

***Metridium farcimen* show little to no preference for prey particle size**

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Abstract

The overabundance of one species in a particular area is typically bolstered by a biotic or abiotic factor that allows them to outcompete other species for space and resources. The undersides of the docks in the town of Friday Harbor and at the Friday Harbor Laboratories are overrun with white plumose anemones, *Metridium farcimen*. The sewage output in the town docks contains particulate matter, which the prey of *M. farcimen* may feed on. To determine if particulate matter contributes to *M. farcimen* abundance, I collected specimens from both locations, placed them in controlled tanks and exposed them to separated samples of zooplankton of varying sizes. The anemone did not show an overall preference for food particle size, although they did show a slight preference of 0.3 mm particles over 0.5 mm particles. It is possible that they are consuming all size classes of zooplankton that feed on sewage particulates.

Introduction

The exponential growth in global population has added to the profuse output of sewage into the world's oceans and other large bodies of water. Many argue this output of waste, especially agricultural runoff, leads to negative effects such as coastal eutrophication and "red tide" algal blooms that can destroy habitats by creating anoxic conditions in which many organisms cannot survive (Snelgrove, 1999). There are other negative consequences that can arise from a poorly managed sewage output. The biodiversity and species composition of the area surrounding the output can be severely affected by the additional chemicals and nutrients. In some cases, the content of the sewage contains nutrients that can either benefit or inhibit propagation of particular species, allowing certain individuals to outcompete others (Lalonde and Ernst, 2012).

Due to the chemical content of sewage, including its high nitrogenous levels, the areas surrounding outputs have been known to be hotspots for a variety of species. The port docks in the town of Friday Harbor are located near the town's sewage output and provide substantial habitat for a number of organisms. Several species of anemone, nudibranchs, mussels, crabs, sea stars, and other organisms can be seen occupying multiple types of substrates found in and around the docks. *Metridium farcimen*, a species of anemone, has displayed a clear dominance on the undersides of Friday Harbor's town docks compared to any other species of anemone (Figure 1).



Figure 1: Profuse growth of *Metridium* on the underside of docks.

M. farcimen has a geographical spread ranging from the Santa Catalina Islands in California to the coast of Alaska. The species is highly prevalent in the Salish Sea. As carnivorous suspension feeders, they use their tentacles and secreted mucus to capture

prey, which they then bring to their mouths. *Metridium* feed on many different kinds of particulate matter, ranging from bacterium to copepods to other types of zooplankton (Fautin, 2000). The feeding efficiency of *Metridium senile*, a species closely related to *M. farcimen*, is determined by multiple factors, but most notably polyp size and flow regime of the passing water.

As a consequence of *M. farcimen*'s conspicuous dominance as the most prevalent anemone species inhabiting the Friday Harbor docks, we wanted to know if the anemones are benefitting from the sewage output. This could either happen directly due to the contents of the sewage or indirectly by supporting the growth of their prey. Our hypothesis is that the sewage output facilitates the growth of zooplankton of a particular size that *M. farcimen* prefers and allows them to outcompete other species of anemone on the docks. It is possible that other factors initiated by the sewage output will have indirect effects on the biodiversity of the docks, including the propagation of bacteria and other microorganisms. In this study we investigated if *M. farcimen* showed a preference for zooplankton of a certain particle size under controlled laboratory conditions.

Methods

Animals

I collected a total of 29 *M. farcimen* from Friday Harbor (48° 32' 7" N, 123° 1' 52" W) and Friday Harbor Laboratory docks (48° 32' 46" N, 123° 0' 46" W). Anemones were removed from a smooth substrate (both plastic and rubber) to reduce the damage done to them during the process of removal and to allow them to easily acclimate to the smooth substratum of the sea tanks. To account for differences in flow regime due to polyp size, specimens collected were within a size range of 2-5cm in diameter.

Experimental Setup

In the laboratory, I transferred specimens to three tanks for observation and testing (Figure 1). When the experiment was not running, each tank was given its own flow of seawater. Drainage holes were drilled through the sides of the tanks to reduce the water volume. Because the experiment was run on stir plates, stir rods were placed into each tank prior to the experiment so that the anemones would not attach themselves in the pathway of the stir rod.

