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Coral Killers

Sometimes good fish go bad. But it's not their fault.

In a three-year effort to understand the effects of known stressors such as overfishing and nutrient pollution on coral reefs, scientists made a totally unexpected finding: A normally healthy interaction between fish and coral had turned deadly.

In typical conditions, parrotfish — like many other species — are essential to the health of coral reefs, nibbling at them to remove algae while causing no permanent damage. However, a new study conducted by UC Santa Barbara field ecologist Deron Burkepile and colleagues in the Florida Keys found that 62 percent of corals weakened by nitrogen and phosphorus pollution died when parrotfish bit them. The results appear in the journal Nature Communications.

"Normally benign predation by the parrotfish turned into coral murder," said Burkepile, an associate professor in the Department of Ecology, Evolution, and Marine Biology. "But it's not the parrotfishes; they're like the reef janitors, keeping it clean. Those extra nutrients — nutrient pollution — turn parrotfishes into an actual source of mortality by facilitating pathogens in the wounds left by their bites. Excess nutrients turn a coral accomplice into a coral killer."

The researchers found that multiple local stressors combined with warming ocean temperatures weaken corals to such an extent that opportunistic pathogens build to levels that kill them. "When we looked at the patterns of how corals died in our

experiment, we saw high coral mortality when we removed herbivorous fishes from the reefs," Burkepile said.

"This allowed seaweeds to grow next to the corals and compete with them, which slowed the corals' growth rate," he added. "Seaweeds also transferred bacterial pathogens directly to the corals from their surface, which made the corals sick."

Investigators from six institutions conducted a three-year experiment that simulated both overfishing and nutrient pollution on a coral reef. They built exclosures to keep herbivorous fishes away from corals; in some reef areas, they added nutrients to mimic nutrient pollution in order to understand the relative roles of each scenario. The large body of field data generated helped to resolve some of the fundamental questions about the cause of coral reef declines.

"When corals are so weakened, they cannot withstand normal impacts," said corresponding author Rebecca Vega Thurber, an assistant professor in the College of Science at Oregon State University (OSU). "The solution will be to help those corals recover their health by ensuring that their local environment is free of nutrient pollution and that fish stocks are not depleted."

The findings make it clear that in the face of rising ocean temperatures, some of the best opportunities to protect coral reefs lie in careful management of fishing and protection of water quality. This would give corals their best chance to have a healthy microbiome and resist warmer conditions without dying, according to the researchers.

"We need to know how human activities are affecting coral reef ecosystems," said David Garrison, program director in the National Science Foundation's Division of Ocean Sciences, which funded the research. "Coral reefs are among the most sensitive indicators of the health of the oceans. This report is a major contribution toward understanding how reefs will fare in the future."

Other UC Santa Barbara co-authors are Andrew Shantz, Catharine Pritchard and Nathan Lemoine. Additional contributors include lead author Jesse Zaneveld and Ryan McMinds, Jérôme Payet, Rory Welsh, Adrienne Correa and Stephanie Rosales of OSU, Corinne Fuchs of the University of Florida in Gainsville and Jeffrey Maynard of the SymbioSeas and Marine Applied Research Center in Wilmington, North Carolina, and Laboratoire d'Excellence in French Polynesia.

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