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Exploratory #2
Adaptations
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Pisaster ochraceus Feeding Preference in Relation to the Optimal Foraging Theory

Introduction

Pisaster ochraceus is a voracious intertidal predator. It is a broad generalist which means that it eats many organisms including mussels, abalone, chitons, barnacles and snails (Niesen 1997). It does, however, eat some animals disproportionately more than others. This is due to many factors which together comprise a feeding preference. This is important because *Pisaster ochraceus* is ecologically very important. It is a keystone species (Paine 1969). A keystone species is one that has a very large effect on biomass or biodiversity in a habitat. Removal of a keystone species would result in drastic changes in the trophic system. Because there is so great of an ecological impact, it is of interest to determine the reasons for the feeding preference.

Selecting a food source can be made depending on many factors, including but not limited to abundance, chemical defenses, physical defenses, caloric value, and handling time. This study focuses on caloric value and handling time. It explores the optimal foraging theory which states that organisms forage in a way that maximizes energy intake per unit time. This means that they will behave in a way that will result in high caloric intake and/or low energetic input.

To determine if *Pisaster ochraceus* feeds according to the optimal foraging theory, a set of experiments will be done. To test this theory, two species of mussels will be offered to the test subject. They will be of differing caloric values but comparable handling time. Handling time for this experiment will be defined as elapsed time from initial contact with the prey item to finishing eating. The two prey items will be *Mytilus californianus* and *Mytilus trossulus*. *Mytilus californianus* is a bivalve that attaches itself to rocky shores especially in wave exposed areas. It has a relatively thick shell and dominates the lower intertidal. *Mytilus trossulus* can be found in more protected areas such as bays or docks. They have a thinner shell than *M. californianus*. Because these species have differing caloric values but similar handling time, one can determine whether *Pisaster ochraceus* will chose one over the other depending on energetic intake per unit of handling time. Mussels will be chosen of similar sizes because the predator will select prey depending on their lengths (McClintock 1986). Eliminating length leaves caloric value as the only variable. If *P. ochraceus* prefers *M. trossulus*, which has a greater caloric value, then it will support the optimal foraging theory.

I hypothesize that *Pisaster ochraceus* will feed according to the optimal foraging theory, selecting *M. trossulus* over *M. californianus* when given the choice. This would be supported if *M. trossulus* was chosen first or if more *M. trossulus* are eaten than *M. californianus*.

Methods/Materials

To conduct this experiment 3 test subjects of the species *P. ochraceus* were selected that had a radius of roughly 10 cm. They were collected from a rocky intertidal area in South cove, Cape Arago, OR. In addition to this, 6 individuals each of *M. californianus* and *M. trossulus* were collected. They were all similar in size with wet weights ranging from 7.24g to 5.16g. The *M. californianus* were collected from Sunset Bay, OR and the *M. trossulus* were collected at the Charleston, OR docks. Three test areas were set up in the lab. Each had one sea star in the middle and two individuals of each prey item at equal distances away from the sea star. Prior to being placed in the test area each prey item was weighed and marked with a paint pen. The sea stars were monitored at roughly twelve hour intervals for three days. At each interval it was noted if one or more of the mussels were eaten. At the end of the three day period the prey items that were eaten were recorded. The species and weight were noted.

Results

Figure 1.

Interval	Subject 1	Subject 2	Subject 3
1	-	-	T5
2	-	-	-
3	-	-	T6
4	-	-	-
5	T1	T3	C5
6	-	-	-

Fig. 1 shows the timing of the predation individual prey items. The letter denotes the species of prey item and the number corresponds to the specific individual (which must be known for weighing purposes).

Figure 2.

Food Preference	# Eaten
californianus	1
trossulus	4

Fig. 2 simply sums up the number of prey items eaten separated by species.

Figure 3.

