotfish that eat seaweed. Fast-growing seaweed is always threatening to engulf the reefs, but it is usually kept in check by grazing fish. About a decade ago, a team of marine scientists conducted an experiment off the coast of Belize that proves this point. To keep fish out, the researchers surrounded a section of coral the size of a small pasture with a chicken-wire fence. Within 10 weeks, they found, the area inside the fence had been completely overgrown by seaweed and many of the corals had died.

A reef is like a complex machine with many redundant components; when one malfunctions, another usually takes over. By the middle of the past century, for example, Jamaica's expanding human population had devastated the stock of seaweed-eating fish. Still, the reefs that surrounded the island looked healthy. Why? The answer, says the Smithsonian's Jackson, is sea urchins, which are also herbivores and which temporarily filled in for the missing fish. In 1983, however, the urchins succumbed to a mysterious disease. All of a sudden Jamaica's reefs crashed. With no urchins to crop back the seaweed, Jamaica's corals, once considered the jewels of the Caribbean, were soon smothered by a vegetative thicket.

Unhappily for reefs, humans upset the balance between corals and their competitors in many ways. Consider the erosion that accompanies deforestation and agriculture. No longer restrained by tree roots, tons of soil laden with nitrogen and phosphate washes into rivers and then sweeps into the sea, forming a muddy plume that may be hundreds of miles long. As this nutrient-rich water flows over a reef, it stimulates the growth of all kinds of algae—including the microscopic diatoms and dinoflagellates that nourish such reef animals as the crown-of-thorns starfish. In recent years hordes of these coral-devouring starfish have infested Australia's 1,200-mile-long Great Barrier Reef, and soil-borne nutrients are at least partly to blame.



SEA URCHINS When a mysterious disease wiped out the algae-eating herbivores in Jamaica, the reefs were quickly overrun with seaweed



GROUPER Fishermen in the Philippines are tracking these valuable reef fish with satellites, harvesting them just as they gather to spawn

But what has brought about the epidemics of "bleaching" that have turned coral reefs white across the Pacific Ocean and parts of the Caribbean? Scientists have known for some time that various kinds of stress can cause corals to expel their zooxanthellae. Since it is the zooxanthellae that give coral colonies their rich coloration, their loss causes entire reefs to turn white. The stress that caused the recent bleachings, scientists say, was a seasonal spike in seawater temperatures. But other sources of stress, such as overfishing and nutrient overload, may have made the corals and their symbiotic friends unusually sensitive to heat.

What if several decades from now global warming causes such swings in temperature to occur more often? That possibility alarms marine scientists, because bleaching—the coral equivalent of running a fever—can be fatal. In 1983 a particularly severe bleaching episode killed 95% of the corals off the Galápagos Islands. Global warming could also trigger more intense hurricanes, scientists fear. And while healthy reefs would no doubt recuperate from the pummeling, sick reefs might not. "What we worry about," says Smithsonian marine biologist Nancy Knowlton, "is a threshold effect, when so much stress piles up that all of a sudden the floor falls through."

The dwindling of reefs in the world's oceans, scientists acknowledge, will not immediately destroy the organisms that build them. Many corals spawn en masse, releasing a vast pinkish slick of fertilized eggs that ride ocean currents for hundreds of miles. In the natural cycle, one reef rises as another declines. This cycle is what humans are now disrupting, however, and no one can foresee what the consequences will be. Creating more marine preserves can help, but even if the reefs are patrolled by armed guards, they may not be able to withstand the twin juggernauts of exploding population and the economic desperation that accompanies it. In the next five decades, the number of people on earth may nearly double, to more than 10 billion, and the pressure that will place on reefs is almost too enormous to contemplate. *—With reporting by Sandra Burton/Hong Kong*