Genetics could help protect coral reefs from global warming

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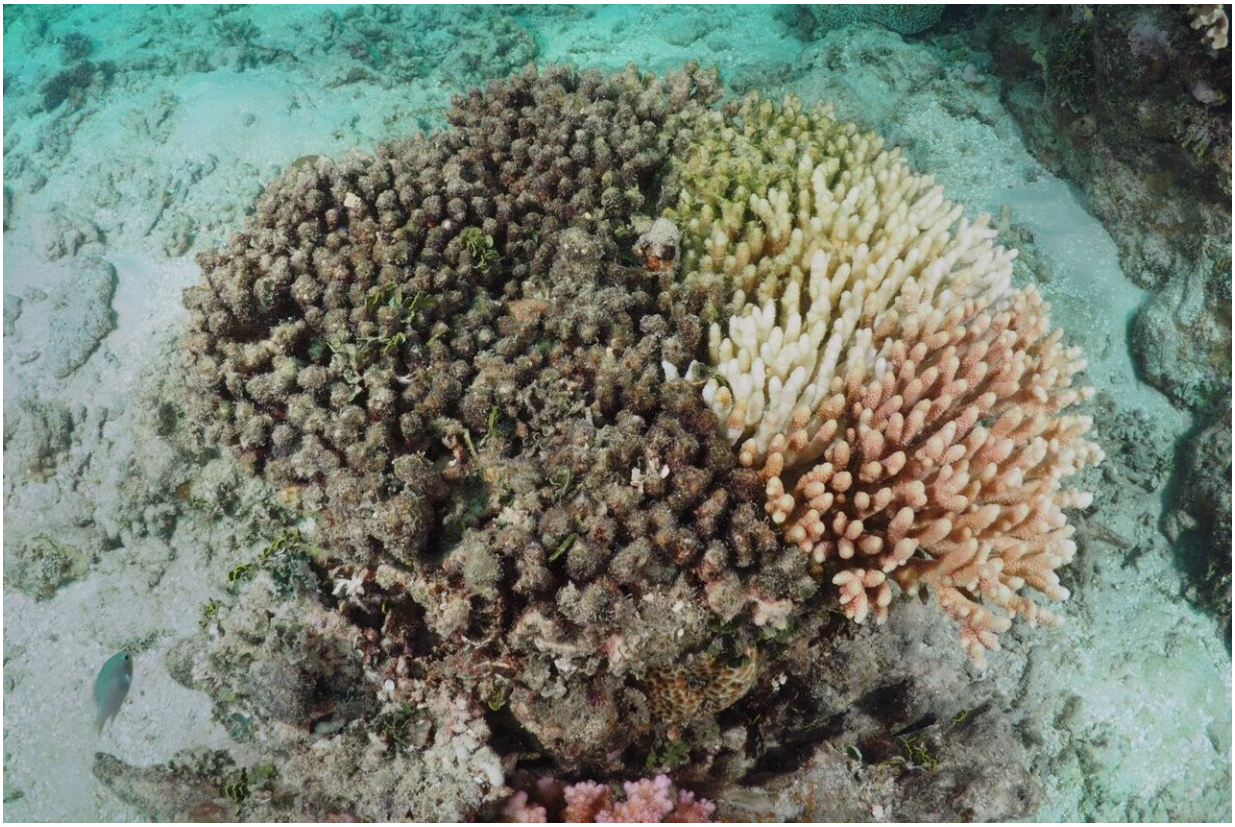

Coral colony in multiple stages of bleaching and mortality, Great Barrier Reef, 2017 Credit: Austrailan Institute of Marine Science / Chris Brunner

Coral reefs are dying at an alarming rate as water temperatures rise worldwide as a result of global warming, pollution and human activities.

In the last three decades, half of Australia's Great Barrier Reef has lost its coral cover.

A new study from Columbia University provides more evidence that genetic-sequencing can reveal evolutionary differences in reef-building corals that one day could help scientists identify which strains could adapt to warmer seas.

The findings, published in *Science* July 17, provide a window into the genetic processes that allow some corals to resist dramatic climate shifts that could complement or improve current preservation efforts.

"We need to use as many tools as possible to intervene or we will continue to see coral reefs vanish," said Zachary Fuller a postdoctoral researcher in biology at Columbia and first author on the study. "Using genomics can help identify which corals have the capacity to live at higher temperatures and reveal genetic variants associated with climate resilience."

Coral reefs, found throughout the world in tropical oceans, are one of the most diverse and valuable ecosystems on Earth. They are actually living animal colonies and important for many reasons. Reefs provide a habitat for a large variety of marine species; protect coastlines from storms, floods and erosion; and help sustain the fishing and tourism industries.

Bleached corals on Pandora Reef, Great Barrier Reef in 2017 Credit: Austrailan Institute of Marine Science / Eric Matson

In the late 1990s, reefs worldwide experienced their first wave of mass bleaching, which occurs when high water temperatures destroy the symbiotic relationship with a colony's colorful algae, causing the corals to turn white. The loss effectively starves them, as corals are dependent on the photosynthetic algae that lives within their tissues for nutrients. Reefs can recover from bleaching, but prolonged periods of environmental stress can eventually kill them.

The Columbia research predicts, to some degree, which corals are likely to withstand unusually high temperatures and resist bleaching events.

"Genomics allows us to examine the genetic differences that could influence survival and bleaching tolerance, helping us work out how we might support coral health," said Molly Przeworski, professor in the Departments of Biological Sciences and Systems Biology at Columbia and senior study author.

To collect their genetic data, Fuller, Przeworski and their collaborators from the Australian Institute of Marine Science analyzed 237 samples collected at 12 locations along the Great Barrier Reef, generating the highest quality sequences of any corals to date. The sequencing allowed the researchers to look across the genome for signatures where adaptation occurred and to find genetically distinct variations associated with bleaching tolerance.

"What we discovered is that no single gene was responsible for differences in a coral's response to bleaching, but instead many genetic variants influence the trait," Fuller said. "On their own, each has a very small effect, but when taken together we can use all these variants to predict which corals may be able to survive in the face of hotter seas."

Fuller and Przeworski said the findings offer a pathway for coral biologists to further search for strains that can better cope with ocean warming and enables similar approaches that can be used in other species most at risk from climate change.

"The best chance we have to save what's left of the Earth's coral reefs is to mitigate the effects of climate change by rapidly reducing greenhouse gas emissions," Fuller said. "In the meantime, genetic approaches may be able to buy us time."

More information: Population genetics of the coral Acropora millepora: Toward genomic prediction of bleaching, *Science* (2020). DOI: 10.1126/science.aba4674

Provided by Columbia University