Heat-tolerant genes could help corals adapt to climate change

26/06/2015

This growing evidence on the surprising resilience of reefs has gained more support today, with news of lab experiments that demonstrate some corals able to withstand rising temperatures can pass the trait on to their offspring through their genes.

Reefs, home to a quarter of all marine life, are facing a one-two punch in the next few decades. Warmer waters bleach corals, stripping away the photosynthetic microbes that live in their tissues. At the same time, the rising level of atmospheric carbon dioxide is affecting ocean chemistry: CO_2 dissolves in the ocean, turning into carbonic acid that lowers pH, and thus making it harder for corals to grow their skeletons. The combination has led some scientists to expect most reefs to die out long before the end of the 21st century.

Recent history seems to support this gloomy prognosis. The El Niño event of 1997-98 wiped out 16 per cent of the world's shallow reefs in one shot. Then the 2009-10 event saw a lesser round of bleaching. Now, just five years later, an ongoing El Niño has swept across the equatorial Pacific. "We're on the brink of the third global bleaching event in history," says Mark Eakin of the National Oceanic and Atmospheric Administration in College Park, Maryland.

Resilience toolkit

But the good news is that evidence is mounting that corals may have a whole toolkit of resistance strategies at their disposal – and, crucially, that they can pass on their genes for climate-change resistance to the next generation.

Working on the Great Barrier Reef, Australian and US researchers cross-bred corals from warmer and colder waters, and subjected the offspring to a heat test. "The corals from warmer locations have babies with higher heat tolerance," says Line Bay from the Australian Institute of Marine Science in Townsville, Queensland.

The researchers also found that mother corals passed on heat resistance more effectively than fathers, and that genes related to mitochondria were particularly helpful for resisting warmer temperatures – an unexpected result that they hope to further examine in future studies.

"It's great stuff," says Andrew Baker at the University of Miami in Florida. "We're starting to see corals resisting heat stress in a variety of different ways."

Baker's own work – on the algae that corals partner with – has identified another strategy. By changing their algae for a more heat-resistant strain, corals can tolerate temperatures about 1.5 °C higher in the weeks or months after a bleaching event, he says.

It's not just larvae, but also adult corals, that can build heat tolerance. Researchers from Stanford University working in American Samoa have found that corals exposed to naturally hot water are primed to use the genes that grant them heat resistance – and that they have a diverse, interacting set of them. We don't know yet whether the coral genes at work on the Great Barrier Reef are the same as those in American Samoa, but the Stanford team is keen to find this out.

Acid resistance

There are hints that corals can resist ocean acidification too. Between limestone islands in Palau, a team from the Woods Hole Oceanographic Institution in Massachusetts has found coral communities living in naturally acidified waters that display few of the detrimental effects expected from the process – the reasons for which the researchers are now exploring.

These are hopeful stories, but biologists will be eager to see if these promising genetic results can be replicated on reefs elsewhere in the world. In addition, it still isn't clear whether corals resistant to high temperatures will also be able to tolerate acidification, and vice versa.

Even so, learning more about how corals can combat climate change is opening up new opportunities, according to Baker. Further work that confirms the importance of heat-resistance genes and identifies reefs that are naturally more resilient amid changing conditions may help conservationists to draw up a list of reefs most likely to survive the next hundred years of carbon emissions. These could then be made a priority for protection from more manageable hazards, such as pollution and fishing.

Alternatively, biologists might be able to transplant particularly heat-resistant adult corals onto reefs that are struggling to adapt to warmer waters – a strategy that might prove useful if the natural spread of resistance is too slow to keep pace with warming.

But there is still one big question hanging over all reefs: how will they cope if we don't slow and eventually reverse the amount of carbon we emit into the atmosphere? The UN Climate Change Conference in Paris at the end of the year could give resilient corals a "fighting chance" if it can set a plan that will keep the world to only 2 °C of warming, Eakin says.

"The corals are doing their part," he says. "Can we do ours?"