Temperature Effects on the Feeding Activity of Marine Bryozoans *Membranipora membranacea* and *Dendrobeania lichenoides*

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Abstract:

Climate change can have a gradual affect on organism interactions gradually in the marine ecosystem which varies in many factors such as temperature. Temperature can alter the feeding habits of marine invertebrates such as bryozoans. There are no known studies on the effects of temperature on the feeding activity of algae by bryozoan (*Membranipora membranacea* and *Dendrobeania lichenoides*) colonies found at Friday Harbor, WA. The aim is to study the effects of temperature on bryozoan feeding on algae. Bryozoan colonies (n=10 of each species per treatment) were exposed to three different temperature treatments, 9 ºC, 12 ºC, and 15 ºC. In this study, these species were fed with a 1 to 200 ratio of phytoplankton, *Isochrysis* sp, and 0.22 µm filtered seawater. The results were inconclusive because the controls were not significantly different from the treatments. This study could have determined the impact of climate change on bryozoans as well as other sessile organisms.

Introduction:

Climate change alters important physiological processes in animals (Pörtner 2001). Sessile marine invertebrates experience variable environmental conditions, which include nutrient availability, water flow, seasonality, salinity, and temperature (Helmuth 1998). These factors can either be beneficial or detrimental to the life of marine invertebrates (Blicke et al 2006). One example is when the temperature increases the immune response of abalone (*Haliotis rubra*) to viruses and bacteria were delayed, which can be detrimental (Dang et al 2012). Although some marine invertebrates might be near their tolerance limits to temperature changes while some might not. Marine invertebrates are capable of tolerating certain variations in temperature (Helmuth 1998; Sorte *et al* 2011). Temperatures can directly affect the metabolic rate, growth, regenerative capabilities, and fitness of marine invertebrates (Saunders and Metaxas 2007). Bryozoans are a good model to test for the affects of temperature because they are sessile suspension feeding marine invertebrates. After settlement, they are unable to detach themselves from their substrate and move to a more suitable habitat. Therefore, bryozoans would have to adapt to the temperature variations occurring in its habitat.

Temperatures affect the growth and regeneration rate of bryozoans, for example, as the temperature increases, the growth accelerates and the regeneration rate increases in three North Sea bryozoans, *Membranipora membranacea*, *Electra pilosa*, and *Conopeum reticulum* (Menon 1972). In addition to the growth of the bryozoans, the feeding rates can vary among different bryozoan species, for example, 0.368 mL h^{-1} $zooid^{-1}$ for *Zoobotryon verticillatum* and 7.5 mL h^{-1} $zooid^{-1}$ for *Flustrellidra hispida* (Bullivant 1967; Riisgard and Manriquez 1997). The East Pacific bryozoan species could possibly predict the response of other sessile organisms due to the gradual temperature fluctuations from climate change.

At Friday Harbor, the temperature could range between 7 ºC and 12 ºC over the past 7 years (NOAA NDBC 2012; see Figure 1). There are no known studies of determining the feeding activity on algae by *Dendrobeania lichenoides* and *Membranipora membranacea* in the East Pacific Ocean due to temperature change. Also, the feeding activity is unknown for *D. lichenoides*. This study might show if one or both species will have a feeding preference at certain temperatures and if their feeding is impacted throughout the year as water temperatures fluctuate. This study might show how climate change could impact the survival of other suspension feeding. The aim of this experiment is to test the effects of temperature changes on the feeding activity of the marine bryozoans, *M. membranacea* and *D. lichenoides* at the Friday Harbor Laboratories dock in Washington State. I hypothesize that the feeding activity of *M. membranacea* will increase as the temperature increases. The feeding activity of *D. lichenoides* might have similar results.

Methods and Materials:

The study was performed from July 7-July 17, 2012. I collected 66 *M. membranacea* and *D. lichenoides* colonies off the tires on the floating dock at the Friday Harbor Laboratory. The bryozoans were cut using a fine scissors to approximately 1-2 cm sizes. I placed the samples in an indoors tank with ambient seawater minimum 6 hours prior to the start of the experiment to alleviate the stress of being dissected. Seawater was vacuum filtered using a 0.22 µm filter. *Isochrysis* sp. was grown in sterilized autoclaved 125 mL-250 mL flasks.