Each tank was exposed to three solutions composed of different sized food particles. To obtain the particulate matter, I performed a plankton tow off the Friday Harbor Lab (FHL) docks using a 333 μm plankton net with a 0.5 m diameter. Copepods were collected from splash pools by Lab 12 and sorted by size. The particulate matter was separated by size using four stacked sieves with 1.0, 0.5, 0.3 and 0.147 mm holes. To collect the layer of particles off of the sieve, I used a squeeze bottle to spray the particles to the sides and then tilted the sieve while it was submerged underwater. I used a plastic pipette to collect the particles that had accumulated on the sides. I suspended the separated particles into marked containers and placed these containers in a seawater bath to keep the zooplankton alive and acclimated to their environment.

Tanks holding anemones were removed from seawater and placed on individual stir plates. Excess suspended matter was removed from tanks. Bubblers with controlled water flow were inserted as an air source. Because two out of three of the stir plates were known to heat up while running, I placed Plexiglas plates and tongue depressors under tanks B and C to diffuse heat away from the tanks (Figure 2). Once the stir rods were set to consistent speeds, I placed a container of suspended food into each tank. Each trial, one tank received one of the treatment prey sizes. A total of three trials were run so that

each tank was exposed to all of the size classes. Each trial ran for 90 minutes.

Immediately after the food solutions were poured into the tanks, I took water samples of each tank. I subsampled 7.5 ml of water from each tank and added an equal proportion of 70% ethanol solution to preserve the zooplankton in the samples. I counted and recorded the number of individual zooplankton in each sample using a microscope.

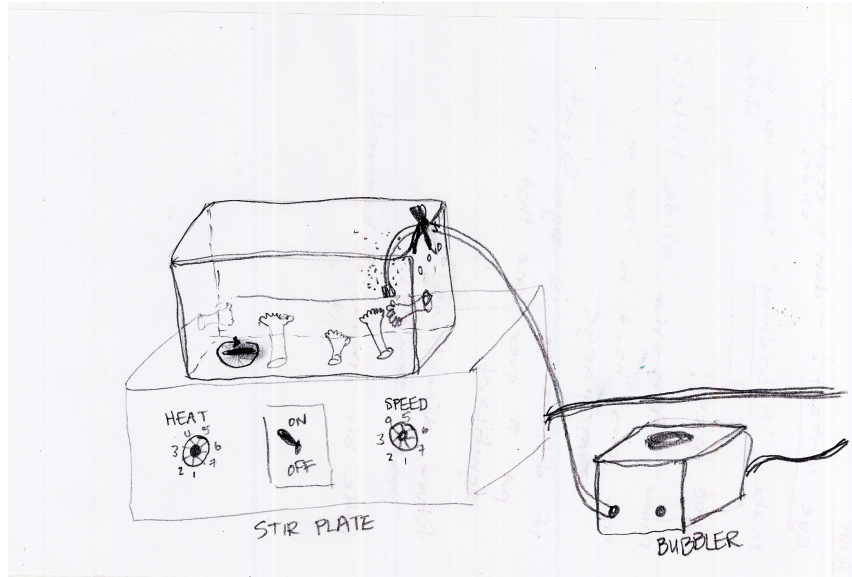


Figure 2 - Experimental Setup: During each trial, a stir stick was put into each tank and the tanks were placed upon a stir plate. Bubblers were inserted as an oxygen source for the duration of the 90-minute trial.

Once each trial was over, the tanks were returned to the seatables and the water flow was replaced. The anemones were given 24 hours to settle between each trial. One trial was performed each day, for three straight days, with particles that had been obtained and separated from a plankton tow done the morning of the trial.

Statistical analysis, including ANOVA and t-tests were performed using the Minitab Program.

Results

Food Particle Preference

The *Metridium* ate a majority of every type of particle presented to them, with a consumption range of 76 – 91 % of the initial starting number of prey particles (Figure 3). These percentages were all very close in value and the anemones showed no overall preference for size class, although they did eat a greater percentage of the starting amount of 0.3 mm particles than 0.5 mm particles (Figure 3, ANOVA, $p = 0.288$, $F = 1.543$, $d.f. = 2$; t-test, $p = 0.049$).

