Algorithm ranks thermotolerance of algae

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Northwestern University researchers have developed a quantitative tool that might help bring back coral from the brink of extinction. The novel algorithm could help assess and predict the future of coral bleaching events by better understanding the coral's symbiotic partner: algae.

"Coral is not an independent organism," said Luisa Marcelino, research assistant professor of civil and environmental engineering at Northwestern's McCormick School of Engineering. "It depends on algae that lives in its tissue to give it food. High temperatures break up that partnership, and the coral essentially starves."

But this does not happen in every case. Some genetic types of algae are more tolerant of climate change's increasing temperatures. Bleaching happens when stressed corals expel their life-providing algae, turning reefs stark white as their skeletons show through. Coral with thermotolerant algae often recover from bleaching or do not bleach at all.

"Coral not associated with thermotolerant algae are at the biggest risk," Marcelino said.

There are more than 400 different types of this *Symbiodinium* algae and thousands of different coral reefs. This expanse—combined with the fact that algae is difficult to cultivate in the laboratory—have made it incredibly difficult to fully study and understand algae's susceptibility to heat.

The Northwestern team's algorithm combines all algae studies published prior to February 2015 to rank which genetic types are most thermotolerant and which are the most thermosensitive. The results are published online in *Functional Ecology*. Northwestern Engineering's Vadim Backman, Walter Dill Scott Professor of Biomedical Engineering, co-authored the paper. Timothy Swain, a postdoctoral fellow in Marcelino's lab, and John Chandler, a graduate student in Backman's lab, served as the paper's co-first authors.

Earlier this spring, Marcelino's group published the first global index to standardize measurements of different coral species' vulnerability to thermal stress. This algorithm, which ranks vulnerability of 110 most common genetic types algae, is a companion piece. Marcelino and Swain anticipate that as the rarer algae types are further studied, the algorithm will eventually include rankings for all different genetic types.

"The first study was just half of the story," Marcelino said. "Together, these studies show a complete picture."

The need to better understand coral's partnership with algae is particularly dire as the world is currently experiencing the longest global coral bleaching event ever recorded. Knowing which coral colonies are associated with more thermosensitive algae can help conservationists focus their efforts. Those sensitive colonies could be shielded from further risk factors, such as tourism, overfishing, and pollution, to aid preservation. Pinpointing the most thermotolerant algae could also help researchers breed more robust coral in the laboratory.

"The bleaching we are experiencing now is unprecedented," Swain said. "Entire populations are collapsing under climate change. We need more information now to give to people who can take action."

Marcelino and Swain's novel iterative algorithm is based on partial rank aggregation, which allows for and reconstructs unresolved or incomplete comparisons of thermotolerance among genetic types. An added benefit: the algorithm can be applied to any type of ranking, including other ecological questions, restaurants, schools, election schemes, search engines, and other science and engineering problems.

"We developed the algorithm to solve a problem on our end," Marcelino said. "But it has enormous applications for any field."

More information: Timothy D. Swain et al. Consensus thermotolerance ranking for 110phylotypes: an exemplar utilization of a novel iterative partial rank aggregation tool with broad application potential, *Functional Ecology* (2016). DOI: 10.1111/1365-2435.12694

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