Distribution of *Ascophyllum nodosum, Mytilus edulis,* and *Balanus balanoides* on Rock Substratum Throughout the Intertidal Zones of New England

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Abstract Competition among species occurs in all habitats across the world. In the rocky intertidal zones of New England, many species are dispersed across the rock substrate. Previous studies have linked vertical height and species dispersal. This study investigates the relationship among *Ascophyllum nodosum, Mytilus edulis,* and *Balanus balanoides* and attempts to determine whether species dispersal throughout the intertidal zones because of intra-species competition is affected by the relative height of species' location on the substrate on which they reside.

Key Words: *Ascophyllum nodosum; Mytilus edulis; Balanus balanoides;* vertical height; competition

Introduction

There are many relationships within rocky intertidal areas that are causes for dispersal of organisms throughout different zones. Competition for space is a major component in relationships among all organisms found in the rocky intertidal zones of New England. In each of the different zones - low, mid and high - there are dominating species that are better adapted to survive competition. For example, the low tidal zone is known for the presence of the algal species, *Ascophyllum nodosum.* Because of its strong holdfast and ability to reside successfully in the low-mid intertidal zones, canopy beds of *Ascophyllum* provide well-protected areas within these zones for other organisms to reside more safely (Bertness 1999). The phenomenon of the water's movement, causing *Ascophyllum* to move, is known as the whiplash effect (Grant, 1977). This disturbance makes the low intertidal zones unsuitable for barnacle survival. As a result, *Balanus balanoides* tend to be found in the high to mid intertidal zones.

A study completed in 1997 transplanted *Ascophyllum* to determine whether success of the plant was dependent on the location within the rocky intertidal shore. It was found that after transplanting to the high intertidal zone, 80% of plants that were moved had died within 3 months of transplanting (Stengel and Dring, 1997). This study shows that the location of the algae within the intertidal zone is essential to the plants' success.

Another factor in the location of organisms within the intertidal zone is the slope of the substrate. A study of slopes within the New England intertidal areas concluded that areas of rock with a steeper slope retained a lower temperature than the gentler sloped areas. The survival rate of *Balanus balanoides* was affected by the temperature range

of the substrate (Bernhardt et al., 2011). The study concluded that in northern areas, where there was less temperature fluctuation, the distribution did not seem to be affected (Bernhardt et al.). Temperature variations may play a role in the distribution of other species such as *Ascophyllum* and *Balanus* throughout the rocky intertidal.

An additional factor that may contribute to distribution of species within the intertidal is the predator-prey relationship. A specific example is its effect on the distribution of *B. balanoides* and *M. edulis* because of their extremely abundant common predator, the snail, *Nucella lapillus* (Menge, 1976). Menge's study looked at the relationship between intraspecific competition and the community structure of the intertidal. The results showed that there was a significant relationship among the distribution of *B. balanoides,* the predator-prey relationship and intraspecific competition (Menge).

The goal of this study is to examine the dispersal of *Ascophyllum nodosum, Mytilus edulis,* and *Balanus balanoides* on the rock substrate of the intertidal zones of Nahant, Massachusetts, with one possible factor being competition. The hypothesis is: in the lower sections of the intertidal zones there will be a fewer *Mytilus edulis* and *Balanus balanoides* because of competition with the algal *Ascophyllum*, which does extremely well in the lower regions; in the mid-intertidal there will be a decrease in *Ascophyllum nodosum* and an increase of *Mytilus edulis* and *Balanus balanoides,* however the dominant species will be *Mytilius;* in the high intertidal zone there will be an increase in *Balanus balanoides* compared to *Mytilus and Ascophyllum*. This study highlights absence versus presence of the three species in relationship to the vertical height of the samples.

Materials and Methods

This study was conducted in Nahant, Massachusetts, at the Northeastern Marine Science Center. The study took place on two different dates, September 15 and October 26, 2012. The procedure for data collection changed between these two dates.

The first day of data collection was focused strictly on absence versus presence of *Ascophyllum nodosum* and *Mytilus edulis*. This was sampled by 25 cm^2 quadrats. The quadrat was randomly thrown and absence or presence of the two species was determined and recorded. A contingency table and chi squared test were performed.

The second day of data collection focused on presence and absence of species depending upon the vertical height of each quadrat measured. Once again, the quadrats were randomly selected. However, each quadrat was measured in height differential compared to a selected "high point" that remained the same throughout the study (reference picture). At the time of low tide the vertical height of this referential point was measured, and the difference between this height and the quadrat height was used to determine the actual vertical height of each quadrat compared to the point of low tide. In order to measure the vertical height, a transect tape measure and a large pole with meter markings were used. The marked pole was held up from each quadrat, and the transect line was held at the reference point, stretching out to the pole (picture1). When the tape measure appeared to be level, the height of where it met the measuring pole was noted. This was done for each quadrat, as well as for the height of

the reference point at low tide. The measurements were then converted to actual vertical height by calculating the difference between the vertical height of low tide and the heights for all the quadrats. It was unable to perform statistical analyses for the second portion of the study because of the limited number of data points per each height.

