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Adaptations of Marine Animals
Exploratory # 1
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Cheliped Force in *Cancer productus* and *Cancer magister.*

Introduction

Cancer productus and *Cancer magister* are two crabs common to the Pacific Northwest. They both feed on several species of Bivalves and rely on the force of their chelipeds to access their prey. The development of powerful chelipeds is a beneficial trait to both of these species because it allows them to break open larger sourced of prey. The *C. productus* or Red Rock crab lives in the low rocky intertidal to depths of 79m. The *C. magister or* Dungeness crab lives in the low intertidal as well but mostly on sandy bottoms and can live as deep as 230m. The Red Rock crab much thicker shell than the Dungeness crab and in comparing a Red Rock crab to a Dungeness crab of similar size the Red Rock has obviously larger chelipeds and what appears to be a thicker shell. The question I am looking at is does this thicker shell and larger chelipeds allow the *C. productus* to have a more powerful cheliped in comparison to a similar sized *C. magister?* This is important to look at because it could allow the Red Rock crab access to better, larger food sources and it could potentially out compete the Dungeness crabs in shared habitats. My Hypothesis is that the thicker shell and larger chelipeds in *C. Productus* allow it to create more pinching force than a C. *Magister* of similar carapace width.

Methods

To begin both species of crabs were collected from the shore using crab rings baited with rockfish, flounder or salmon. Two of each species of similar carapace width were collected and used for testing. The crabs were kept in a divided water table supplied with constant freshwater and air.

Two different tests were used to determine the cheliped. First, the crabs were tested to see which species could open a larger *Mytilus californianus* and second, the crabs were encouraged to compress an aluminum matrix with one of their chelipeds. Over a period of a week the crabs were fed different sized *Mytilus californianus* to try to find the largest size of muscle each crab could open. The width and height of *M californianus* were measured across the middle of the shell and length was not measured. The crabs were first fed large *M californianus* and if these were not broken a smaller shell was given the next day. After a week of feeding the largest muscle that was opened by each crab was recorded.

The second test was used to try to measure cheliped force through the compression of an aluminum matrix. The crab was removed from water and encouraged to compress the aluminum then the distance of the indentation was measured at its midpoint with a pair of calipers. Several other items were also tested, such as clay, high-density Styrofoam and wooden dowel-rod but they were either too soft and were completely crushed or too hard and created poor data.

Results

Table 1

	Species			
	C. *magister A*	C. *magister B*	C. *productus A*	C. *productus B*
Largest Muscle Opened	1.08X 1.32	.92X1.55	.89x1.25	1.78X1.51

Table 2

		Cheliped Dimensions			
		C. magister A	*C. magister B*	*C. productus A*	*C. productus B*
Propodus	Height	2.42	2.5	2.77	3.19
	Width	1.37	1.32	1.52	2
	Length	6	6.07	6.51	7.18
Dactyl	Length	3.48	3.55	2.7	3.55

