Research reveals that corals are adapting to climate change in complex and varied ways

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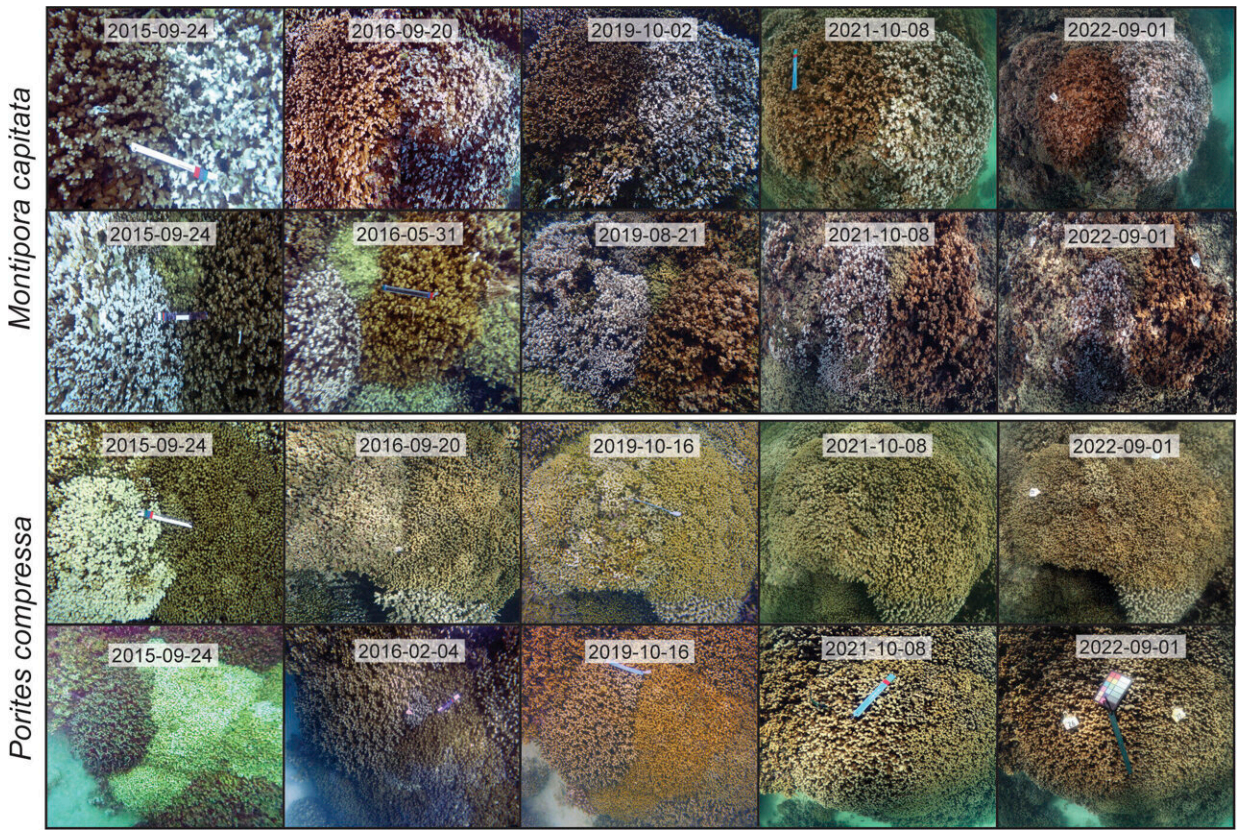

Representative images of M. capitata and P. compressa pairs over time in Kāneʻohe Bay. Each row depicts a single pair of bleaching-susceptible and bleaching-resistant individuals from 2015 to 2022 (the Inset indicates the date the image was taken), and the corals appear in the same orientation in each image within each row. Credit: *Proceedings of the National Academy of Sciences* (2023). DOI: 10.1073/pnas.2312104120

From intensifying wildfires to record-breaking floods year on year, the effects of climate change have manifested in devastating outcomes on ecosystems that threaten species worldwide. One such ecosystem in peril is coral reefs, which play a major role in sustaining biodiversity in the planet's oceans but are facing increasingly severe conditions as waters heat up, leading to a phenomenon known as marine heat waves.

For nearly a decade, Katie Barott, assistant professor of biology at the University of Pennsylvania, has led a collaborative team of researchers studying two coral species in Hawaii better to understand their adaptability to the effects of climate change.

Their recent paper published in the *Proceedings of the National Academy of Sciences* sheds light on this issue, revealing the complex and varied ways corals are adapting, or struggling to adapt, to the rapidly changing oceanic environment.

"We tracked more than 40 large coral colonies over ten years and found that certain species have an improved ability to endure and recover from subsequent marine heat waves after surviving one such event," Barott says. "It's a bit like working out; the more often you exercise, the easier it is to go through the same exercise stress."

The researchers studied two dominant coral species in Kaneohe Bay in Oahu, Hawaii: rice coral, Montipora capitata, and finger coral, Porites compressa.

Over the decade, these corals were subjected to significant marine heat waves in 2014, 2015, and 2019. These provided a unique opportunity to identify bleaching-resistant and bleaching-susceptible individuals of each species and then observe their responses to repeated heat stress. Their findings highlight the resilience of some corals while underscoring the vulnerability of others.

Researchers from the Barott Lab at Penn retrieve samples of coral in Kaneohe Bay in Oahu, Hawai, as part of a longitudinal study on the effects of climate change on coral reef bleaching. Credit: Kristen Brown

"One of our key discoveries is the role of 'acclimatization,'" says Kristen Brown, first author of the paper and a postdoctoral researcher in the Barott Lab. "This refers to the ability of some corals to adjust to higher temperatures, thereby reducing their susceptibility to bleaching, a phenomenon wherein corals expel the algae living in their tissues, causing them to turn white and increasing the risk of death."

The researchers found that bleaching-resistant individuals of both coral species remained pigmented throughout the study period, suggesting a persistent form of thermal tolerance; however, pigmentation alone was not a definitive indicator of overall health or resilience.

The researchers reveal contrasting recovery patterns between the bleaching-susceptible individuals of each species following the heat waves.

Montipora capitata, despite some evidence of acclimatization, repeatedly experienced bleaching and showed significant mortality for as long as three years after the last heat wave; conversely, initially sensitive individuals of Porites compressa exhibited a remarkable capacity for recovery and acclimatization, with no bleaching or mortality during the third heat wave and most physiological metrics returning to normal within one year.

This difference underscores a critical aspect of coral resilience: the ability to survive heat stress and recover from it effectively.

The researchers suggest that coral responses to climate change are diverse and complex, influenced by a range of factors, including species -specific characteristics and past exposure to environmental stressors. And, as a next step, the team plans to continue monitoring and exploring aspects like coral growth, calcification, and the impacts of recurring marine heat waves.

More information: Kristen T. Brown et al, Divergent bleaching and recovery trajectories in reef-building corals following a decade of successive marine heatwaves, *Proceedings of the National Academy of Sciences* (2023). DOI: 10.1073/pnas.2312104120