For corals adapting to climate change, it's survival of the fattest—and most flexible

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Andréa Grottoli, professor in the School of Earth Sciences at The Ohio State University, collects coral for a study of the factors that may help the symbiotic organism adapt to climate change. Credit: The Ohio State University.

The future health of the world's coral reefs and the animals that depend on them relies in part on the ability of one tiny symbiotic sea creature to get fat—and to be flexible about the type of algae it cooperates with.

In the first study of its kind, scientists at The Ohio State University discovered that corals—tiny reef-forming animals that live symbiotically with algae—are better able to recover from yearly bouts of heat stress, called "bleaching," when they keep large energy reserves—mostly as fat—socked away in their cells.

"We found that some coral are able to acclimatize to annual bleaching, while others actually become more susceptible to it over time," said Andréa Grottoli, professor in the School of Earth Sciences at Ohio State. "We concluded that annual coral bleaching could cause a decline in coral diversity, and an overall decline of coral reefs worldwide."

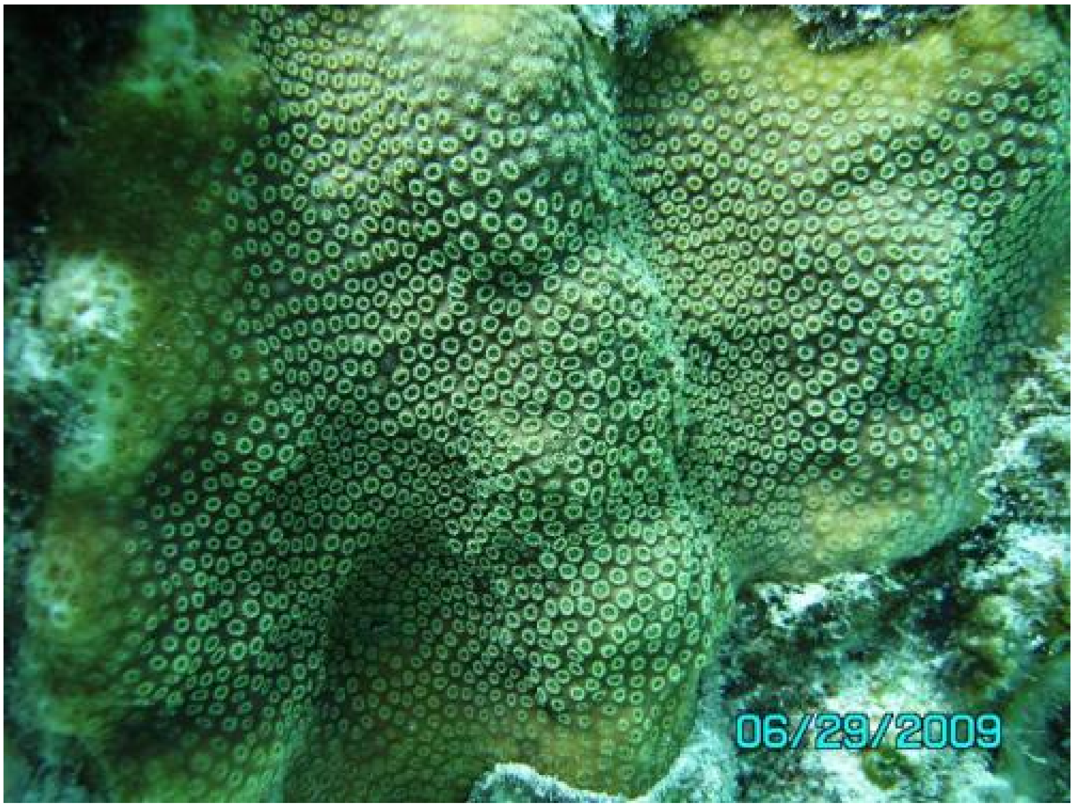
The study, which appears in the July 9 online edition of *Global Change Biology*, indicates that some coral species will almost certainly decline with global climate change, while others that exhibit large fat storage and flexibility in the types of algae they partner with will stand a better chance of enduring repeated rounds of stress as oceans get hotter.

