# IMCS to study how warming will stress coral symbionts

Two coral colonies, Porites (left) and Montipora (right) in an IMCS coral facility tank. The Porites colony is almost completely bleached, a process by which they lose their endosymbionts, while the Montipora colony is healthy. The bright colors in healthy corals are mostly due to the photosynthetic endosymbionts residing within their tissues. The symbionts, the dinoflagellate Symbiodinium, possess chlorophyll and other pigments used for harvesting sunlight. Corals may also have green or red fluorescent proteins, the function of which is not well understood.

Coral reefs are among the most diverse ecosystems on Earth and are critical for the health and productivity of coastal food webs in tropical marine biomes. Rising sea-surface temperatures, brought on by global climate change, are now threatening the survival of many coral reef communities around the world. In response to rising ocean temperatures, many corals are unable to cope with heat stress, resulting in massive "bleaching" events where corals loose their endosymbiotic algal partners. These algae, belonging to the genus Symbiodinium, are members of the dinoflagellates, a globally important group of protists that live in marine and freshwater environments. When stressed, many of the Symbiodinium algae living in corals release damaging reactive oxygen species, such as hydrogen peroxide, and undergo programmed cell death. Other Symbiodinium, however, are unfazed by the rising temperatures and show no outward signs of stress. The discovery of distinct stress phenotypes of Symbiodinium has raised an interesting paradox: why aren't resilient symbionts selected in nature for symbiosis with corals under conditions of high temperature stress? Indeed, this may be nature's eventual solution to the problem of coral bleaching, but in the mean time many reefs continue to suffer dire consequences.

In an effort to take an experimental approach to understanding this global crisis, IMCS scientists Paul Falkowski and Matthew Johnson were recently funded by the National Science Foundation to study how global warming will select for certain stress phenotypes of Symbiodinium. One of the main goals of the project is to understand why certain coral symbionts are resilient to high temperature stress. To address this, they will analyze gene expression in Symbiodinium, in an effort to pin point the underlying causes of high temperature stress tolerance and sensitivity. Johnson and Falkowski will also look at the physiological trigger for programmed cell death in Symbiodinium, and investigate the biochemical signals between corals and their symbionts which coordinate bleaching events. The real experimental approach, however, will then be to induce bleaching of corals in the laboratory, and try to make them form a new symbiosis with distinct stress phenotypes. This will allow them to directly test if stress-resistant symbionts allow corals to resist bleaching, and whether or not corals can select for these stress-resilient phenotypes following bleaching events. The project will provide fundamental knowledge of the coral-Symbiodinium symbiosis, and how this relationship is tested during times of heat stress. Such knowledge will prove valuable for understanding the mechanism of coral bleaching and perhaps how we can manage it.

Healthy colonies of the coral Fungia scutaria with a sea urchin (middle) in the coral tanks at IMCS. The Fungia colonies have extended polyps, which are individual animals making up a coral colony. (photo. cred. Frank Natale)

The IMCS coral culturing facility, housing a variety of Pacific corals used for research.

The symbiont of corals, Symbiodinium, may also form endosymbiotic associations with other organisms- including other singled celled protists! Here is a transmission electron micrograph cross-section of a ciliate, Euplotes, with Symbiodinium living inside. The ciliates live among the corals in the coral tanks at IMCS.

This graph illustrates the rapid loss of photosynthetic capacity in a heat sensitive strain (black) of Symbiodinium (the endosymbiont of corals). Heat tolerant strains of Symbiodinium (red), may withstand high temperature stress without negative side effects.

A variety of hard and soft corals in an IMCS coral tank.