To determine the *Isochrysis* concentration necessary for the bryozoans to feed normally without being overwhelmed, I performed preliminary trials. There were 2 controls, one with no *Isochrysis* and one with *Isochrysis* only. To detect a difference in algal concentration, I added two hundred µL from each sample to its own individual well on a Falcon 96-well plate. An initial concentration was sampled prior to the treatment and a final concentration was sampled after an hour. A µQuant 96 well spectrophotometer (Biotek Instruments, INC) was set at $\lambda = 440$ nm to detect the absorbance of chl *a* (Ohi et al 2003). During the first preliminary trial, the measurable difference in absorbance was -0.001 between the initial and the final reading for the container with *Isochrysis* sp. and the container with only *Isochrysis*. These results indicated that either the bryozoans did not feed or the algal concentration was too high in the container to detect a noticeable difference in feeding. The absorbance difference should be positive to indicate feeding. Therefore, I tested different concentration ratios of *Isochrysis* to filtered seawater: 1:20, 1:40, and 1:200. The time was determined after sampling every hour for 2 hours. I found that 1:200 ratio was the best optimal concentration to use for a one hour treatment. The concentration difference was 0.006. Thus, this ratio was used in the treatments.

I tested three temperature treatments: 9 ºC, 12 ºC, and 15 ºC. The temperatures were tested one at a time in a plastic tub with seawater, which were achieved using ice to decrease the temperature, an aquarium heater to increase the temperature attached to a temperature controller. For each temperature, the tub contained 23 small 30 mL containers on a plastic rack (Table 1). A sample of n=10 of each species was placed in the treatments. Each small container had a total volume of 20mL of 30.5ppt filtered seawater. The salinity was determined with an YSI Model 85 device. The temperature was gradually increased to the three temperatures to the temperature treatments. The water in the containers was adjusted to the necessary temperature prior to adding the bryozoans and algae. The bryozoans were acclimated at the treatment temperature an hour prior to the experiment. All treatments and controls were in no flow conditions. I used a Kruskal-Wallis One Way ANOVA on Ranks to determine statistical difference between the controls and the treatments. The statistical program I used was Sigma Plot for Windows.

Results:

Although *M. membranacea* and *D. lichenoides* were exposed to the different temperature treatments, the difference in concentration in the controls was not significantly different to that of the treatments ($p>0.05$). Zooids were observed feeding but did not significantly decrease the algae concentration in the container to where there was a detectable change.

Discussion:

In this study, the results were inconclusive. My hypothesis of bryozoans feeding on algae increasing as the temperature increases remains elusive. The methods need to be refined. The ingestion rate might be due to the amount ingested prior to the treatment and the bryozoans' gut might possibly be full (Petersen and Riisgård 1992). Therefore, the next step is to starve the bryozoans prior to the feeding experiment. Bryozoans regulate on the particle sizes with their ciliated tentacles which might suggest that some of the algae were rejected (Strathmann 1982). In addition, zooids might be damaged or stressed, in which they did not have enough time to recover during the collection (Pratt 2008). The colony might have experienced stress when I added the bryozoans to each container.

Many studies have shown that bryozoans are capable of feeding at different flow conditions (Okamura 1987; Eckman and Okamura 1998; Okamura and Partridge 1999; Pratt 2008). The ingestion rate increases as the flow speed increases (Pratt 2008). Bryozoans are capable of creating their own flow, but the flow of algae to their lophophore might not be detectable. Bryozoans were known to shut down without any stressors (Lisbjerg and Petersen 2001). Lisbjerg and Petersen also found that only a quarter of the water pumped was filtered by the lophophore.

An additional factor, despite the results, could be that the treatments were not done simultaneously due to the limited equipment. Therefore, the next step would be to obtain a chiller instead of using ice for cooling, an aquarium heater and a water pump for each treatment setup so the treatments could be run simultaneously instead of independently. This could reduce the possibility of error from additional variables like time of day experiment was performed, during the treatments.

