Coral reefs are better at coping with rising sea temperatures than we thought

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Close up of polyps are arrayed on a coral, waving their tentacles. There can be thousands of polyps on a single coral branch. Credit: Wikipedia

(Phys.org) —Coral reefs are under threat from rising sea temperatures caused by global warming. But in a recent paper, published in Science, it was found that certain types of coral are able to adapt to tolerate higher sea temperatures by changing the genes they express. Scientists think this new discovery could be used to devise new ways of protecting coral reefs, as well as improving our predictions of how they will cope with climate change in the future.

Marine rainforests

Known as the "rainforests of the sea," coral reefs form some of the most diverse ecosystems on earth. Despite only covering 0.1 percent of the ocean's surface, they provide a home for 25 percent of all maritime species, including fish, mollusks, and sponges.

Coral reefs are actually deposits of calcium carbonate, the substance found in sea shells. The makeup of any coral reef is complex and consists of microscopic organisms called corals that live together in small colonies known as polyps. Polyps that contain "reef building" coral species are responsible for laying down the calcium carbonate that form the reefs. Corals live together with algae, and this relationship helps coral reefs survive.

But when coral reefs experience stress, such as an increase in sea temperature, they sometimes expel the algae, which results in coral bleaching, a phenomenon in which the coral loses all its color, appearing completely white. This can result in the death of the reef. For example, in 2005, the US lost half of its coral reefs in the Caribbean to a massive bleaching event.

It is already known that some corals are better than others at coping with stress. So Professor Stephen Palumbi and his colleagues at Stanford University in California set out to assess whether coral species have the ability to acclimate to warmer temperatures by increasing their thermal tolerance levels.

Palumbi and his team completed their fieldwork on coral reefs in the U.S. National Park of American Samoa on Ofu Island. They concentrated on an important reef-building coral species. The corals were contained in two adjacent pools. In the first pool, water temperatures were more varied, reaching temperatures as high as 35°C. This was known as the highly variable pool. The second pool, known as the moderately variable pool, rarely experienced water temperatures of above 32°C.

Coral transplant

First, the researchers tested the photosynthesis rates of corals from both pools to compare how well they coped with high temperatures. They then transplanted coral colonies from the moderately variable pool to the highly variable pool to see if the coral would adapt to higher water temperatures. The transplanted corals were left to acclimate over the course of about two years, and were regularly tested for thermal tolerance over this time. The researchers conducted genetic analysis to see if there was any change in gene expression during this period that would result in higher thermal tolerance.

It was found that corals in the highly variable pool were more tolerant of higher temperatures when compared to the corals in the moderately variable pool. But the most interesting finding involved the ability of the coral to acclimate to higher water temperatures. Dr Daniel Barshis, part of the team that completed the research, said: "The most important finding was that corals are capable of increasing their thermal tolerance limits substantially in just 12 to 18 months. This acclimation in upper tolerance limits correlates with changes in gene expression as well."

Real-world applications

Barshis went on to say that this new knowledge should be integrated into models that predict the effects of global warming on coral reefs to help us understand how they will respond to rising sea temperatures in the future, he said: "This research provides some glimmer of hope that corals may have the ability to survive more than we've given them credit for, but only if we reduce the amount of current and future stresses."

This research also has many real-world applications that could help protect coral reefs from future climate change. Palumbi said, "It should be possible to use climate-resistant corals in transplant/restoration efforts in order to replant reefs with greater future resilience. This is one of the things we are doing this summer in a set of pilot projects in Samoa."

More information: Mechanisms of reef coral resistance to future climate change, *Science* 23 May 2014: Vol. 344 no. 6186 pp. 895-898. DOI: 10.1126/science.1251336

ABSTRACT

Reef corals are highly sensitive to heat, yet populations resistant to climate change have recently been identified. To determine the mechanisms of temperature tolerance, we reciprocally transplanted corals between reef sites experiencing distinct temperature regimes and tested subsequent physiological and gene expression profiles. Local acclimatization and fixed effects, such as adaptation, contributed about equally to heat tolerance and are reflected in patterns of gene expression. In less than 2 years, acclimatization achieves the same heat tolerance that we would expect from strong natural selection over many generations for these long-lived organisms. Our results show both short-term acclimatory and longer-term adaptive acquisition of climate resistance. Adding these adaptive abilities to ecosystem models is likely to slow predictions of demise for coral reef ecosystems.

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