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Exploratory 2

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Differential responses based upon size of the Plate Limpet, *Lottia Scutum,* to two predators, *Pycnopodia helianthoides* and *Pisaster ochraceus*

Introduction: Limpets are an intertidal species of gastropod that can be found along most coast lines across the world, and the coast of west North America is no exception. There are multiple species of limpets that live along the coast, one of which is the plate limpet. The plate limpet can be found from Alaska to Baja Mexico and usually occurs from the high to low intertidal (Sept 1999). They have made a living off of grazing plants and algae off the surface of rocks and other hard substrates, and their simple design allows them to be incredibly efficient at this. Limpets have been shown to significantly decrease the level of plant biomass in a region, and in some cases they are so effective at this they can become the limiting factor for how high up the intertidal can grow (Underwood et al. 1980). They are resistant to desiccation and are easily found on rocks in the intertidal. Because they are relatively slow moving animals, predation becomes a strong selection factor. The plate limpet, *Lottia scutum,* has been shown to do this in a number of ways. The home scar is one common defense mechanism, by finding or making a scar in the rock that the limpet can suck its self to a substrate so a predator and the predator will pass over the top(Iwasaki, 1993). This can cause problems if the shell of the limpet grows larger than to scar, if it is caught out on a foraging trip from away from the scar. When studying the predatory defense behavior of the plate limpet it would only be logical to look at what is a natural predator. The *Pycnopodia helianthoides* and the *Pisaster ochraceus* are both common predators of the plate limpet and based on this there should be a behavioral response to avoid the predator (Bros 1986). This leads to the question of what does the limpet do if it encounters a predator while away from the home scar, and does age or size of the limpet affect the way it can or will respond. I hypothesized that the plate limpets will respond to a predator and that in the absence of a home scar they will exhibit a response of trying to outrun the predator, further I hypothesized that the larger the limpet, the faster it will be able to move.

Materials and methods: The limpets were all collected at a single time and place. During a low tide, in the morning I collected 15 limpets, *Lottia scutum*, at Sunset Bay, in Cape Arago State Park, Coos County, Oregon. These individuals were selected based on variation in size. I selected some limpets that were as large as I could find and also some that seemed to be small individuals. These were pulled off the rock and transported back to the Oregon Institute of Marine Biology in a plastic bag. The stars that were used in the study were both taken from the open tank room at the IOMB.

Once they were back in at the campus the limpets were placed in an open tank with 4 inches of water that was continuously running. They were placed in the tank for 24 hours to acclimate to the new setting. Then the next day all the limpets were lined up on 1x.25m piece of Plexiglas. On this Plexiglas

there is a 1x1cm grid on it so the movements can b e measured. The limpets were left for 40 min, and their location and movement was noted on 10 min intervals.

Each of the following trials was run with no less than 2 hours between the times that the limpets were used. This was to get the limpets back to a state where they were not excited by the presence of a predator.

Two times the four largest limpets were lined up next to each other near the origin of the graph on the Plexiglas. The limpets were always placed with the anterior end on the reference line. They were set on plate for one minute, out of water, so placement could be more exact. After one minute the plate was submerged in the water table for an additional one minute. These two minute rests were set aside so that the limpets would be less stress and in a more natural mindset. After the two minute acclamation period a *Pycnopodia* was placed with one of its legs touching at least one limpet. In each of the trials the star was placed on the anterior side of the limpet. The limpets and the star were left undisturbed in the tank for time varying from one to two and a half minutes. Time was based on time needed to elicit a response from the limpet and was usually stopped when the star got on top of the limpet and started to ingest the limpet. The direction moved and total distance moved was recorded. This was immediately repeated with the four smallest limpet individuals that were collected.

All of these procedures were repeated twice with the small set of limpets with the *Pycnopodia* and the *Pisaster* and repeated twice with the large set of limpets for both the *Pycnopodia* and the *Pisaster.*

Results: The control for this experiment was a measure of how much a limpet would move over a given time period if there is no predator present. Was shown to be quite variant, and the maximum speed that was observed the limpet covered 7cm in a matter of 10 minutes, meaning it could at approximately 42cm per minute. During the given time period only three limpets made any movement and their movements are tabulated below:

Distance traveled by Limpets without predator present:

Distance from Origen at time:	10min	20min	30min
Limpet 1	7cm	7cm	7cm
Limpet 2	0cm	.5cm	.5cm
Limpet 3	0cm	8.5cm	8.5cm

The Limpets were then measured based both upon the surface area of the ventral surface of the shell and the size of the foot. All of the 15 limpets were tabulated and the largest and smallest four were then used for the trials using predators. The sizes of the 8 limpets used in the trials are tabulated below:

Limpet groups by size:

Large limpet group, shell size (foot size)	Small limpet group, shell size (foot size)
1) 9.07cm ^{2} (4.33cm)	5) 3.46cm^2 (1.76 cm)

2) 11.94cm² (4.9cm)	6) 4.15cm² (1.539cm)
3) 9.60cm² (2.83cm)	7) 7.06cm² (1.92cm)
4) 10.75cm² (4.9cm)	8) 7.06cm² (2.91cm)

Average distance moved in response to *Pycnopodia:*

Large group: individual) response:	Small group: individual) response
1) 0cm	5)11.9cm
2)7cm	6)10.8cm
3)9cm	7)7.9cm
4).5cm	8)2.69cm

The distances reported above are the average of the two distances traveled, and the greatest distance that was traveled in response to the star was by individual number 2, when in the first trial it traveled approximately 16cm. in the second trial It only traveled less than a centimeter before the trial ended. The smallest of the limpets, number 5, was the most active, in the sense that in both trials with the *Pycnopodia* present it moved at least 9 cm. In each of the four total trials at least one individual did not move at all, and there was great variance in the direction of movement. Approximately half of the time the limpet would just move toward the predator, based upon it was already facing the predator. The other half of the individuals would turn in place and move away from the predator.

The results concerning the movement of the limpets in response to the *Pisaster* are tabulated below.

Average distance moved in response to *Pisaster:*

Large group: individual) response:	Small group: individual) response
1)0	5)1cm
2)0	6)1cm
3)4cm	7)0cm
4)1cm	8)2.5cm

Overall the limpets responded less to the *Pisaster* than they did for the *Pycnopodia.* In these trials the limpets barley moved at all over the given time period, but there was a response in the type of movement. Three of the four limpets that moved, excluding number 6, turned before moving, so they were oriented away from the predator both times.

Discussion: Overall there seems to be little evidence for a difference in the rates of locomotion, particularly in response to a predator, based upon differences in size of individuals. In fact, the smallest of the limpets, number 5, seemed to move the most and fastest. Following that, the next fastest were in the large group, being individuals 3 and 4. This data seems to be quite inconclusive, showing no link between the size of the limpet and the rate at which it could or did move.

If this experiment could be redone it could be done in a way that may have gotten some more conclusive data. First, the test population was far too small. By having one individual that is outside the norm for all of the other leads to the idea that with a larger sample population the data could show a

larger trend instead of having some very different results between the individuals. The next thing that could be done is video the response of the limpets so the path they take and the rate they traveled could be more easily followed. Also by exposing only one limpet at a time to the predator, instead on four at a time more exact results could have been obtained.

Sources cited

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