The results indicated that this study were not significant enough to draw a conclusion about temperatures affecting the feeding activity of *M. membranacea* and *D. lichenoides*. Climate change changing water temperatures affects the feeding of these bryozoans on algae remains elusive. Thus, more experimentation is necessary.

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Table 1: Shows the treatments and the controls. All containers had bryozoans except the algae only control.

Species	Treatments	Control	Control
M. membranacea	M1-10	No Algae	Algae only, no bryozoan
D. lichenoides	D1-10		Algae only, no bryozoan

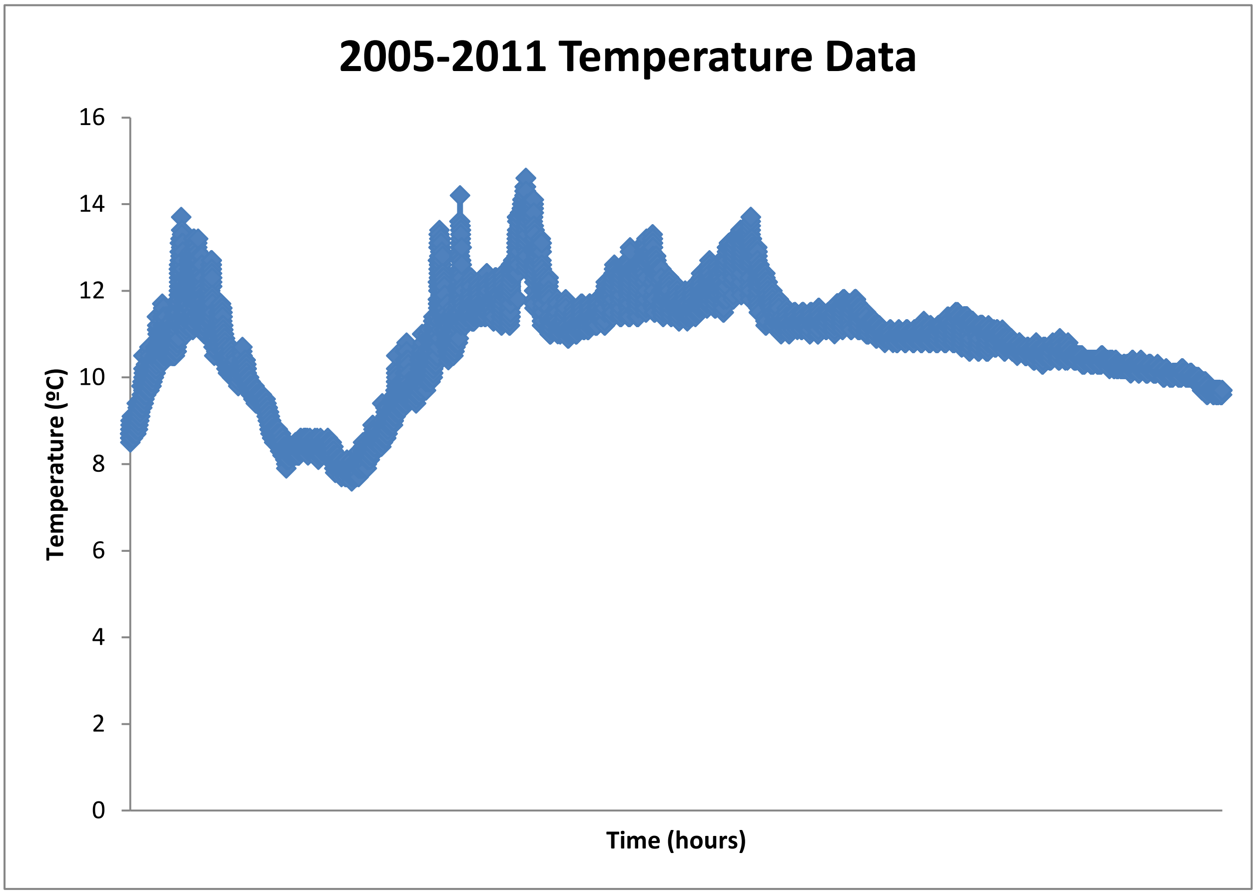

Figure 1: The temperature data ranging from 7ºC to 15ºC between 2005 and 2011.