

Symbiosis on the Reef

By Dr. Richard D. Braley. Written in 2003 for Magnetic Times.

The Macquarie Dictionary says of Symbiosis, "the living together of two species of organisms, a term usually restricted to cases in which the union of the two animals or plants is advantageous or necessary to both, as in the case of the fungus and the alga which together make up the lichen; mutualism."

The coral reef would not have the diversity of species that it is well-known for without symbiosis, which exists on a significant scale. Corals (both hard and soft corals except for a few species) have a symbiotic microalga living within their inner layer of cells (intracellular), whilst giant clams have a different subspecies of this microalga, living within fine extensions of their gut (extracellular).

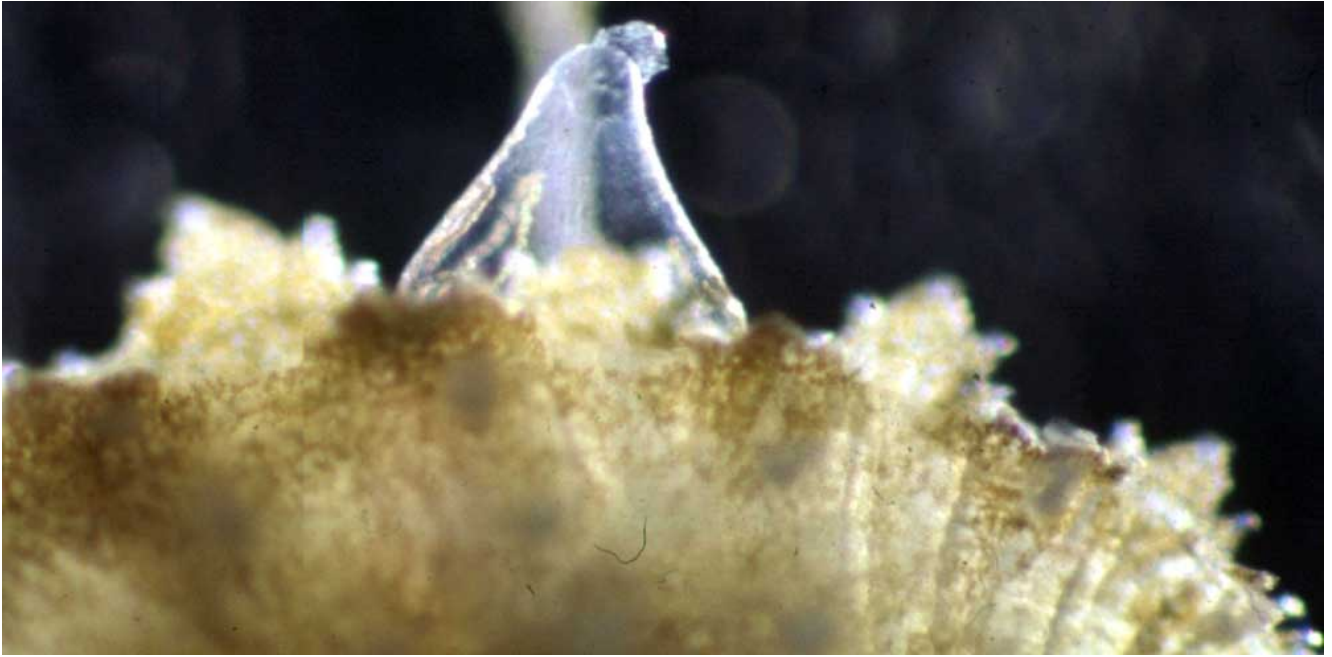
The dinoflagellate microalgae, *Symbiodinium microadriaticum*, which biologists call zooxanthellae, is the cause of coral bleaching (expulsion of the zooxanthellae), for the brown colours in live corals indicate the densities of zooxanthellae in the host. Basically, the corals and the giant clams (the host of the zooxanthellae) are Solar Animals, since they utilize the products of photosynthesis (simple sugars, amino acids) by the symbiotic algae, for at least a portion of their food requirements. The zooxanthellae give up more than half of its production from photosynthesis to the host.

The modern corals and the giant clams had evolved this successful union with the zooxanthellae back in the Eocene Period (about 65 million years ago), so they have been doing it just fine for a long time. The amount of carbon produced by this symbiosis allows the corals to grow over wide areas of shallow bottom, where sufficient sunlight can reach to keep the zooxanthellae 'solar cells' producing carbon food.

