The Effect of *Ulva intestinalis* on Crab Abundance

Matthew R. Smith
Department of Biology, Clark University,
Worcester, MA, 01610 USA
(masmith@clarku.edu)

Abstract Organisms have developed a variety of deterrents to predation since the beginning of life. One such adaptation is the use of algal refuges by crabs to avoid predation. Crab abundance was calculated at sites where *Ulva intestinalis* was present and absent; the algae was then transplanted to determine if any immigration or emigration occurred by the crab species. The number of crabs found in areas without *U. intestinalis* was higher than in areas that contained *U. intestinalis.* It was concluded from the experiment that *U. intestinalis* does have a significant negative effect on the number of crabs present, and thus is not considered an algal refuge. Possible superior methods to evade predation are discussed, including morphological traits and habitat choice.

Key Words: *predation* – *refuge* – Ulva intestinalis

Introduction

Predation is a key biological interaction between species where one species, the predator, feeds upon the other species, the prey. This type of interaction is seen all over the world in a variety of different ecosystems. To combat being killed prey species have evolved and adapted in order to survive. The green crab (*Carcinus maenas*) has a variety of morphologies, including changes in carapace patterns and widths that denote crypsis (Todd et al. 2005). These morphologies correspond to the specific environment in which the crab resides; that is crabs with patterns on their carapace are found in mussel beds while plain crabs can be found in algal refuges (Todd et al. 2005). Another way in which crabs avoid predation by birds is through the use of algal refuges or rock crevices (Moksnes et al. 1998). By settling in areas with increased algal cover crabs mortality rates are lower than in areas of open sand (Moksnes et al. 1998).
A particular species of algae, *Ulva intestinalis*, thrives in the intertidal zone of Nahant, Massachusetts. This alga was found to cover many rocks along the shore, and was seen in a variety of tide pools. Since it is known that crabs take refuge in alga beds, the question of whether crabs used *U. intestinalis* for hiding spots was raised. Thus it was hypothesized that an increased number of crabs would be found in tides pools that contained *U. intestinalis* compared to tide pools that did not contain the algae.

Materials and Methods

Study Organisms: Three species of crabs were observed during the study: The Green Crab (*Carcinus maenas*), the Rock Crab (*Cancer irroratus*), and the Jonah Crab (*Cancer borealis*). These crabs are found in the lower intertidal and subtidal zones, usually submerged under rocks in or outside of tide pools (Pollock 1998). These crabs feed on muscles and snails (Pollock 1998; Donahue et al. 2009). Predators of these

crabs include: shrimp(*Crangon crangon)*, fish, cannibalistic crabs, and gulls (Hedvall et al. 1998; Donahue et al. 2009).
The other species studied during this experiment was the alga *Ulva intestinalis*. Green in color this organism also resides in the intertidal zone, on the sides or top of rocks, and on the edges of tide pools. An ephemeral alga that is grazed on by snails, including Littorina littorea (Trussell and Ewanchuk 2004).

Study Site: This experiment was conducted on September 15th and October 26th 2012 in Nahant, Massachusetts (+42° 25' 8.80", -70° 54' 22.85"). A rocky intertidal region with a variety of marine species, tide pools, and large rock walls (Figure 1).

Figure 1.

A photograph of the study site in Nahant, Massachusetts.

Experimental and Observational Methods: The study was performed on two separate occasions between September and October of 2012. Initial observations of five tide pools that contained *Ulva intestinalis* and 5 tide pools that did not contain *U. intestinalis* were made between September 15th and October 26th. Crabs were removed from the tide pools, placed into collecting dishes, and were identified to species and counted. Crabs were placed back into the tide pools after the counting had been completed. *U. intestinalis* was removed from the tide pools where it was initially present, collected from rocks, and placed into garbage bags. The samples were then transplanted to tide pools where *U. intestinalis* originally was absent. One hour was allotted to go by. The number of crabs in tide pools where *U. intestinalis* was added and removed was then counted again and recorded as previously stated. A total of five tide pools with *U. intestinalis* present and five tide pools with *U. intestinalis* absent were used during this study.

Results and Discussion

It was determined that *Ulva intestinalis* does influence the number of crabs found in areas with *U. intestinalis.* The amount of crabs found in tide pools that did not contain *U. intestinalis* was greater than tide pools that did contain *U. intestinalis* (Figure 2).

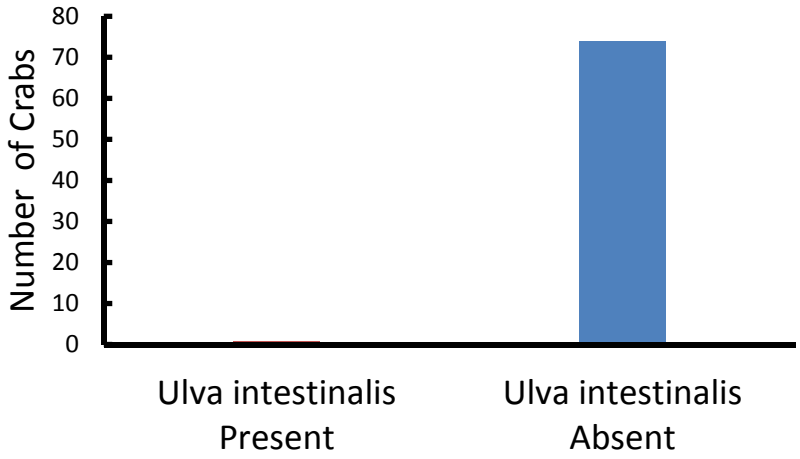

Figure 2

Total number of crabs found in tide pools where *Ulva intestinalis* was present and where *U. intestinalis* was absent.

