Science & Technology

The Life-and-Death Struggle of Coral Reefs

As warming seas threaten these essential marine ecosystems, Braddock Linsley drills down on their history.

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This past spring, the National Oceanic and Atmospheric Administration announced that the world was undergoing a “global coral-bleaching event” due to the record-setting warmth of our oceans — the fourth such event ever recorded and the second

in the past ten years. For Braddock Linsley, a research professor at the Lamont-Doherty Earth Observatory, it's another worrying twist in a story he's been investigating for four decades.

Linsley studies coral. More specifically, he studies hard corals in the Pacific Ocean that lie within the tropical rain belt that extends around the equator. He has been to the coasts of Panama, Fiji, Tonga, and Samoa in search of samples for his research. He'll take out a boat, put on a snorkel, and look beneath the water's surface until he sees the massive, branching architecture, the mushroom-like protuberances, the blooming, varied colors of a coral reef. Then he'll get to work.

Called the "rainforests of the sea" for their dazzling biodiversity, coral reefs cover less than 1 percent of the ocean floor but provide habitat for more than a quarter of all marine life. As Linsley explains, there are some six thousand known species of coral, each made up of colonies of tiny tentacled creatures called polyps, whose often vivid hues come from symbiotic algae that help the coral grow its limestone skeleton. "When you look at a large coral that's ten or twenty feet high, only about a half centimeter of material is the living tissue — it's like a skin — and underneath is this calcified mass that the coral has generated over the years," Linsley says. "When the water temperature is elevated, the algae can produce harmful toxins and so the coral expels them, leaving the translucent tissue with the white skeleton below it."

This "bleaching" is a sign of distress and poor health, and scientists warn that increased warming will kill off the corals. "They're the foundation of the marine ecosystem," Linsley says. "Coral reefs break wave energy, which allows all sorts of other types of organisms to colonize the seafloor, which then brings in fish. Without a healthy coral structure, the whole ecosystem will collapse."

Linsley wants to know more about undersea warming patterns, and coral is an ideal instrument through which to peer into the ocean-climate past. On the reefs, Linsley and his team use drills to retrieve cylindrical core samples about three inches in diameter and up to twenty feet long and then fill the holes with concrete plugs, which the coral will grow over. In the lab at Lamont, they cut the cylinders into slabs and use X-rays to reveal annual growth rings, similar to those of trees. "There are also chemical tracers in the coral that are sensitive to water temperature and salinity, so we can measure the geochemistry of the skeleton," Linsley says. He has studied many aspects of coral, from the effects of growth rates and water depth on skeletal carbon isotopes to the harms of acidification. Now he's looking at past El

Niño events: “Are these events becoming more frequent? Less frequent? Are they getting stronger? The jury’s still out.”

El Niño is a weather pattern that pushes warm water in the equatorial Pacific east to the west coast of the Americas. It occurs every two to seven years and can raise temperatures a couple of degrees on the Pacific side of Panama. Linsley went to Panama in 2018 and visited some coral that he knew had been bleached during the big El Niño event of 2015–16. But when he found the reef, he saw, to his surprise, that it had started to regrow tissue.

Linsley’s team took core samples and identified “dead zones” in the coral’s history, including the El Niño of 1997–98. “We figured out exactly when it had died during that event and could calculate that it started growing again eighteen months later.” The reef, which had succumbed twice in the past twenty years, was able to recolonize polyps and begin calcifying again. “It looked perfectly healthy when we were there,” Linsley says.

Such resiliency is limited, however: each bleaching makes coral more vulnerable to starvation, sickness, and ultimately a final, irreversible death.

This pattern is particularly evident in the Great Barrier Reef, a 1,400-mile-long system of reefs and coral islands off the Australian coast — the largest animal-made structure on the planet. Linsley is a coauthor of a paper published in August in *Nature* titled “Highest ocean heat in four centuries places Great Barrier Reef in danger.” A 2018 underwater heat wave killed almost a third of the reef. It has endured five bleaching events in the last eight years, with the current one proving to be the most devastating on record.

Linsley, at sixty-four, has seen a lot of changes underseas, many of them, in his words, “scary and sad.” He often reflects on the large tropical coral colonies from which he quarried boatloads of core samples, knowing that some of them might now be dead.

For now, though, his real work is on land. “We’ve got a lot of corals to be analyzed, so I’ve been trying to focus on what’s in the lab,” he says. But he can’t help thinking about the future of the planet’s reef builders, fighting for survival in the warming seas.

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