Exploratory 1:

A Structural Comparison of the Peduncle Thickness of Inner Colony *Pollicipes Polymerus* vs. Outer Colony *Pollicipes Polymerus*

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Introduction:

Pollicipes polymerus, or more commonly called the goose neck barnacle, is an intertidal cirripede that lives attached to rocks in very exposed shores, forming dense aggregations (Molares, 485). It reaches sexual maturity at approximately five years and is believed to be able to live for up to 20 years. In it's larval stage, P. polymerus is a free swimming animal. As it matures it attaches to a rock that will provide it with fairly constant water flow and ample food supply. This is obviously the most pivotal transition of the Barnacles life cycle as mortality among larvae is high.

P. polymerus is found on the North American west coast and is characterized much like the other two Pollicipes species, *P. pollicipes* and *P. elegans,* in that is has a well developed capitulum harboring an average of more than five calcified plates on either side. These plates are used to protect the soft inner organs and to house the feeding mechanism of the barnacle. *P. polymerus* is a filter feeder and so it utilizes an aparatus made of cirri as a net to filter out small organic matter from the backwash of wave splash. It is for this reason that they inhabit crevaces and channels where water is directed after waves crash.

P. Polymerus is also characterized by a tough, leathery peduncle composed of a soft inner integument and a hard caliced exterior skin. (Molares, 485). This barnacle is often found in aggragations combined with the Californian muscle, *Mytilus californianus* (Wooton,196) and can range from only a few mm in it's larval stage to around 15cm as an adult (Sept, 107). The *P. polymerus* is a resliant species able to withstand heavy wave action during high tide and resist dessication during low tide. P. polymerus, as mentioned, aggregates in very dense colonies and so competition for space within the colonies is very high (Wooton,199). The more central members of the colony will grow taller in order to out compete neighboring barnacles, but what is the structural advantage of being an outer member of the colony? I hypothesixze that the outer members of the colony develop thicker peduncles than the inner members in order to withstand the brunt of wave action and to resist predation.

Methods:

To test my hypothesis I collected 20 *P. polymerus* from a single colony (colony A) located on a rock at Lighthouse beach. This colony was in a mid-intertidal zone with heavy splash during high tide and a fair amount of spray during high low tides. It was completely dry during low low tides. Of the 20 individuals 10 were from the center of the colony, no less than three rows from the outer edge and 10 were from the very outer edge of the colony. I then collected a second bunch of twenty individuals from a colony (colony B) on another rock on Lighthouse beach that was in a high-intertidal zone. These barnacles were more sheltered than the barnacles from colony A and experienced far less wave action druing high tide than the colony A barnacles. I used a simple scraping method to remove the barncales,

leaving at least 5mm from the base of the plates to the cut. I then measured across the plates of the barnacles from the rostrum to the carina (shown on diagram 3). I then measured and recorded the width of the peduncles five mm down from the base of the lateral plates (shown in diagram 3). Finally I sliced open the peduncle vertically, scraped it of the gonads measured the width of the remaining muscle and skin (show in diagram 3A). I then recorded all of this data for the individuals of the outer and inner positions of both colony A and colony B (Shown in Table1).

Results:

Once the experiment was concluded and all of the selected *P. polymerus* were measured, the data was charted and graphed. Tables 1 and 2 show the measurements collected from at the three points, the width of the plates, the width of the stalk at 5mm, and the peduncle thickness. The tables also shows the data collected from the different intertidal zones, High (colony B) and mid-intertidal (colony A), at lighthouse Beach. Table 1 shows data collected from mid-colony individuals while table 2 shows data from the outer edge individuals. This data is also displayed in Chart 1 which shows that the outer *P.polymerus* had thicker peduncles than inner individuals in most of the P.polymerus sampled.There were however two points where the outer *P. polymerus* had thinner peduncles than the inner *P.polymerus*, the second and thirteenth individuals having peduncle thicknesses of 1.5mm. There was also seven outer individuals with peduncle thicknesses of 2mm and six inner individuals with the same peduncle thickness.