Moreover, when *U. intestinalis* was moved from tide pools no significant immigration or emmigration of crabs occurred (Figure 3).

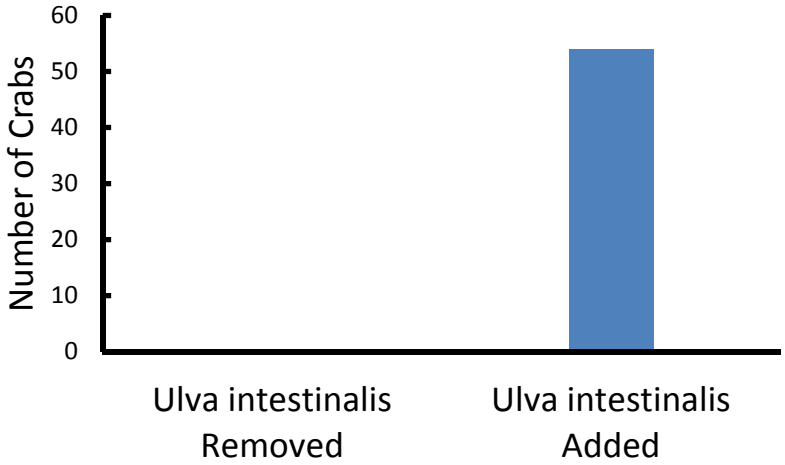

Figure 3.

Total number of crabs found in tide pools where *Ulva intestinalis* was added and where *U. intestinalis* was removed after 1 hour.

The number of crabs compared between the control and experimental data showed a significant negative correlation (P value < .01), leading to the conclusion that *U. intestinalis* is not an algal refuge. A statistical T-Test was completed along with a Student T-Distribution test to test the significance.

Algal refuges are not the only resource crabs use in order to avoid predation. As previously stated many morphological traits have been developed by crabs to be concealed from predators (Todd et al. 2005). In this particular area of the Atlantic Shore it may be advantageous for crabs to rely more on their physical appearance than hiding in algal refuges. This coincides with many of the crabs found in tide pools were completely submerged underwater underneath large or medium sized rocks (closely resembling the color and shading of their habitat). This suggests that crab species choose structurally complex habitats to reside in to avoid predation, which matches their morphologies (Hedvall et al. 1998).
Furthermore, *U. intestinalis* that resided on the sides of tide pools may have not been large enough to completely hide the crabs from predation. The tide pools that contained *U. intestinalis* were also located in areas with high concentrations of bird waste. This suggests that many birds frequent this area of the intertidal; because birds are a large predator to crabs it would be beneficial to avoid these areas (Hedvall et al 1998; Donahue et al. 2009). Overall the location that crabs are found can vary dramatically but are heavily due to factors based on predators, and the crabs own survival.
Future research on algal refuges and predation on crabs could include focusing on a specific species of crab in the intertidal zone, and observing its abundance and location across a variety of habitats. This could potentially lead to more knowledge on algal species that make up algal refuges, and the types of species that reside in them.

Acknowledgements

I would like to thank Professor Livdahl and Robertson for taking our class to Nahant, Massachusetts. I would also like to thank my fellow students who helped with my experiment.

Literature Cited

Donahue, Megan J., Nichols, Allison, Santamaria, Carlos A., League-Pike, Paloma E., Krediet, Cory J., Perez, Kestrel O., Shulman, Myra J. 2009. Predation risk, prey abundance, and the vertical distribution of three Brachyuran crabs on Gulf of Maine shores. *Journal of Crustacean Biology*. 29(4): 523-531.

Hedvall, Ola, Moksnes, P. O., Pihl, L. 1998. Active habitat selection by megalopae and

juvenile shore crabs *Carcinus maenas*: a laboratory study in an annular flume. *Hydrobiologia.* 375/376: 89-100.

Moksnes, P. O., Pihl, L., van Montfrans, J. 1998. Predation on postlarvae and juveniles of the shore crab *Carcinus maenas*: importance of shelter, size and cannibalism. *Marine Ecology Project Series.* 166:211-225.

Pollock, Leland W. *A Practical Guide to the Marine Animals of Northeastern North America*. Rutgers University Press, North Carolina. pp. 261-262.

Todd, P. A., Briers, R. A., Ladle, R. J., Middleton, F. 2005. Phenotype-environment matching in the shore crab (*Carcinus maenas*). *Marine Biology.* 148:1357-1367.

Trussell, Geoffrey C., Ewanchuk, Patrick J. 2004. Trophic cascades in rocky shore tide pools: distinguishing lethal and nonlethal effects. *Oecologia*. 139: 427-432.