CORRELATION ANALYSIS BETWEEN *PALAEMONETES* SHRIMP AND VARIOUS ALGAL SPECIES IN ROCKY TIDE POOLS IN NEW ENGLAND

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Abstract *Palamonetes* is a genus of shrimp that can be found in a variety of habitats from mangrove stands in Florida to rocky intertidal pools in Massachusetts. The majority of the research on this genus is conducted in tidal marshes, not tidepools. Therefore, this study examined the distribution and density of *Palaemonetes* shrimp in tidepools as well as whether there was any correlation between the shrimp and algal cover. We determined that there is a significant correlation between the presence of shrimp and the presence of both canopy and holdfast algae using a chi-squared analysis (p-values of 0.004 and 0.03 respectively). Furthermore, there is significant correlation between the presence of shrimp and the presence of brown algae (p-value of 0.019 for *Ascophyllum nodosum* and 0.049 for*Fucus vesiculosus*) where there isn't a significant correlation between the presence of shrimp and red algae (p-value of 0.57 for *Chrondris crispus).* However, our sample size is relatively small and, due to the lack of literature on the genus, more research is necessary to accurately determine the roles and relationships of *Palamonetes* shrimp and algae in tide pools in New England.

Key Words: *Palamonetes* shrimp, algal cover, rocky intertidal

Introduction

Numerous species of shrimp comprise economically important fisheries around the globe (Dallagnolo et al. 2009; Hart and NOOA Fisheries 2012). However, they often serve an equally important ecological role in their respective ecosystems. For example, the grass shrimp, *Palaemonetes pugio*, serves an important role consuming detritus in tidal marshes where decomposition far outweighs consumption by herbivores (Welsh 1975). Members of the *Palaemonetes* genus are small (>2in), clear-bodied shrimp that live in estuaries, mangrove stands, seagrass beds, mud flats and rocky intertidal pools from the Gulf of Mexico to the shores of New England (Anderson 1985). Several studies of *Palaemonetes* have examined their reaction to environmental toxins and their potential to be used as an environmental indicator species (Sunda et al. 1978; Far 2011; Cochran and Burnett 1996). Most of the ecological literature discusses their role in salt marshes while there is next to no research about their role in rocky intertidal pools (Morgan 1980; Welsh 1975; Kneib 1987). Therefore, in an effort to compile more information about their role in the rocky intertidal ecosystem we sampled coastal tide pools in coastal Massachusetts to determine shrimp abundance. While in other environments *Palaemonetes* shrimp have been shown to be detritivores (Welsh 1975) they are primarily opportunistic omnivores and are therefore able to adapt to their environment to consume detritus, algae, macrophytes and animal remains (Odum and Heald 1972). In order to determine the role of algae as food or refuge for *Palaemonetes* shrimp we will measure percent algal cover of various species of algae with respect to shrimp abundance (Kneib 1987). The goal of this research is to determine the role of algal cover as it relates to an under-researched genus of shrimp (*Palaemonetes*) in an environment (rocky intertidal New England) in which it has yet to be fully researched .

Materials and Methods

Research Species

The relationship between the genus *Palaemonetes* and various rocky intertidal algal species such as *Ascophyllum nodosum*, *Fucus vesiculosus*, and *Chondrus crispus* was examined. *Palaemonetes* shrimp are opportunistic omnivores which can consume detritus, algae, macrophytes and animal remains (Odum and Heald 1972). Because they can consume most forms of organic matter *Palaemonetes* shrimp live in a variety of habitats including estuaries, mangrove stands, sea grass beds, mud flats and rocky intertidal pools (Morgan 1980). It's possible that their main source of food in a rocky intertidal ecosystem is various species of algae. It is also possible that the shrimp use algae as refuge from predators as they do with other types of vegetation in tidal marsh habitats (Welsh 1975). The species within *Palaemonetes* share many morphological similarities and rarely grow to more than 2 inches, thus a dissecting scope is necessary for individual species identification (Anderson 1985). It appeared that we were observing only a single species of *Palaemonetes* in our study site however due to the many similarities of species within the genus it is possible they were numerous different species. Therefore, in an attempt to avoid miss-classification this research will focus on the genus rather than trying determine which species are present in this study area.