The results of the experiment are also shown in Chart 2 as the average peduncle thickness of outer vs. inner individuals. The averages in this chart were calculated by adding the thicknesses of each of the inner individuals and each of the outer individuals and then dividing each of these numbers by twenty, the total number of individuals from each location. Chart 2 shows a .7mm difference between the inner and outer *P. polymerus* peduncle thicknesses, the inner individuals having an average thickness of 1.55mm and the outer individuals having an average thickness of 2.25mm.

Conclusion:

Based on the results of this experiment, my hypothesis that *P. polymerus* along the outer edges of the colony would have thicker peduncles than those of the individuals occupying the middle of the colony, was correct. There are several explanations for this result. First of all the environment on the outer edge of the colony is more suseptible to heavy wave action as the middle of the colony is protected by outer *P. polymerus* and often by Californian Muscles. Wave action would encourage the development of a thicker, stronger peduncle which is used for anchoring the barnacle to the colony site. It should be noted that during the collection of the specimens it was observed that the outer individuals of the colony were more difficult to remove than the individuals in the middle of the colony also suggesting a stronger

anchoring system in the outer individuals of the colony. So developing a stonger, thicker peduncle may also play an important role in predation resistance.

Outer members of the colony are more exposed and so predation is probably higher along the outer edges by gulls and other barnacle eaters, but the thicker peduncle of the outer P. *polymerus* makes it tough for a predator, such as a bird, to break through into the body cavity. Another observation made while collecting the specim ins was that the inner *P. polymerus* grow taller in order to out compete neighbors resulting in long thin peduncles which are easily plucked from the surface of a rock. This allows predators to overlook the outer *P. polymerus* and to consume inner barnacles instead. So in this case, the outer *P. polymerus* have adapted to their positions in the colony in a way that is very beneficial for them while inner *P. polymerus* have had to develop competetive advantages over neighboring *P. polymerus* that makes them easier prey for predators.

Althought the outer barnacles are more suseptable to heavy wave action during high tide they are also more suseptible to dessication during low tide. The inner members of the colony are able to harbor water during low tide between their tightly nestled bodies and are less expose as they are surrounded by other individuals. On the other hand , outer P. polymerus are not as densely surrounded by other individuals and so their ability to hold onto water has adapted into finding ways to avoid evaporation. By having a thick peduncle water can be saved during low tide as evaporation is slowed thorugh the peduncle because of it's thickness.

Overall the *P. polymerus* individuals in the middle of the colony are more protected by other *P. polymerus* and Californian Muscles and so the develoement of a thick peduncle is not necessary. The outer barnacles of the colony, despite living only a few centimeters from inner individuals, experience a much harsher environment and have had to adapt. The outer *P. polymerus* need protection from waves, predation and dessicatoin and so the development of a thick peduncle is very beneficial. Some of the error in the experiment may have been because I was unable to age the specimens . The variation in peduncle thickness among individuals of the same are in the colony is most likely due to the age of the barnacle. Individuals were chosed based on similar plate widths but this did not show how old the barnacles were. Some of the thinner outer *P. polymerus* may have been younger barnacles and some of the thicker inner *P. polymerus* may have been older barnacles. Another area of error was the precisoin of measurment was not as great as it maybe should have been. While measuring the individuals a more precise measurment would have been more conclusive as the diferrence in thickness was very small and the actual thickness of the peduncle was also very small. A more precise measurment would have shown a relatively greater difference between outer and inner *P. polymerus.* In conclusion the majority of outer *P. polymerus* did in fact have thicker peduncles than the majority of mid-colony *P. polymerus,* just as I had hypothesized.

