Predator Response to *Acmaea mitra*, an Observational Study

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Introduction

The duncecap limpet, *A. mitra*, is a specialist limpet found in low rocky intertidal zones that feeds specifically on encrusting coralline and whose outer shell also harbors this alga. In the Pacific Northwest, there are three genera of coralline: *Lithophyllum, Pseudolithophyllum,* and *Lithothamnion*. However, even the most educated ecologists have a difficult time distinguishing between them, so coralline algae are commonly referred to as "lithothamnia". *A. mitra* is an interesting limpet because in all studies in which it has been used as a subject, no escape responses to seastars have been recorded for this organism. In a notable paper by Margolin, he experimented with multiple *Acmaea* limpets and found that *A. mitra* had no response whatsoever to thirteen different seastar predator manipulations. Margolin attributed this lack of response to two things. He stated that *A. mitra* "fastens itself to the substratum more strongly…[and] it feeds on coralline algae, a habit which might give it a flavor unpalatable to seastars" (Margolin, 1964).

To expand on this idea, I fashioned this experiment after Margolin's study, but focused directly on *A. mitra* and two common Pacific Northwest seastar predators. The question asked was: will seastars consume *A. mitra* when it is their only available prey choice? After careful research on this topic, I hypothesized that seastars would avoid the limpets because of their close relationship with coralline algae, but eventually target and consume those whose shells were relatively free of this alga and were of small stature.

Materials & Methods

Twenty *Acmaea mitra* were collected on July 18, 2008 from North Cove and Middle Cove, Cape Arago. They had varying coralline algae cover on their shells and were of different sizes and heights. The limpets were allowed to settle into their new surroundings in the water tables for two days after initial collection. It was observed during this time period that the limpets moved around their secluded container and settled on the rocks that I provided for them. None of them were flipped or turned over. On Monday July 21, all twenty specimens were placed into a secluded portion of the water table in a large circle surrounding two *Pisaster ochraceus* predators. Initial observations were recorded and new observations were made every 24 hours. Each time *Acmaea mitra* were turned over by the predators, their measurements were taken in centimeters and their approximate coralline algae percent cover was noted. On Thursday July 24, one *Pycnopodia helianthoides* was added to the secluded habitat and additional observations were made over the following days. A plate limpet, *Lottia scutum*, was added to the habitat in the evening of Friday July 25, and additional observations were made. This limpet was introduced into this experiment to test the aggressiveness of the predators and determine if this was a confounding variable in the study. The experiment was ceased on Saturday July 26 in the mid afternoon and the living duncecap limpets were returned to their natural habitats.

Results

Entering day two of this experiment, one *A. mitra* had been turned on its back by *P. ochraceus*. The limpet had a relatively small percent cover of coralline algae present on its outer shell and was 2.6 cm in diameter. The following day, two more limpets were turned over who also had little coralline cover on their shells. The diameters of these limpets were 3.1 cm and 1.0 cm. Between the observational visits made on July 24 and July 25, the limpet that was first flipped over perished for unknown reasons, leaving 19 *A. mitra* in the habitat. Although *Pycnopodia helianthoides*, an aggressive predator, and one *Lottia scutum* were introduced into the experiment, no limpets were consumed over the six days of observation. (Figure 1)

Discussion

According to the results, the hypothesis for this study was not supported. The three limpets that were overturned by the seastars did have a small percentage of coralline algae covering their shells, but there were other *A. mitra* present that had little or no algae growing on them and remained untouched. Also, none of the limpets were eaten for the duration of the experiment. Although there was little data to come to a confident conclusion about a prey size preference of the seastars, the diameter measurements of the three limpets that were turned over suggest that there was none.

After analyzing the results, I believe that there are several reasons why no *A. mitra* were consumed. As a red alga, coralline naturally contains bromophenols, making it unattractive to predators. One of the only known beneficial associations between this alga and other organisms occurs with *A. mitra*. Light grazing by this specialist limpet prevents the algae from being completely overgrown by diatoms and other competitive algae. The mere presence of lithothamnia on the shells of these limpets may have deterred *P. ochraceus* and *P. helianthoides* from preying on them, suggesting a possible commensal relationship between *A. mitra* and encrusting coralline.

Additionally, a study done on coralline algae revealed that secondary metabolites extracted from this alga were shown to generally deter organisms. This same paper went on to state that "in marine systems, predation pressure is commonly high on small grazers and can select for specialization on chemically defended plants in order to reduce encounters with, and susceptibility to, predators" which is what I believe is ultimately affecting seastar aggressiveness, or lack thereof, toward *A. mitra* (Stachowicz & Hay, 1996).

Duncecap limpets may be chemically defended beyond the presence of coralline algae on their outer shells. None of the seastar predators pursued the limpets after they were overturned. This could indicate that *A. mitra* is possibly harboring a percentage of the aforementioned unattractive chemicals within its body cavity to ward off predators.

A possible source of error in this experiment may have arisen from the seastars used. I did not collect the two *P. ochraceus*, so I do not know if they came from a habitat shared with *A. mitra* which could ultimately affect the responses of the seastars to this particular limpet. I did collect the *P. helianthoides* from North Cove, a setting where many *A. mitra* live, but it autotomized a leg when I placed it into the water table, signifying that it was deeply stressed by frequent relocations. All of the predators may have also been physically full. To test this, I placed one *Lottia scutum* into the habitat with all three seastars. After 24 hours, it had not been eaten. From this behavior, I can confidently consider predator satiety as a confounding variable in this study.

For further research, I would like to introduce more species of seastars from habitats shared and unshared with *A. mitra* and coralline algae to determine if this has an effect on predator and prey relations. Also, I believe that testing the body cavities of *A. mitra* to investigate their chemical composition is very worthy of exploration.

Figure 1

Quantitative and qualitative results displaying the noted observations per day, diameter measurements of flipped *A. mitra*, and percent cover of coralline algae on shell tops of those turned over. Predators and prey available differed throughout the experiment and none were removed from the habitat unless they died.

Observation Day	Predators Present	Prey Present	Number of Limpets Turned Over	Diameter Measurement(s)	Percent Cover of Algae	Number of Limpets Eaten
Monday July 21, 2008	2 *Pisaster ochraceus*	20 *Acmaea mitra*	0	N/A	N/A	0
Tuesday July 22, 2008	2 *Pisaster ochraceus*	20 *Acmaea mitra*	1	2.6 cm	10%	0
Wednesday July 23, 2008	2 *Pisaster ochraceus*	20 *Acmaea mitra*	2	3.1 cm 1.0 cm	15% 0%	0
Thursday July 24, 2008	2 *Pisaster ochraceus* 1 *Pycnopodia helianthoides*	20 *Acmaea mitra*	0	N/A	N/A	0
Friday July 25, 2008	2 *Pisaster ochraceus* 1 *Pycnopodia helianthoides*	19 *Acmaea mitra* 1 *Lottia scutum*	0	N/A	N/A	0
Saturday July 26, 2008	2 *Pisaster ochraceus* 1 *Pycnopodia helianthoides*	19 *Acmaea mitra* 1 *Lottia scutum*	0	N/A	N/A	0

Works Consulted and Cited

Margolin, Abe S., 1964. A Running Response of Acmaea to Seastars. Ecology. 45: 191-193.

Stachowicz, John J., and Mark E. Hay, 1996. Facultative mutualism between an herbivorous crab and a coralline alga: advantages of eating noxious seaweeds. Oecologia. 105: 377-387.