Some coral species might be more resilient to climate change than previously thought

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OSU coral researcher Alex Vompe off the north shore of Mo'orea. Credit: Mackenzie Kawahara

Some coral species can be resilient to marine heat waves by "remembering" how they lived through previous ones, research by

Oregon State University scientists suggests.

The study also contains evidence that the ecological memory response is likely linked to the microbial communities that dwell among the corals.

The findings, published in *Global Change Biology,* are important because coral reefs, crucial to the functioning of planet Earth, are in decline from a range of human pressures including climate change, said the study's lead author, Alex Vompe.

"It is vital to understand how quickly reefs can adapt to ever more frequent, repeated disturbances such as marine heat waves," said Vompe, a doctoral student who works in the lab of microbiology professor Rebecca Vega Thurber. "The microbiomes living within their coral hosts might be a key component of rapid adaptation."

Heat waves are likely to increase in frequency and severity because of climate change, he added. Slowing down the rate of coral cover and species loss is a major conservation goal, and predicting and engineering heat tolerance are two important tools.

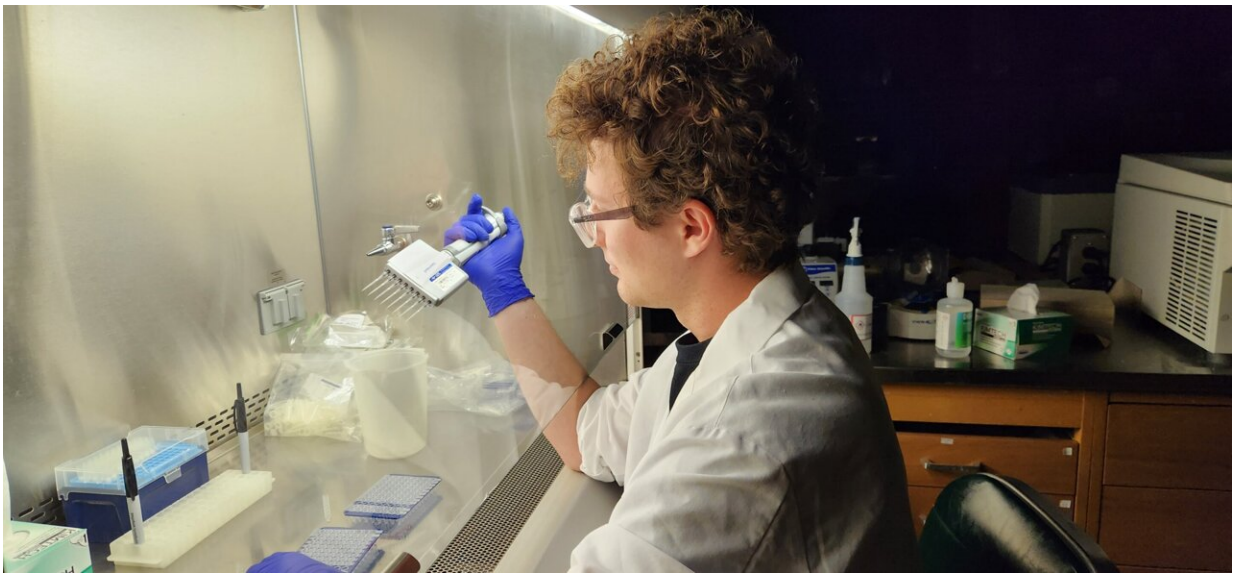
Knowing the role microbes play in adaptation can inform coral gardening and planting efforts, Vompe said. A deeper understanding of the microbial processes, and the organisms responsible for ecological memory, can also aid in developing probiotics and/or monitoring protocols to assess and act on the quality of ecological memory of individual coral colonies.

Coral reefs are found in less than 1% of the ocean but are home to nearly one-quarter of all known marine species. They also help regulate the sea's carbon dioxide levels and are a crucial source for scientists searching for new medicines.

Corals are made up of interconnected animal hosts called polyps that house microscopic algae inside their cells. Corals also house functionally and taxonomically diverse bacteria, viruses, archaea and microeukaryotes. The community of bacteria and archaea living within corals are referred to as the coral microbiome.

Symbiosis is the foundation of the coral reef ecosystem as these microbes benefit coral hosts by assisting in carbon, nitrogen and sulfur cycling, essential vitamin supplementation, and protection against pathogens. The coral polyps in turn provide nutrition and protection to the algae and bacteria.

Climate change is threatening coral reefs in part because some of the relationships between coral and their microbes can be stressed by warming oceans to the point of dissolution—a collapse of the host-microbe partnerships, which results in a phenomenon known as coral bleaching.



OSU coral researcher Alex Vompe working in a biosafety cabinet. Credit: Olivia

"But Acropora retusa, a prevalent coral species in the Mo'orean coral reef that we studied, appears to have a powerful ecological memory response to heat waves that the microbiome seems to play a role in," Vompe said. "This means some coral species may be more resilient to climate change than previously thought."

Vompe, Vega Thurber and colleagues at OSU, the University of California, Santa Barbara, Arizona State University, and the University of Essex spent five years studying 200 coral colonies at a reef on the north shore of Mo'orea, French Polynesia. Mo'orea is an island in the South Pacific, roughly halfway between Australia and South America.

Because of the reef's recent history, it presented a unique opportunity to examine heat wave response, the researchers said.

In 2010, crown-of-thorns starfish and a cyclone destroyed more than 99% of the corals, effectively hitting the reset button on the reef. Corals reestablished and went through comparatively minor heat wave events in 2016 and 2017 before experiencing the area's most severe marine heat wave in recorded history between December 2018 and July 2019.

The second-most severe heat wave soon followed, between February and July of 2020.

"We observed that some species of coral seem to remember exposure to past marine heat waves and maintain a higher level of health in subsequent heat waves," Vega Thurber said. "And Acropora retusa's memory response was strongly linked to changes in its microbiome, supporting the idea that the microbial community has a part in this

process."

Cauliflower corals in the genus Pocillopora stayed in good health through the heat events, and their microbiomes also showed an ecological memory response, she noted. They were perturbed by the initial 2019 heat wave but recovered to their predisturbance state despite the second heat wave in 2020.

"Members of coral microbial communities have unique biological features that make them more adaptable and responsive to environmental change—short generation cycles, large population sizes and diverse metabolic potential," Vega Thurber said. "In two of the three coral species we focused on, we identified initial microbiome resilience, host and microbiome acclimatization, or developed microbiome resistance to repeated heat stress. The latter two patterns are consistent with the concept of ecological memory."

Other Oregon State researchers involved the research were Thomas Sharpton, Hannah Epstein and Emily Schmeltzer. Sharpton is an associate professor of microbiology and statistics; Epstein was a postdoctoral researcher during the study and is now a lecturer at the University of Essex; Schmeltzer, a doctoral student in Vega Thurber's lab, has graduated and is working as a biologist with the U.S. Geological Survey.

More information: Alex Vompe et al, Microbiome ecological memory and responses to repeated marine heatwaves clarify variation in coral bleaching and mortality, *Global Change Biology* (2023). DOI: 10.1111/gcb.17088

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