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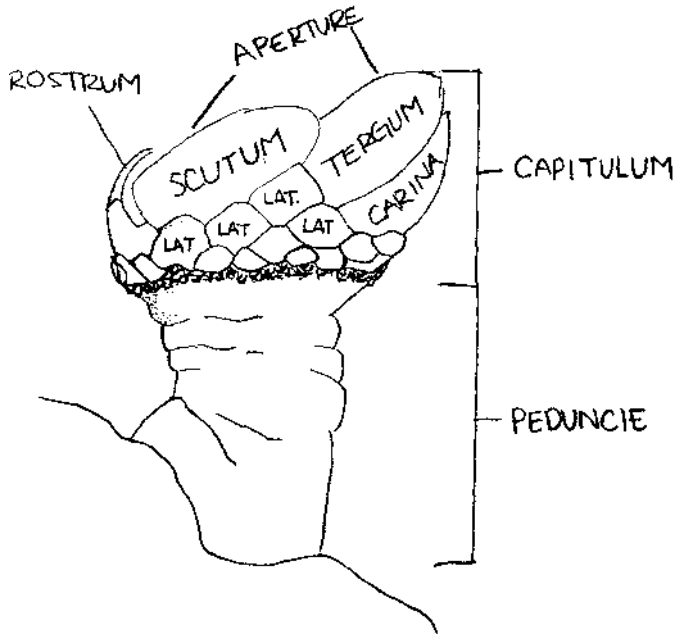
DIAGRAM 1



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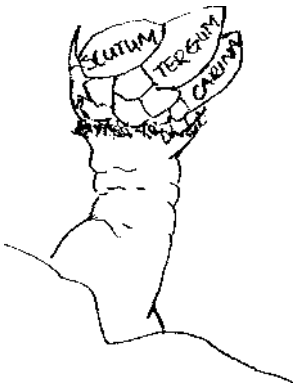

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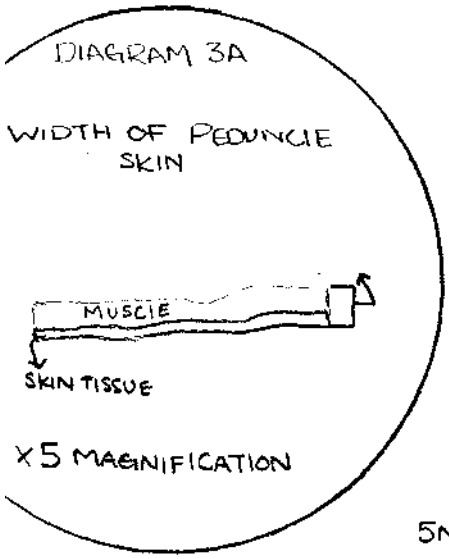