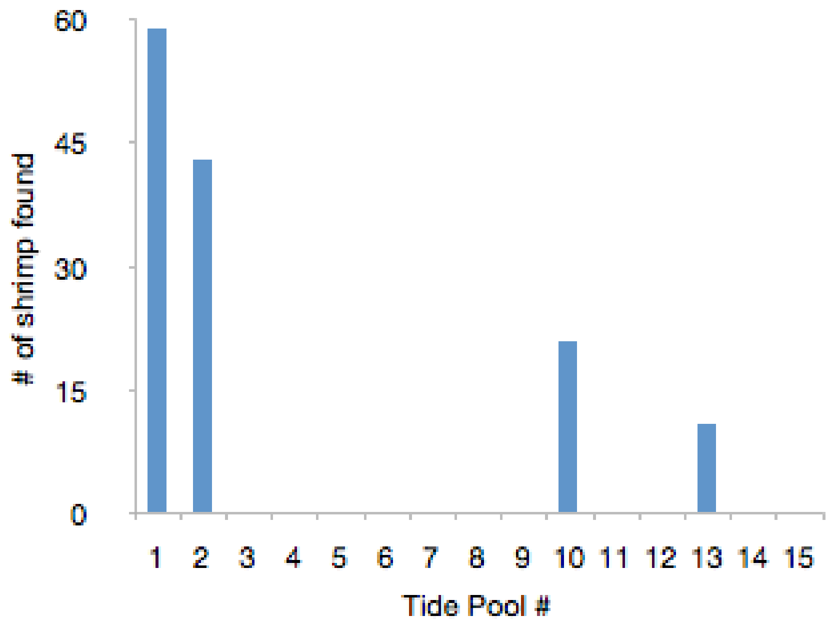
Study Site and Methods

Our data were collected using a 25 cm quadrat in a number of randomly selected rocky tidepools at Northeastern University's Marine Science Center in Nahant, Massachusetts on the dates of September 15th and October 26th 2012. Once a quadrat was placed, floating on the top of a pool, percent algal cover was measured recording both canopy algal cover as well as the percent cover of the algae with holdfasts within the quadrat. Floating algae was then cleared to the side with a resting period of 1-2 minutes to allow any shrimp who were disturbed by the movement of the algae to return. After this resting period shrimp were counted and, because the shrimp are clear and rarely move, it was sometimes necessary to disturb the area beneath quadrat to determine if there were any remaining, uncounted shrimp in the area.

Relationships between shrimp abundance and canopy/holdfast algal cover were analyzed in Microsoft Excel using a chi-squared test for association and a regression analysis to compare increasing algal cover and shrimp abundance (table 1 and fig. 3). These tests were also run individually for the three most common algal species (*Ascophyllum nodosum, Fucus vesiculosus* and *Chondrus cripspus)* to determine if they had a preference towards any specific species of algae (table 2 and fig. 4).

Results and Discussion

We found a total of 134 shrimp within 43 quadrat samples in 15 tide pools. 26.6% of tide pools sampled contained shrimp while 39.5% of quadrats contained at least one shrimp. Many tidepools sampled contained zero shrimp, however, where shrimp are present there are often relatively large numbers of them (at least 11) (fig. 1). One pattern that was observed throughout this research was that in sampling along the shore moving towards the northeast (red arrow) shrimp were fairly abundant, however once around the corner marked by the yellow star very few shrimp were found (fig. 2). Both locations had relatively equal levels of algal cover with the key difference being that the area beyond the point is significantly less protected from wave action than the area delineated by the red arrow. Therefore, it is possible that *Palamonetes* shrimp require moderate to low wave intensity to persist in the rocky intertidal. Furthermore, significantly fewer shrimp were observed on our second day of sampling (32 as opposed to 102) despite the fact that more pools were sampled on the latter date. This may be due to the spatial distribution of wave intensity (as discussed above) or perhaps, due to some life history change as a result of changing weather or seasons (first sample conducted on September 15th and the second on October 26th). *Palamonetes* shrimp generally spawn between February and October thus it is possible that there was such low shrimp abundance on the second sample date because many of the individuals were spawning, perhaps in a specific location outside our sample area (Anderson



1985).
Figure 1- Graph displaying the number of shrimp found per tide pool

Figure 2- Map of Notheastern University's Marine Science Center. The red arrow indicates the direction of sampling and the yellow star marks the point after which shrimp were rare.

