# Scientists discover balance of thermal energy and low climate stress drive coral species diversity

May 1 2018

A Coral Reef in the Mozambique Channel in the Western Indian Ocean. Marine scientists from WCS (Wildlife Conservation Society), University of Warwick, and University of Queensland have identified two key factors that create the ideal conditions needed for high species diversity in coral reefs: thermal energy in the form of warm water and low climate stress. Credit: Emily Darling.

Marine scientists from WCS (Wildlife Conservation Society), University of Warwick, and University of Queensland have identified two key factors that create the ideal conditions needed for high species diversity in coral reefs: thermal energy in the form of warm water and low climate stress.

In a new study recently published in the *Journal of Biogeography*, scientists from a number of institutions working in the western Indian Ocean found that, in certain locations, thermal energy and low climate stress in the right proportions allow many coral species to grow and thrive together. The discovery has implications to where the strongest management is needed to avert declines in coral species associated with heavy fishing and climate change.

The authors of the study titled "Thermal energy and stress properties as the main drivers of regional distribution of coral species richness in the Indian Ocean" are: Mebrahtu Ateweberhan of the University of Warwick and WCS (Wildlife Conservation Society); Tim R. McClanahan of WCS; Joseph Maina of WCS and the University of Queensland; and Charles Sheppard of the University of Warwick.

Using published species lists and satellite-derived environmental datasets for the Indian Ocean, the researchers calculated many standard and unique oceanographic variables and uncommon statistical methods to uncover this finding. Reef area was also among the main controlling factors, highlighting the significance of the combination of available energy, thermal stress, and large reef areas for driving the numbers of species.

A consistent finding was that the type of the temperature distribution was the strongest factor controlling the number of coral species. The second most important factor was the thermal energy; thus, warm water supports more species but unusually hot and cold water reduce their numbers. Coral reefs with the most species were located along a swath of ocean from Western Australia to Central Indian Ocean Islands and southern India but locations between East Africa and Mozambique Channel and Southern Red Sea and Gulf of Aden also had high diversity. Reefs with the lowest numbers of species were in the Arabian Gulf, Gulf of Oman, South Africa and southwest Madagascar, Gulf of Kutch, Bay of Bengal, and the Mascarenes Islands.

"Diverse coral communities live on the edge between warm and stressful seawater," said Dr. McClanahan, study co-author and Senior Conservation Zoologist for WCS. "Warm seawater is critical to supporting the creation and maintenance of species, but experiencing hot and cold water at some rare frequencies is deadly for many of these same species."

The current results modelled species and environmental relationship in 44 Indian Ocean reef locations with the good natural history surveys to provide evidence linking large-scale geography and oceanography with seawater temperature frequencies, where climate warming is changing these frequencies.

McClanahan also reminds us that "warm water events are becoming more common as climate variability increases with global warming. More stressful temperatures will increasingly penetrate these high diversity locations and drive local species extinctions."

Lead author Dr. Ateweberhan added: "The study emphasizes the critical need to incorporate seawater temperature variability in coral reef conservation programs if plans are going to effective at insuring the persistence of high diversity reefs."

The study made two unique advances. The first was to include unique seawater temperature distribution metrics and the other was the choice of the analytic statistical tools. These new metrics suggest that properties of the temperature distributions patterns matter more than average temperature stability for driving species diversity.

And, these metrics are different enough that they are not replaceable when evaluating coral species distributions. The new statistical technique, called quantile regression, has the ability to investigate relationships for specific parts of the data distribution, a key difference to standard methods that evaluate responses around averages. This makes it appropriate for analysing ecological and species data where environmental conditions vary considerably and equally distributed environmental variance is uncommon.

Ateweberhan explained: "Our conclusions from the quantile regression method would have been hidden and less convincing using standard regression methods. Consequently, we found patterns previously obscured by increasing the variables examined and loosening the assumptions of the data distributions."

Corals form the foundation of the reef ecosystem that in turn support a vast diversity of fish and invertebrate species that live on tropical reefs. Consequently, the findings contribute substantially to a new understanding of the forces that promote coexistence of the Earth's vast richness of species and provides a better understanding on how to manage them.

**More information:** Mebrahtu Ateweberhan et al, Thermal energy and stress properties as the main drivers of regional distribution of coral species richness in the Indian Ocean, *Journal of Biogeography* (2018).

DOI: 10.1111/jbi.13224

Provided by Wildlife Conservation Society