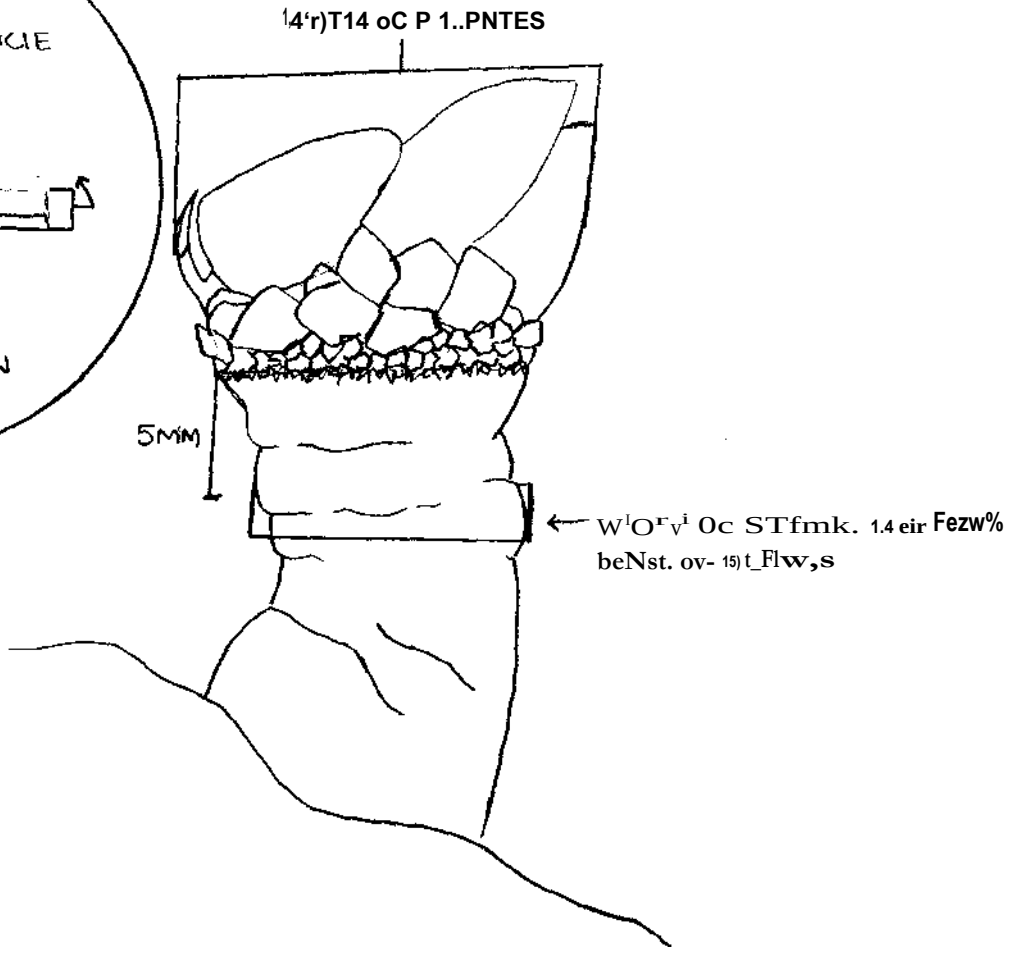

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Table 1: Data Collected From Gooseneck Barnacles; **Middle Colony**

Member #	Width of Plates (mm)	Width of Stalk 5mm from Base of Plates (mm)	Peduncle Thickness (mm)
Lighthouse Beach High Intertidal			
1	19	8.5	I
2	19	7	1
3	21	10	2
4	18.5	7.5	1
5	20	10	1.5
6	20	8	1
7	20	9.5	1.5
8	21	9	2
9	22	11.5	1.5
10 *Lighthouse Beach Mid-Intertidal*	20	9	1.5
11	17.5	7.5	1
12	18	7	1.5
13	18	8	2
14	16	6	1.5
15	14.5	5.5	1.5
16	18.5	6	1.5
17	17.5	7	1.5
18	17	7.5	2
19	18.5	8	2
20	17	7.5	2

Table 2: Data Collected from Gooseneck Barnacles; **Outer Edge Colony**

Member #	Width of Plates [redacted]	Width of Stalk 5mm from Base of [redacted]	Peduncle Thickness (mm)
Lighthouse Beach High Intertidal			
1	16	7.5	2.5
2	17	10	1.5
3	19	11.5	2
4	20	8.5	2.5
5	MA ItDS)	6	2
6	21	10	2.5
7	20	9	2.5
8	18	9	2
9	17.5	8.5	2.5
10 *Lighthouse Beach Mid-Intertidal*	18.5	7	3
11	21	9.5	2
12	17.5	9	2
13	21	6.5	2.5

14	19.5	8	1.5
15	19.5	9	2
16	19	9	2.5
17	18	8.5	2.5
18	19	8.5	2.5
19	19.5	9	2.5
20	19	8	2

Chart 1:

Peduncle Thickness of P. Polymerus: Middle of the Colony vs. Outer Edge of the Colony

