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Corals respond to changing ocean conditions by altering regulation of the DNA message

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Summary: Some corals may cope with climate change by changing markings on their DNA to modify what the DNA produces.

FULL STORY

A reef-building coral (Pocillopora species) and fish on a lagoon reef in Moorea, French Polynesia.

Credit: Hollie Putnam

If an ocean gets too acidic for a coral's liking, it can't just swim away and find a nicer place to live. So how can corals survive in changing waters? Coral reefs sustain fisheries that feed millions of people, provide protection to coastlines from storms, and bolster economies through tourism. But with climate change altering ocean conditions important for healthy coral, the future of coral reefs is unclear.

Dr. Hollie Putnam, a National Science Foundation Ocean Sciences Post-Doctoral Fellow, is researching the mechanisms that corals use to respond to altered ocean conditions. Her work in the Hawai'i Institute of Marine Biology at the University of Hawai'i at Mānoa is revealing that some coral are responding to climate change by changing markings on their DNA to modify what the DNA produces. Like punctuation marks in an alphabet, this changes the result (proteins made) without altering the original letters (the DNA). Although this is a known phenomenon in many organisms, how coral use this to their advantage is largely a mystery.

Putnam recently investigated two species of coral in Kane'ohe Bay off the coast of the Hawaiian island of O'ahu. Montipora capitata, known as the rice coral, is a species common to Hawai'i that is environmentally resistant. Pocillopora damicornis, the cauliflower coral, is found throughout the Pacific and Indo-Pacific regions and is more environmentally susceptible.

To answer the question of how the corals respond differently to environmental changes, Putnam performed an experiment in which she altered the acidity levels on the corals in the lab. She housed some corals in normal water at natural pH levels, and other corals in more acidic water. Putnam monitored changes in growth, physiology, and DNA methylation, a process that modifies what genes make by editing the regulatory markers on DNA.

She found that the rice coral was not substantially affected by the acidic water, indicating high environmental resistance, but the cauliflower coral showed stunted growth, altered physiology, and increased levels of DNA methylation -- a dramatic response to acidity.

Why do the two coral species differ so greatly in their response? The rice coral is more resistant because it may not sense pH changes in the water, or it could buffer itself to these changes. Putnam says this could indicate "it's not getting the same sort of environmental signal," which could mean that "corals are potentially not experiencing the environment in the same way."

The cauliflower coral, which was vulnerable to acidification, showed an increase in DNA methylation. This ability to regulate what the DNA produces may be a mechanism by which this species responds to environmental perturbations. While it might appear that this tactic of modifying DNA markers leads to environmental susceptibility, Putnam explains that the process is much more complex.

"Just because there was a decline in growth in Pocillopora that correlated with flexibility, doesn't necessarily mean that methylation is bad." The changes to the markers on the DNA of adults could potentially transfer to offspring and benefit them so that they are more prepared to live in an acidic environment, explains Putnam, because "they're getting a signal from the parent which may allow them to perform in a better way in that same type of condition in the future." These edits to DNA markings also are "generating more variation, which then has the possibility to be acted on by natural selection," Putnam continues, creating differences amongst organisms that can have crucial evolutionary effects across generations.

It is still unclear what the overall effects of DNA methylation are for coral. If it leads to more viable offspring, then corals capable of regulating their DNA may be more successful on a long-term scale. But if DNA methylation does not confer benefits across generations, and instead is an ineffective method of coping with change, then more resistant corals are likely to thrive in future acidic oceans.

Better understanding of this mechanism can lead to improved practices for conservation of coral reefs. In a process called "pre-conditioning," corals are exposed to treatments of certain pH levels or temperature that induce alterations to DNA markings. While most studies of pre-conditioning have been done in the laboratory, it is possible to apply this technique to wild coral. If DNA methylation yields benefits for offspring, pre-conditioning corals would prepare future generations to succeed in particular environments, but more must be known about this process before it could be adopted on a large scale.

Preserving the coral reefs benefits humans and ecosystems alike. Knowing corals from the inside-out is a major step in making successful ocean conservation a reality. Putnam presented her research at the 2016 annual meeting of the Society for Integrative and Comparative Biology in Portland, Oregon.

Story Source:

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