Response to environmental change depends on individual variation in partnership between corals and algae

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Elkhorn coral in Bonaire. Credit: Jessica Levy, Coral Restoration Foundation

New research reveals that some corals are more protective than others of their partner algae in harsh environmental conditions. This individual variation among corals could reflect a greater capacity than currently recognized to adapt to changing ocean conditions brought about by climate change. The study, led by marine biologists at Penn State University, will be published online October 26, 2015 in the open access journal *Scientific Reports*.

"Our study provides a glimmer of hope that corals can respond to and survive climate change, as long as it's not too fast," said Iliana Baums, associate professor of biology at Penn State. "The variation in response to extreme temperature that we observed is the raw material for evolutionary change and indicates that these corals may be more adaptable than previously thought."

Reef-building corals depend on single-celled algae called *Symbiodinium* to provide energy through photosynthesis, while the algae benefit from the corals' nutrients. "This delicate symbiosis can break down under extreme ocean temperatures associated with climate change," said John Parkinson, the lead author of the study and a former graduate student at Penn State. "Just this summer—the hottest on record—major thermal anomalies in Florida, Hawaii, and Panama have seriously damaged local reefs, which provide essential ecological and economic resources."

For some time, scientists have known that certain combinations of coral and algal species were more tolerant to temperature extremes than others, and therefore more likely to survive in the changing conditions predicted for the future. "But we had no idea if the same dynamic could play out among different combinations of individuals within species," said Parkinson.

Using high-resolution DNA markers developed at Penn State that can distinguish individual corals and strains of algae from one another, the

researchers mapped out host-symbiont associations on a reef in Puerto Morelos, Mexico. They identified six genetically distinct colonies of the Elkhorn coral *Acropora palmata* that all shared the same strain of algae. Then they exposed fragments of the colonies to extreme temperatures and monitored the response of the algae. In all hosts, the algae suffered due to the stress, but the effect was half as intense in some corals compared to others.

"The beauty of the research is that we were able to disentangle the contribution of the host coral and its symbiotic partner algae in their collective response to environmental pressure," said Baums.

The researchers also monitored changes in gene expression levels—an indication of how much a given gene is being used—in the corals. In cells of the corals that were protective of their partner algae, the expression level of 184 genes changed after being exposed to the temperature shock. In corals with algae more heavily impacted by the environmental change, the expression level changed for only 14 genes.

"Think of it like a couple's dancing competition," said Parkinson. "Who you are paired with really matters for your overall score." It is encouraging to the researchers that this is true not only for different mixes of coral and algae species, but also for different combinations of individuals within a species. This discovery suggests that there is an extra layer of complexity to coral-algae symbioses that may prove critical in how they respond to climate change in the long-term.

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