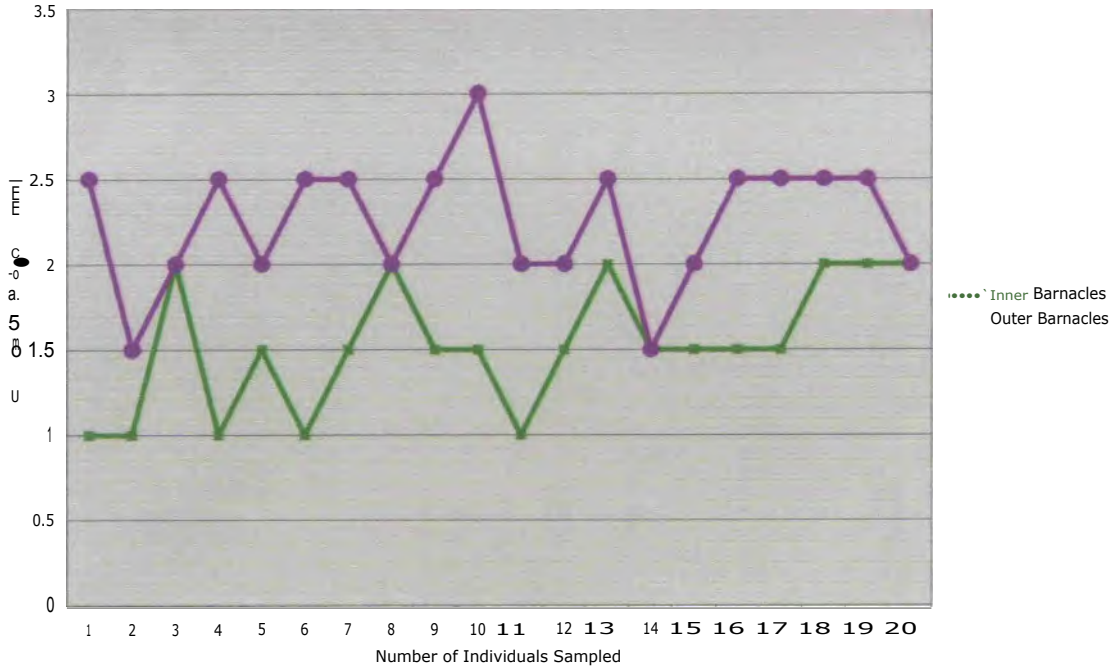
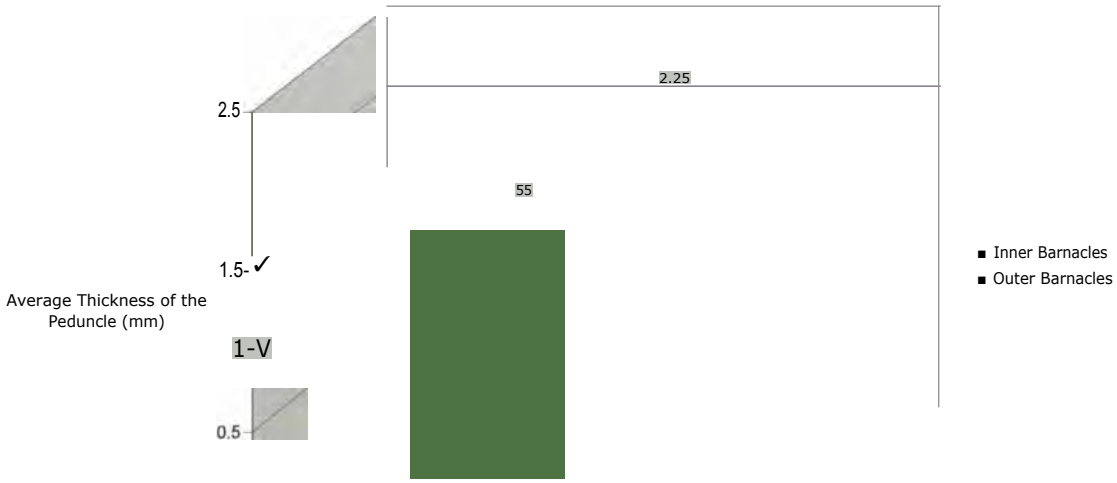


Chart 2:

The Average Thickness of the P. Polymerus Peduncles: Inner Barnacles vs. Outer Barnacles



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