A new bacterium may be associated with reef bleaching

A colony of the Mediterranean coral *Oculina patagonica* showing bleached and healthy polyps. Moaz Fine

The coral-eating fireworm acts as a vector for the bacterium that causes bleaching in *Oculina patagonica*. Moaz Fine

Israeli researchers who discovered that a bacterium is implicated in bleaching of at least one coral species overseas have recently worked with James Cook University scientists to help identify a possible new Australian strain. While further research is now underway to determine whether or not the find may provide important information about why the Great Barrier Reef's corals bleach, the bacterium's interaction with corals around the world has been illuminating in itself for marine science.

The researchers have discovered from other international work that behind the bacterium's bleaching effect, there is a complex interaction involving the coral, its resident algae, the toxic temperature-sensitive bacterium and a coral-grazing marine worm.

Coral bleaching occurs when sea temperatures rise by more than a degree or so above the normal maximum, a stress causing the loss of the colourful symbiotic algae (zooxanthellae) that live in the tissues of corals. Severe coral bleaching events occurred on the Great Barrier Reef and elsewhere around the world in 1998 and 2000 and, with global warming, scientists expect they won't be the last.

Back in the 1990s, Professor Eugene Rosenberg and his colleagues at the Tel Aviv University, Israel, made the important discovery that bleaching in the hard coral *Oculina patagonica*, a relatively new resident of the Mediterranean Sea, is caused by a pathogenic bacterium, *Vibrio shiloi*. There the coral tends to bleach in the summer, but usually recovers each winter.

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The scientists established that the bacterium infects the coral polyps by sticking to receptors in the normally protective coral mucus. The bacteria then invade the coral tissues and multiply.

Bleaching occurs because the bacteria produce toxins that inhibit photosynthesis by the zooxanthellae living within the coral, rupturing the algae. The Israeli scientists now know that one of the toxins is a peptide, which forms ammonia channels in the algal membranes, destroying the pH gradient, and blocking photosynthetic processes. This deprives the coral polyps because of the food that the algae normally provide; more than 50% of the coral's nutrients come from its algae.

Why, though, does bleaching occur only when sea temperatures rise? In *O. patagonica*, the scientists' aquarium experiments showed that at 29°C, the corals did not bleach unless the bacterium was added. On the other hand, the coral did not bleach at a wintry 16°C even if bacteria were added to the water. The team think that this temperature dependence is, among other things, due to an enzyme called SOD (superoxide dismutase). The bacterium, *V. shiloi*, manages to survive in the oxygen rich tissues of the coral by producing the SOD enzyme and it can only make the enzyme at temperatures above 22°C.

All this is intricate enough, but the plot thickens. Using a fluorescence method to track the bacteria, the scientists found that, during winter, the coral-infecting bacterium takes refuge in a marine fireworm, *Hermodice carunculata*. The worm serves as a winter reservoir for the microbe and also acts as a carrier of the disease during spring and summer. As the worms feed on the coral, the fresh infections occur and the annual bleaching cycle continues.

So can this new bacterial explanation for coral bleaching account for the mass bleaching of coral reefs in other parts of the world?

It is too early to say, according to Rosenberg. 'We are waiting for another major bleaching event to test the bacterial hypothesis further. It is difficult to extrapolate because *O. patagonica* does not exist on tropical coral reefs, but rather as colonies in temperate waters.'

Seasonal seawater temperature differences off the Israeli coast are also much greater (about 14°C) than those generally found in waters supporting coral reefs. However, two lines of evidence suggest that bleaching on coral reefs might be the result of microbial infection.

'Firstly, says Rosenberg, 'the often random, patchy distribution of coral bleaching is difficult to attribute to environmental stress alone and the spreading nature of coral bleaching is highly symptomatic of a microbial infection. Secondly, another *Vibrio* species (*V. coralliilyticus*) has been found to cause bleaching in a coral on reefs in the Indian Ocean and the Red Sea.'

It appears, according to Rosenberg, that the strain of bacterium identified on the Barrier Reef near Townsville may be a new variety of *V. coralliilyticus.*

'Nonetheless', he says concertedly, 'we really don't yet know what role infection plays in periodic mass coral bleaching events around the world.'

'However, from a practical viewpoint, if and where we find that these phenomena are caused by an infection, we will be able to apply our vast experience of dealing with infectious diseases in other animals, plants and humans to the worrying problem of coral whitening.'

● **Steve Davidson**

More information:
Rosenberg, E. and Falkovitz, L. (2004) The *Vibrio shiloi/Oculina patagonica* model system of coral bleaching. *Annual Review of Microbiology*, **58**: 143–59.