Our chi-square analysis determined that there is a significant correlation between the presence of shrimp and the presence of both canopy algae and holdfast algae (p-values of 0.004 and 0.033 respectively) (table 1). One would assume that this association would mean there are more shrimp in pools with more algae however, when comparing regressions between percent algal cover and number of shrimp found per quadrat for holdfast cover, canopy cover and combined cover all showed slight negative trends (figure 3). However, it appears that this is not a significant trend as the p values are all very high: 0.78 for holdfast cover, 0.67 canopy cover and 0.69 for combined cover.

	Chi-Square Statistic	**p-value**
Canopy Algae	4.56	0.032
Holdfast Algae	8.49	0.003

Table1- Chi-squared statistic and p-value results of Chi-squared analysis for the association between shrimp and canopy/holdfast algae. Displays significance for both canopy and holdfast algae.

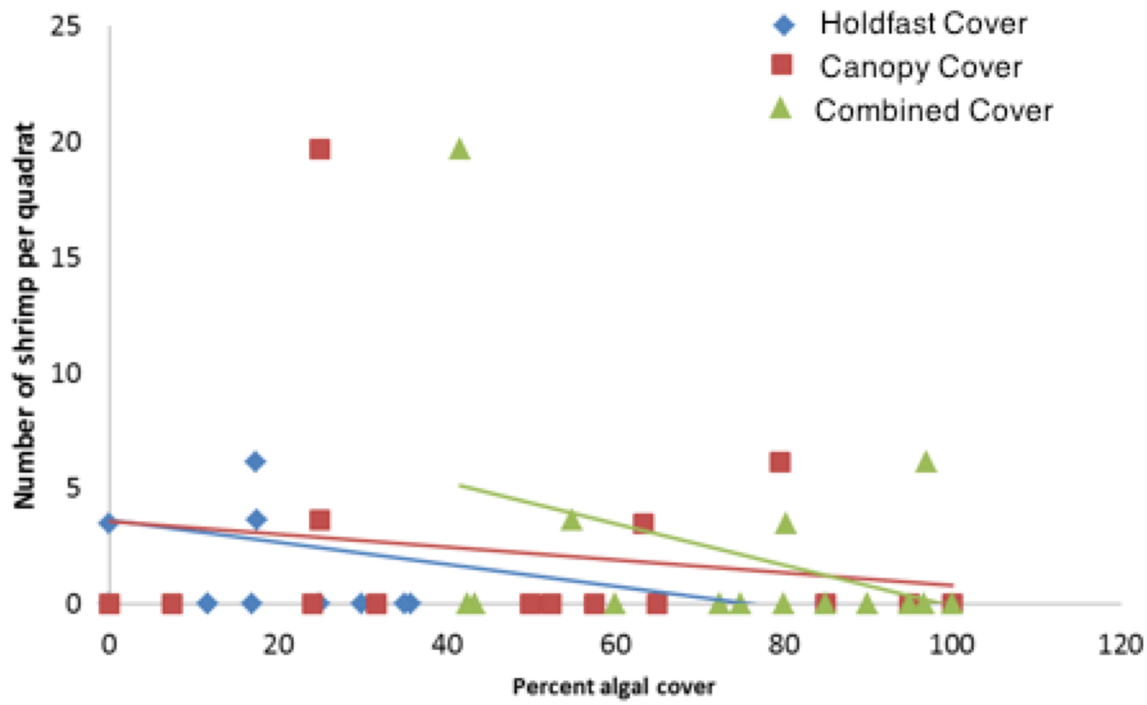


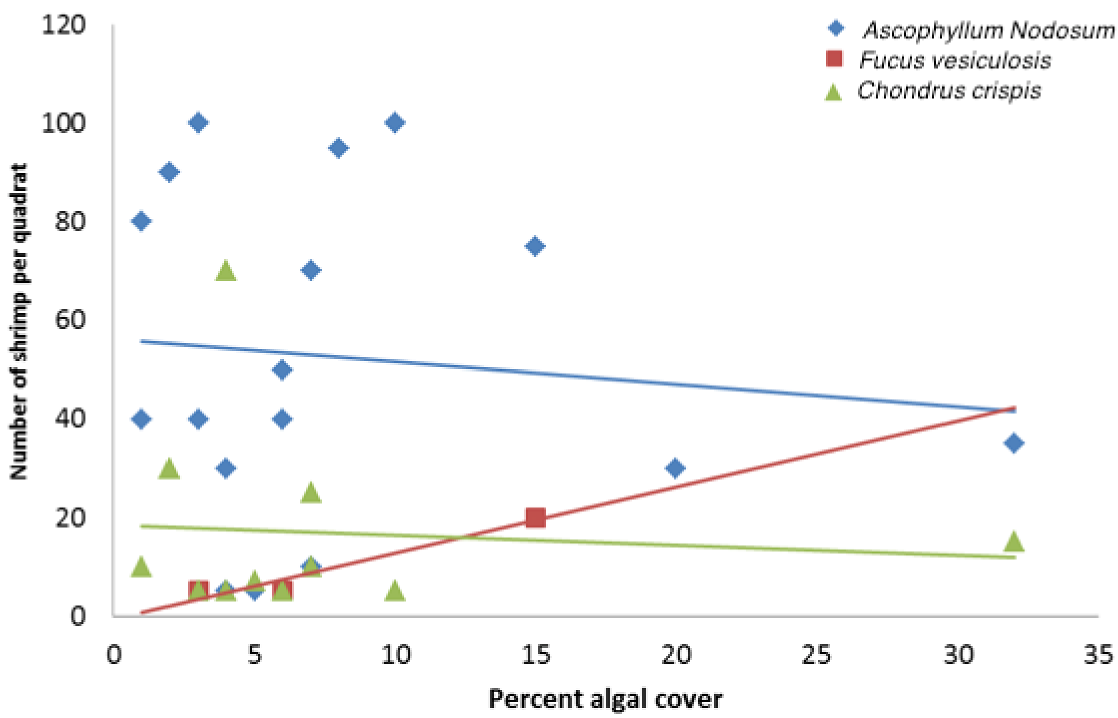
Figure 3- Regression analysis for the number of shrimp found as a function of percent holdfast (p-value 0.78), canopy (p-value 0.67), and combined cover (p-value 0.69). Displays no significance.

Our chi-squared analysis between the most common species of algae (*Ascophyllum nodosum, Fucus vesiculosis,* and *Chondrus crispus*) displayed a clear preference in *Palaemonetes* for brown algae over red algae. Both *Ascophyllum nodosum* and *Fucus vesiculosis* showed a significant correlation (p-values of 0.019 and 0.049 respectively) while *Chondrus crispus* showed no such association (p-value of 0.571) (table 2). A regression analysis was used to determine if the number of shrimp increased with increased levels of brown and red algae cover which did not show significance (fig. 4). Both *Ascophyllum nodosum* and *Chondrus crispus* had a slight negative trend and were very statistically insignificant (p-values of 0.64 and 0.69 respectively). In contrast, *Fucus vesiculosis* showed strong positive correlation but also did not show significance (p value of 0.53).