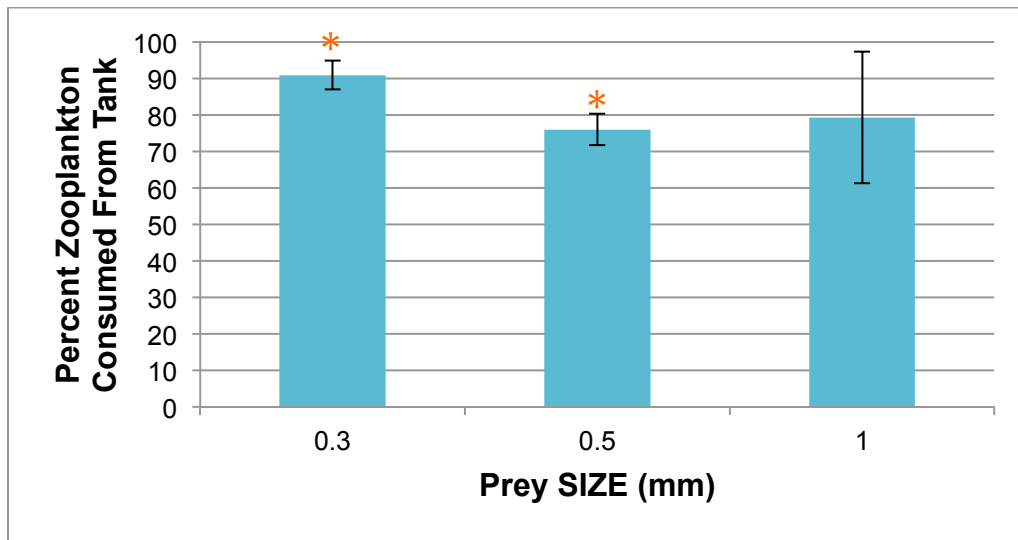


Figure 3 – Percent of initial number of counted zooplankton consumed by size class (Mean +/- standard deviation). There was no significant difference in percent consumed.

Biovolume Consumption Rates

There was a significant difference between the anemones' consumption rates (volume of particles consumed by anemone in a tank divided by the total volume of anemone in that tank over a period of 90 minutes) of the different size classes: (Figure 4, ANOVA, $p = 0.055$, $F = 4.91$, $d.f. = 2$).

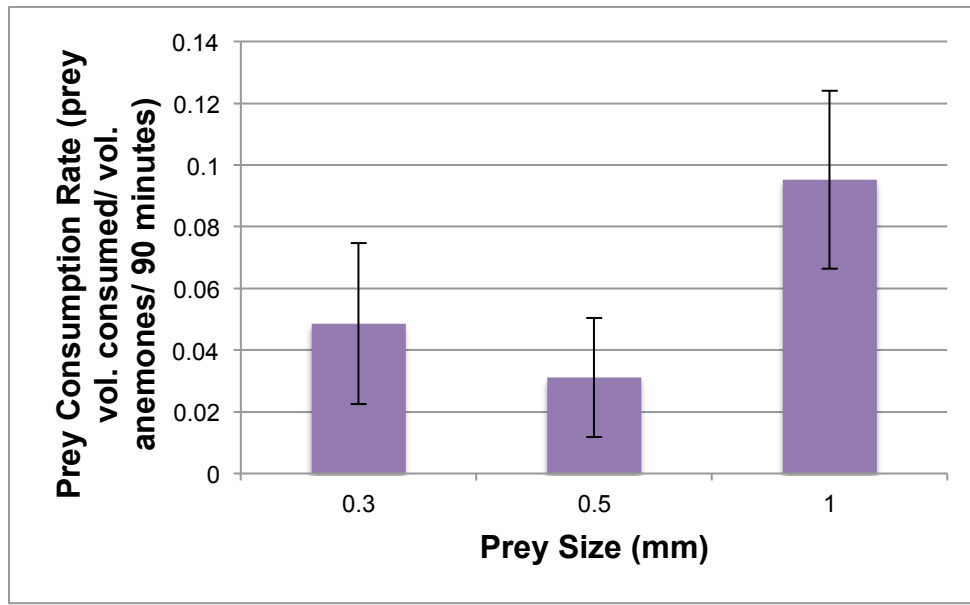


Figure 4 - The average rate of food consumption by the anemone based on particle size (Mean +/- standard deviation). Rate was determined by average volume of particles that were consumed divided by total volume of anemones over a 90-minute period (ANOVA, $p=0.055$, $F = 4.91$, $d.f. = 2$).

There was no significant difference between consumption rates of particle sizes of 0.3 mm and 0.5 mm or between the consumption rates of sizes of 1.0 mm and 0.3 mm (Figure 4, t-test, $p = 0.147$ and 0.059 , respectively). The anemones did, however, display a significantly higher rate of feeding with the 1.0 mm particles compared with the 0.5 mm particles (Figure 4, t-test, $p = 0.012$).