It also suggests that the most adaptable species would make good targets for conservation efforts because they are most likely to survive.

"If we conserve reefs that contain coral species with these survival traits, then we're hedging our bets that we might be able to preserve those reefs for an extra decade or two, buying them enough time to acclimatize to climate change," Grottoli said.

Corals are essentially colorless; the brilliant browns, yellows, and greens that we associate with them are actually the colors of algae living inside the corals' animal cells. That's why, when stressed coral dump most of the algae from their cells, their bodies appear pale, or "bleached."

Bleached corals can recover by growing more algae or acquiring new algae once water temperatures return to normal. This research shows that corals' ability to switch the type of algae that they internally grow has a large effect on their recovery.



This is a closeup of polyps of *Orbicella faveolata*, more commonly known as boulder coral. Credit: The Ohio State University.

But if corals don't recover and reefs die, thousands of fish species and other sea creatures lose their habitat.

Normally, bleaching is a rare event. But by 2025, Caribbean waters are expected to be hot enough that the coral living there will be stressed to the point of bleaching once a year. The rest of the tropics are expected to experience annual bleaching by 2050.

Previous studies have only followed coral through one bleaching event, or through two events several years apart. So Grottoli and her team tested what would happen if they subjected some common Caribbean corals to bleaching for two years in a row.

Corals can supplement their diet by eating plankton, but they get most of their energy from their symbiotic relationship with algae. The algae get nutrients from the coral, and the corals get to siphon off sugars that the algae produce in photosynthesis. Like humans, corals can store excess energy as fat.

Two key survival strategies emerged in this study: the most resilient corals stored up fat reserves in times of plenty, and were willing to switch to a new dominant algal type in order to gather food in times of stress. Corals that didn't store fat or were stuck with their algal partner didn't fare as well.

And species that bounced back from one round of bleaching didn't necessarily bounce back a second time.

"We found that the research on single bleaching events is misleading," Grottoli said. "Species that we think are resilient to temperature stress are actually susceptible and vice versa when stressed annually."

Three coral species, from left are shown: *Porites astreoides, Orbicella faveolata*, and *Porites divaricata* -- more commonly known as mustard hill coral, boulder coral, and finger coral -- in a bleaching tank during the study in Puerto Morelos Reef National Park. Credit: The Ohio State University.

Grottoli and her colleagues tested three corals from Puerto Morelos Reef National Park, off the coast of Mexico. Two years in a row, they plucked samples of *Porites divaricata*, *Porites astreoides*, and *Orbicella faveolata*—more commonly known as finger coral, mustard hill coral, and boulder coral—from the ocean floor, and placed them in warm water tanks in an outdoor lab until the corals bleached. Both times, the researchers returned the corals to the ocean to let them recover. They measured several indicators of how well the different species recovered, including the number and type of algae present in the corals' cells and remaining energy reserve.

The mustard hill coral kept lower fat reserves, and partnered with only one algal species. It recovered from the first round of bleaching but not the second. The boulder coral kept moderate fat reserves, but partnered with six different algae and changed between dominant algal types following each bleaching. It recovered from both rounds of bleaching, though it's growth slowed.

The real winner was the finger coral, which switched completely from one algal partner type to another over the course of the study, and had the largest fat reserves—47 percent higher than the boulder coral or mustard hill coral. The finger coral was barely even affected by the second bleaching and maintained a healthy growth rate.

The bottom line: as some species adapt to climate change and others don't, there will be less diversity in reefs, where all the different sizes and shapes of coral provide specialized habitats for fish and other creatures. Interactions among hosts, symbionts, predators and prey would all change in a domino effect, Grottoli said. Reefs would be more vulnerable to storms and disease in general.

It sounds like a bleak picture.

"We're actually a bit optimistic, because we showed that there's acclimation in a one-year window, that it's possible," she said. "In two of our three coral species, we have recovery in six weeks. The paths they took to recovery are different, but they both got there."

Provided by The Ohio State University

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