	Chi-square statistic	p-value
Ascophyllum nodosum	5.47	0.019

	Chi-square statistic	p-value
Chondrus crispus	0.32	0.571
Fucus vesiculosus	3.88	0.049

Table 2- Chi-squared statistic and p-value results of Chi-squared analysis for the association between shrimp and various algae species. Displays significance for brown algae (*Ascophyllum nodosum* and *Fucus vesiculosus*) but not for red algae (*Chondrus*



crispus).
Figure 4- Regression analysis Regression analysis for the number of shrimp found as a function of percent *Ascophyllum nodosum* (p-value 0.64), *Fucus vesiculosis* (p-value 0.53), and *Chondrus crispis* (p-value 0.53). Displays no significance.

These results could mean a couple different things: First, *Palaemonetes* shrimp in coastal tide pools in New England do not consume algae as their primary food source or that they depend on the algae so little that they are not correlated with high algal cover. Second, Unlike in other habitats such as salt marshes, *Palaemonetes* shrimp are not dependent on the algae for refuge from predators and therefore are not directly correlated with high percent algal cover. However, our chi-squared analysis did determine that *Palaemonetes* shrimp do prefer brown alage (phylum *Phaeophyta,* species *Ascophyllum nodosum* and *Fucus vesiculosis*) over red algae (phylum *Rhodophyta,* species *Chondrus crispus)*. Future research will be necessary to determine what characteristics of brown algae the shrimp prefer and whether they use the brown algae as food or as refuge. This research is important because it focuses on an important genus of shrimp in a novel research environment. However, it was conducted by a single student and only on two samples dates in the months of September and October.. Therefore, more research is necessary to determine whether there is a relationship between *Palamonetes* shrimp and percent algal cover and even the more basic functions of how these shrimp adapt to live in the rocky intertidal.

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