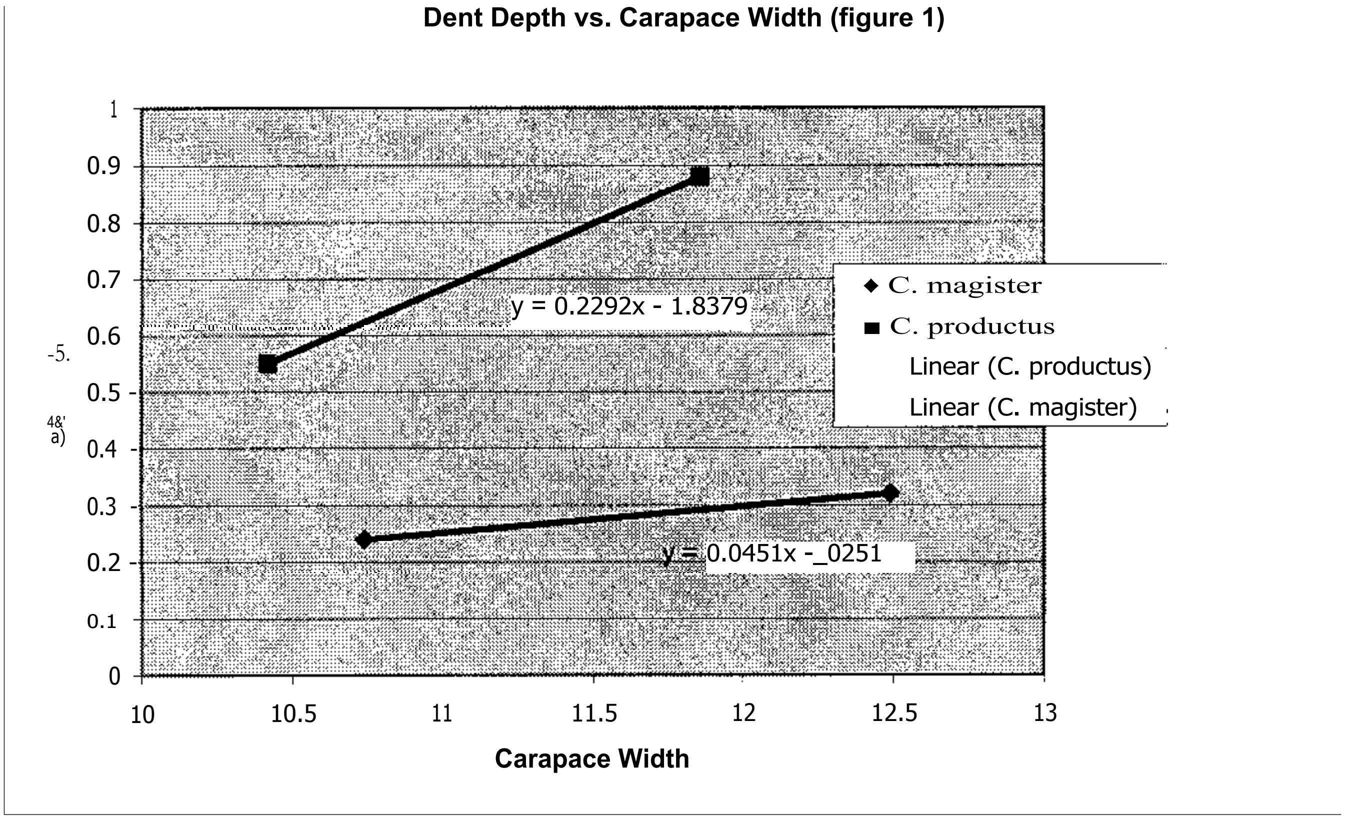

Table 1 shows the largest *M californianus* that each crab was able to crush. There is no real trend here because *C. magister* A was able to open a larger muscle than *C productus* A and *C productus* B opened a larger muscle than C. *magister* B. Table 2 shows the dimensions of the right cheliped of the crabs in the test and it shows that *C productus* has larger dimensions in all cases excluding the dactyl length. Figure 1 shows the relationship between carapace width and the depth of the dent created by the crab. *C productus* has a higher ratio than *C. magister* in the crabs that were measured.

Conclusion

The data above allows several conclusions to be drawn. First the *C. productus* has larger chelipeds than *C. magister* for similar sized individuals; even the smallest *C. productus* had larger propodus dimensions than the largest *C. magister.* The information gathered in the muscle feeding does not create any obvious conclusions. Although the large *C. productus* opened the largest muscle recorded the smaller *C. magister* opened a muscle larger than the one opened by the *C. productus* of the same size. More time would be needed to draw clear conclusions using this method. There are also other sources of error in this method because some crabs could be more skilled at opening muscles, some of the muscles may be overly weak for their size or maybe the crab simply is not feeding, any of these factors could throw off the data. The graph showing the relation between carapace width and dent depth confirms my hypothesis. The *C. productus* clearly has a greater (dent depth)/(carapace width) ratio than the *C. magister.* Although the data confirms my hypothesis I would like to repeat the experiment with more data points, maybe measure 20 crabs instead of 4. A study entitled Maximum force production: why are crabs so strong? By Graeme Taylor (2000) sought to test a hypothesis similar to mine. The study measured the force production between 6 species of *Cancer* crabs. The data from the study showed that for a given body mass *C. productus* could create the greatest force in comparison to 5 other *Cancer* species including *C. magister.* This study also confirms my hypothesis and in their study they used 7 to 10 crabs of each species, showing that my data would likely create the same conclusions if I had used more crabs. It would also have been nice to have better testing equipment than the aluminum matrix. In the study by Taylor they used a strain force gauge apparatus that could give actual units of force and a tool such as this would have been very helpful in my experiment. The aluminum matrix created a few of its own problems because sometimes the crabs would only pinch the front edge an as a result they would create an abnormally large dent. I had to be selective with the dents I chose to make sure that they were an accurate representation of the force created. Despite this problem I am happy with the overall results of the aluminum matrix and I feel that my data is correct. With my data and the data from the Taylor study confirming my hypothesis I feel confident with the results from my project and the larger chelipeds in *C. productus* allow it to create more force than *C. magister.*

Bibliography

Taylor, G. M. 2000 Maximum force production: why are crabs so strong? *Proceedings: Biological Sciences.* 276, 1475,1480.

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