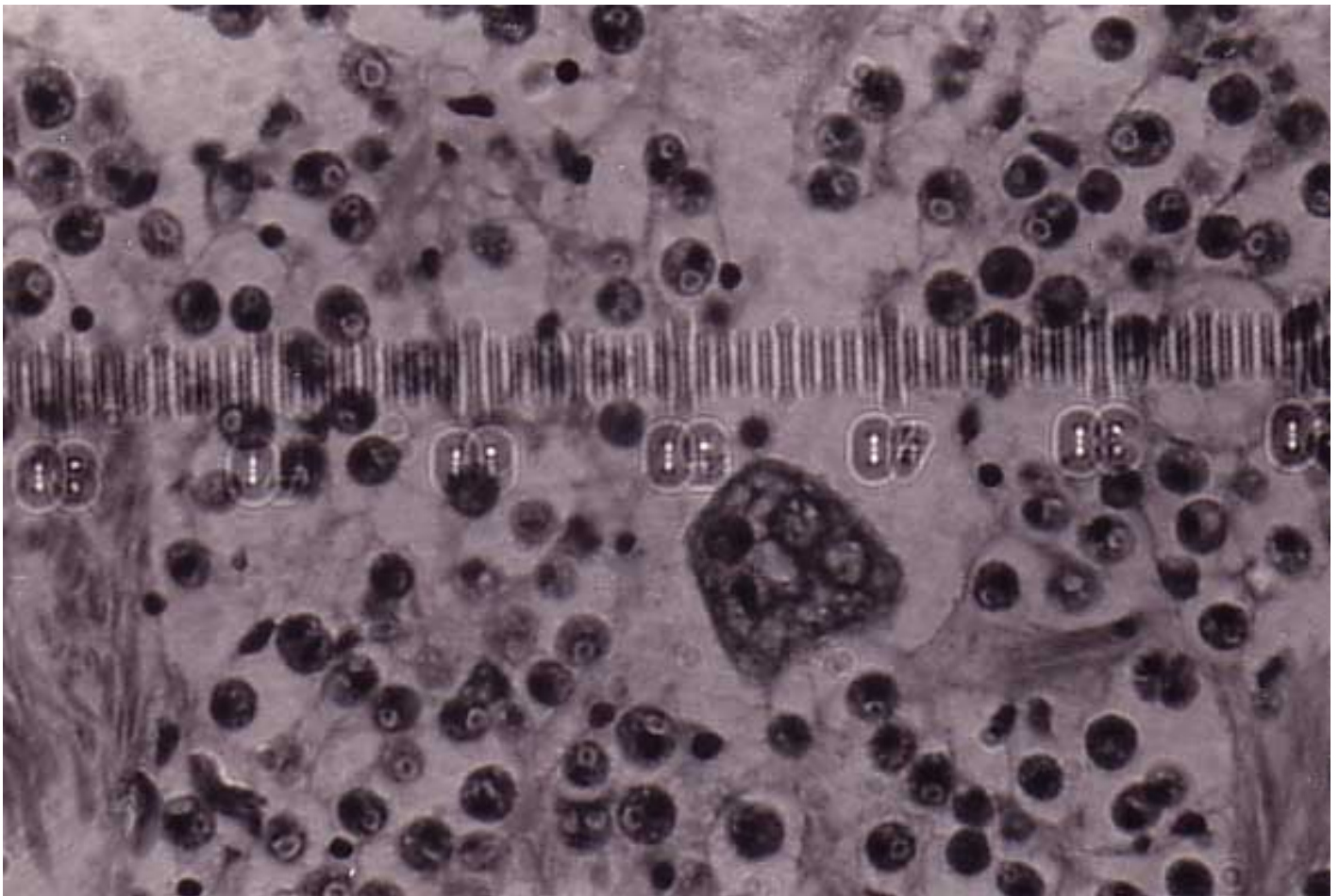
You may have heard it said before that tropical coral reef waters are like deserts. It is true that the clear water of outer reefs (not Magnetic Island) or reefs in the Pacific Ocean have very little in the way of nutrients or organics and that is why the water is so clear. However, the production of carbon from symbiosis is so great that many species, utilizing many different niches, have evolved around coral reefs.

There are other organisms that also have symbiosis with microalgae, such as some foraminiferans, some *Mastigias* sp. jellyfish, and some tunicates (sea-squirts or ascidians). Other symbiotic relationships are not between animals and microalgae and include anemones and anemonefish (these can be seen at Aquasearch Aquarium, Nelly Bay), shrimps with fish, shrimps with sea cucumbers, pea crabs with pearl oysters and clams, etc.

My favourite Solar animal, the giant clam, will bleach when high temperatures or low salinity water persists. In 1998 it affected >30% of clams at my reef study sites, mainly around Magnetic Island with low incidence at Orpheus Island. One of my cultured 17-year-old *Tridacna gigas* (can be seen at Aquasearch Aquarium) still displays a white section of tissue in the centre of its mantle, a result of bleaching 2 summers ago (2001).



1 cm long giant clam juvenile with zooxanthellae cells seen through the quite clear shell and mantle tissue (R. Braley photo)



Histology section mantle tissue of moribund *T. gigas* showing zooxanthellae and unknown protozoan possibly engulfing zooxanthellae, 200x magnification. (R. Braley photo).