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Corals use multiple tricks to adapt to hotter seas

Genes and physiological acclimation contribute equally to heat resistance.

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The reefs of Ofu Island in American Samoa are a natural laboratory for studies of coral heat resistance.

Coral reefs face a daunting future: climate change, ocean acidification, and overfishing are projected to take a harsh toll in the coming decades. But a study published today suggests that some corals can adjust their physiology to cope with ocean warming.

A population of the table-top coral *Acropora hyacinthus* living in a back-reef lagoon off Ofu Island in American Samoa can acclimate to hot water temperatures — at least up to a point, researchers report today in *Science*[1]. The team teased apart the role of genetic adaptation (natural selection that occurs within a population) and physiological acclimatization (which occurs in individuals), showing that each had roughly equal roles in the corals' heat resistance.

In the past few decades, reef-building corals have seen global declines owing to bleaching — discoloration that results when corals lose the photosynthetic algae that nourish them — caused by local warming spells.

The study suggests that "corals can buy more time to evolve the necessary adaptations by using acclimatization as a first line of response," says Christian Voolstra, a coral reef genomicist at King Abdullah University of Science and Technology in Thuwal, Saudi Arabia, who was not involved in the research. But the degree to which the findings apply to other coral species and coral reef ecosystems still needs to be determined, he adds.

Stephen Palumbi, a marine biologist at Stanford University in California, and his colleagues compared individuals of *A. hyacinthus* from two parts of the lagoon. One population basks in a shallow tidal pool that experiences large temperature swings and reaches a toasty 35 °C during mid-day low tides in the summer; the other population, which experiences lower variability, is rarely exposed to water temperatures higher than 32 °C. The team exposed corals from each population to 29–34 °C heat for three hours and then bathed them in 34 °C water for another three hours. By analysing chlorophyll content to measure bleaching, the researchers found that most of the corals native to the hotter pool were able to withstand the heat, whereas more than half of those from the cooler pool bleached after the heat spike.

Then, to test the corals' ability to acclimate, the team transplanted corals from the cooler to the hotter sites and vice versa, and checked their heat resistance after 12, 19 and 27 months. Corals from the cooler area partially acclimated to the scalding temperatures, becoming more resistant to bleaching. The researchers also investigated gene-expression patterns and identified 74 genes that changed after the corals were transplanted. The scientists say that many of these contribute to heat acclimation, including genes that turn on heat-resistant proteins.

"That tells us that there are genes that allow for acclimation," says Anne Cohen, a biogeochemist at Woods Hole Oceanographic Institution in Massachusetts, who was not involved with the research. These genes seem to be "sleeping", says Cohen, and can be switched on by thermal stress.

The study suggests that some corals may be able to adjust to ocean warming, says Palumbi. "What we don't know is what their limits are, and when those limits are going to be reached by future climate change."

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References

1. Palumbi, S. R., Barshis, D. J., Traylor-Knowles, N. & Bay, R. A. *Science* http://dx.doi.org/10.1126/science.1251336 (2014).