The starting amounts of each prey size differed with each class because they were not kept uniform prior to being added to the tanks during the experiment. There was a considerably larger quantity of the 1.0 mm prey added to the tanks at the beginning of each trial compared to the other size class, with 0.5 mm prey having the least quantity at the start of each experiment (Figure 6).

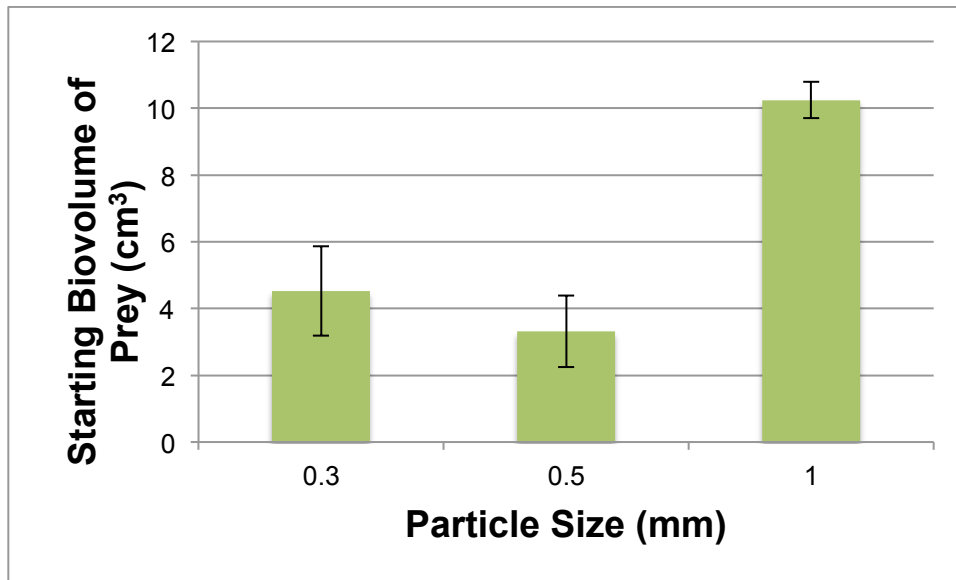


Figure 6– Initial biovolume of food particles before trials (Mean +/- standard deviation). There was a considerably higher volume of 1.0 mm particles used during each trial than the two other particle size classes.

Discussion

The purpose of this experiment was to determine why the anemones are such a dominant species in the areas surrounding the lab and town docks. My initial question was to determine whether or not *M. farcimen* display a preference for food particle size. Based on my results, I believe they do not. The anemones ate more than a majority of all of the different sized food particles they were exposed to, with a consumption range of 76 – 91 % of total starting particles (Table 1) and, based on particle size, there was no significant difference in the percentage of food particles they consumed (Figure 4, ANOVA, $p = 0.288$).

There are two hypotheses we have as to why the anemones ate a considerably higher biovolume of the 1.0 mm prey class: I did not keep the volume of particles or the volume of anemones per tank constant throughout the experiment because I wanted to get an estimated general trend of particle preference. I speculate that the increase in available

food volume affected the volume of food consumed by the anemones, so the amount of food available initially is positively correlated with the volume of food the anemones consumed. Another possibility is that the anemones just prefer the larger sized particles because they can get more sustenance in one “catch” of the larger particles compared to the smaller particles (0.3, 0.5 mm). I believe my calculations for the total particles consumed, which exhibited the anemones’ lack of prey size preference, has a greater indication of what occurs in the wild because seems logical for the anemones to catch all prey available to them to maximize their energy intake. An observational study would assist in clarifying this statement.

New specimens were collected after two-thirds of my specimens did not survive a pilot study where water was inadvertently heated to a lethal temperature. The new set of anemones did eat more biovolume overall, but I do not think this would have affected my data at all.

To follow up on this experiment, I would take water samples from near the output to look at the content of the sewage so analyze what the zooplankton are feeding on. I would also re-perform this experiment in a more controlled environment by keeping the biovolume of both the prey and anemones uniform throughout the duration of the experiment. I would also like to integrate the use of a light meter or nephelometer to measure particle density.

I hypothesized that anemones are so prevalent under the docks because sewage output is increasing their ecological fitness by providing their prey with an additional source of food. Because the anemones have not displayed a preference for prey particle

size, they are feeding on *all* the prey particles, regardless of size; I conclude that the sewage output is contributing to *M. farcimen*'s dominance on the docks.

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