Symbioses are close and sustained interactions between two different species. These relationships include: (1) mutualisms in which both species benefit from the interaction, (2) commensalisms where one species benefits and the other is unaffected, and (3) parasitisms wherein one species benefits at the detriment of the other. Although symbioses are typically viewed as these distinct categories, in reality, mutualisms, commensalisms, and parasitisms are merely points on a continuum; the nature of a symbiosis may shift between these categories depending on the relationship’s ecological context (Sachs et al., 2006).

One prominent example of a marine symbiosis occurs on tropical coral reefs. Here, a mutualism between reef-building corals and single-celled photosynthetic algae, also known as Symbiodinium, enable this ecosystem to thrive. Symbiodinium live within the digestive cells of the coral and where they are actively photosynthetic. In fact, Symbiodinium cells actively pass sugars and other energy rich compounds to their host, thereby providing up to 90% of the coral’s energetic needs. Thus, the coral host derives energy, while the symbiotic algae receive a safe environment.

Although symbioses between corals and Symbiodinium are most prominent on coral reefs, there are also symbiotic corals that live in non-tropical ecosystems. One local example is the coral Astrangia poculata. This coral occurs all along the U.S. east coast, from the Gulf of Mexico to the Gulf of Maine (Thornhill et al. 2008). Interestingly, A. poculata can be found both with and without symbionts, a phenomenon known as “facultative” symbiosis (Dimond and Carrington 2007).

It is highly unusual to find symbiotic corals this far from the tropics. The Gulf of Maine is approximately the northern limit of where Symbiodinium can occur. Here, only a single species of Symbiodinium, known as “type B2”, can be found (Thornhill et al. 2008). Unlike most Symbiodinium, “type B2” is able to withstand periods of low temperature and recover when temperatures are raised (Thornhill et al. 2008). However, when temperatures decrease below about 15°C, these symbionts nearly stop photosynthesizing (Thornhill et al. 2008). Considering the nearly year-round cool temperatures of the Gulf of Maine, it is unclear how Symbiodinium “type B2” could be providing energy to A. poculata.

In light of the information presented above, the facultative symbiosis between A. poculata and Symbiodinium “type B2” provides a fascinating model for studying the costs and benefits of symbiosis. Living inside the host coral’s tissue, Symbiodinium cells take up space and demand nutrients. When these algae are not photosynthesizing, they require energy to survive, energy which they may take from the host corals. Thus, if Symbiodinium B2 is not actively photosynthetic under most conditions, this symbiosis may shift from a beneficial mutualism to a costly parasitism (e.g., Sachs and Wilcox 2005). We tested this hypothesis at Bowdoin’s Coastal Studies Center (CSC) over the past summer.

### Experiment 1 Results

**Polyp Counts**

- **Symbiotic**
- **Asymptotic**
- **Cold, dark**
- **Cold, light**
- **Warm, dark**
- **Warm, light**

**PAM Measurements**

- **Warm dark**
- **Warm light**
- **Cold light**
- **Cold dark**

**Cell Density**

- **Symbiotic**
- **Asymptotic**
- **Cold, dark**
- **Cold, light**
- **Warm, dark**
- **Warm, light**

**Polyp Difference from T0**

- **Treatment**
- **Dec-09**
- **Jun-09**
- **Sep-09**
- **Apr-10**

- **In warm light treatment, the symbiotic colonies increased in polyp number while the asymbiotic colonies declined in number (Figure 1)**
- **In all other treatments there was no statistically significant difference between symbiotic and asymbiotic corals (Figure 1)**
- **The cold light symbiotic treatment displays the lowest photochemical efficiency and highest symbiont density (Figures 2 and 3)**
- **The warm light symbiotic treatment has the highest photochemical efficiency and the second highest cell density of symbionts (Figures 2 and 3)**

**Discussion**

- **These preliminary data indicate that under warm light conditions, the relationship between Astrangia and B2 is mutualistic.**
- **In the cold treatments there was no clear benefit to being symbiotic or asymptotic. This data suggests a weak parasitism or commensalism.**
- **The state of the symbiosis between Astrangia and Symbiodinium B2 will be further investigated by analyzing the data from tissue thickness for experiment 1**
- **For experiment 2 the corals will be processed for tissue thickness and symbiont density**
- **Additionally for experiment 2 we will aim to better understand Symbiodinium’s contribution to growth through analysis of respiration versus photosynthesis.**

**References**


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