Picture 1: Measuring the vertical height of the reference point at the time of low tide. October 26th, 2012 at Northeastern Marine Science Center, Nahant, MA.

Results and Discussion

The first portion of the study showed that there was an overall trend to a greater distribution of *Mytilus edulis* than *Ascophyllum nodosum* (figure 1). Out of the 12 sampled quadrats, there were 8 that had *Mytilus* present and 5 that had *Ascophyllum*. A chi squared test, with 1 degree of freedom, yielded a chi square value of 0.17 and a p-value of 0.67; $p > 0.05$, therefore the data are not statistically significant.

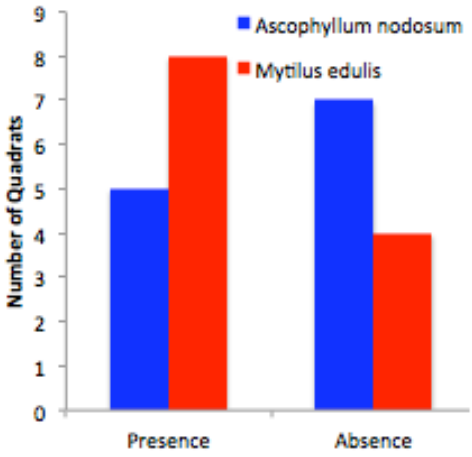

Figure 1: The presence vs. absence of Ascophyllum nodosum and Mytilus edulis. There was a larger presence of Mytilus edulis than Ascophyllum nodosum when only one type of organism was present, however there were overlaps between the two species.

The second portion of the study showed that there was a difference among the three species, *Mytilus edulis, Ascophyllum nodosum,* and *Balanus balanoides*, in terms of the vertical heights of their distributions within the intertidal zones of Nahant, MA. In the middle regions of the intertidal there was an even distribution between the species. There is an overall trend of *Balanus balanoides* being more abundant within the higher regions, *Mytilus edulis* being more abundant in the mid-intertidal regions, and *Ascophyllum nodosum* being more abundant within the low-intertidal regions.

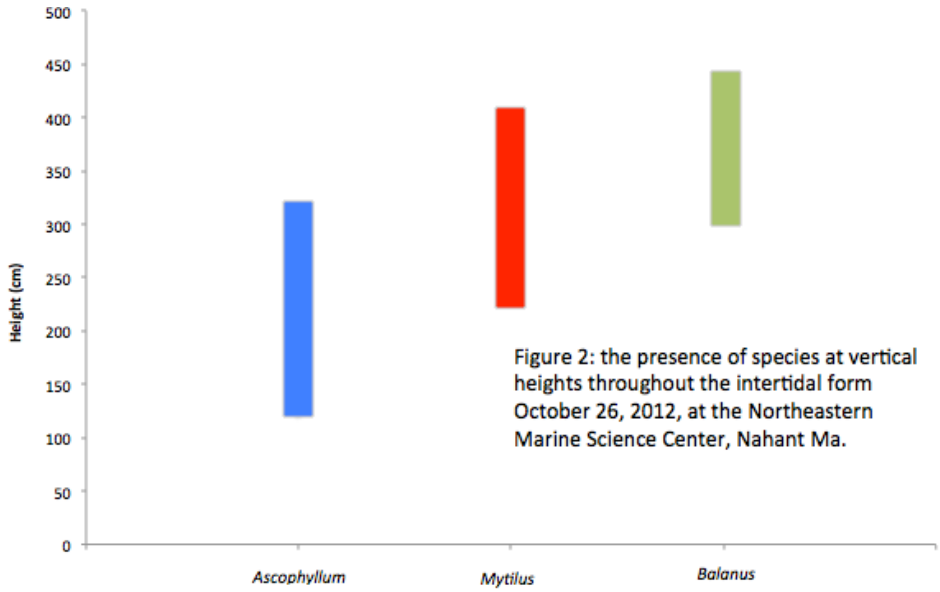

Figure 2: the presence of species at vertical heights throughout the intertidal form October 26, 2012, at the Northeastern Marine Science Center, Nahant Ma.

A major improvement for future studies for similar interests would be to ensure a larger sample size. This could be done by collecting data on multiple days. A larger sample size would be more likely to enable researchers to obtain significant results. The smaller data size did not lend it self to statistical analyses.

Another aspect of the study that could be improved would be to use more accurate tools to determine vertical height. For example, use of a level to ensure that the measuring tape is straight and at a right angle to the measuring pole may add more precision to the data collected.

An interesting addition to a future study that could determine other possible organismal relationships that may affect dispersal within the rocky intertidal zones of New England would be to observe a larger number of species.

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