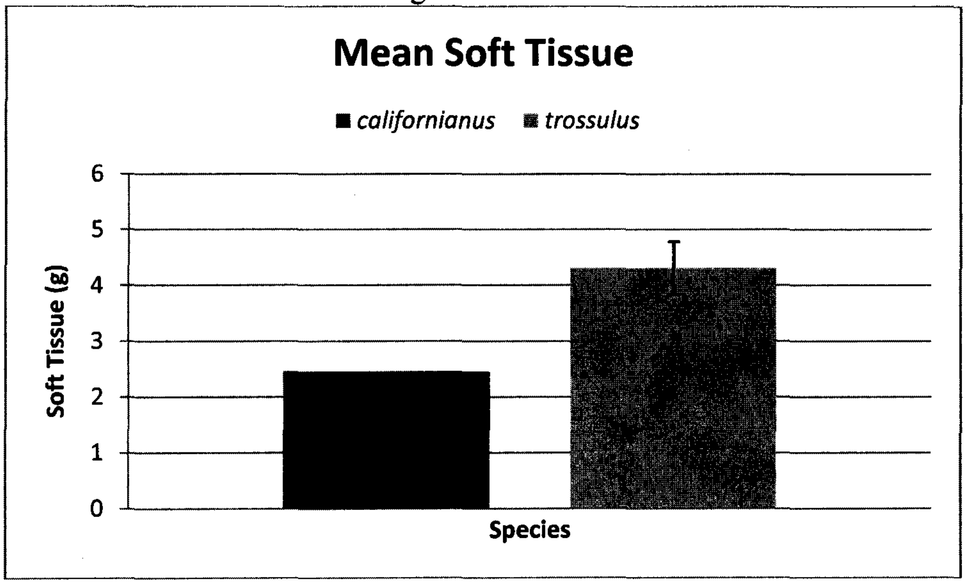

Fig. 3 graphically represents the mean soft tissue of the different species of the prey items which is calculated by subtracting the final wet weight of the eaten mussels from the initial wet weight.

Figure 4.

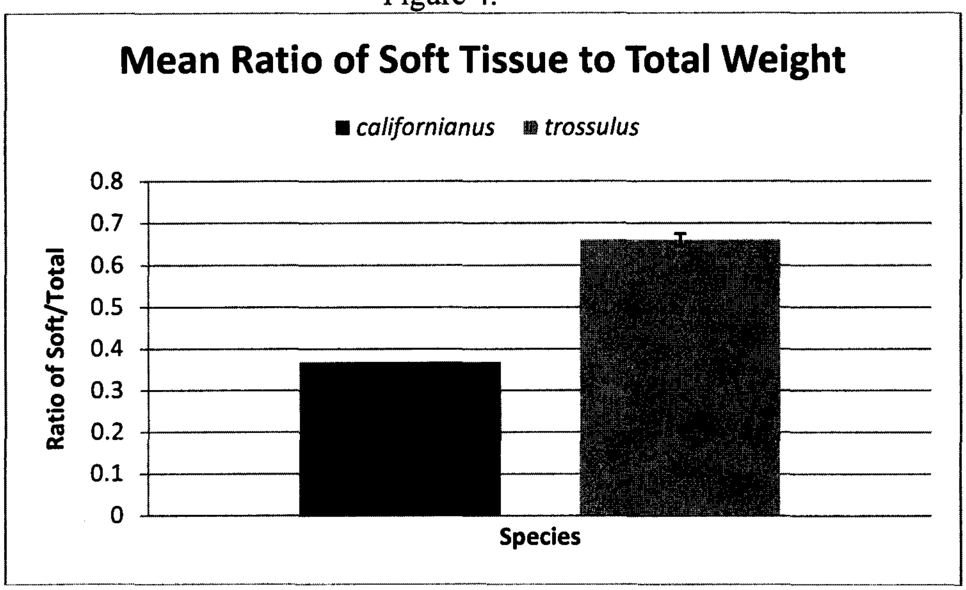

Fig. 4 shows the graphical results of the ratio of soft tissue to the initial wet weight of the mussels eaten. This is calculated by dividing the soft tissue weight by the initial wet weight of the eaten mussels.

There are several trends of note one should observe in the data. The first trend that one might see is that *M. trossulus* was chosen over *M. californianus* at a ratio of 4:1. Another thing to observe is that M. trossulus has more soft tissue and therefore more caloric value. *M. trossulus* also has a greater soft tissue to total weight ratio. This is semi-redundant, yet confirms the idea that there is more energetic gain from eating *M. trossulus*. Lastly, one should note that in every case *M. trossulus* was chosen before *M. californianus*. The only time *M. californianus* was chosen was when both *M. trossulus* food items had been consumed in the test area.

Conclusion

As can be seen above, *M. trossulus* was selected for predation preferentially over *M. californianus* with a large amount of regularity. This illustrates the fact that *Pisaster ochraceus* does exhibit a feeding preference and that when all other variables are eliminated, chooses to feed on prey items with greater caloric value. This supports the idea that *P. ochraceus* feeds according to the optimal foraging theory.

In many other studies *Pisaster ochraceus* is shown to regulate the populations of *M. californianus* (Paine 1966). The reason for this is most likely abundance. In the rocky intertidal, which is *Pisaster ochraceus'* primary habitat, there is a great abundance of *M. californianus*. This abundance would contribute to the feeding preference seen in the wild. This does still, however, fit in with the optimal foraging theory as little energy is spent searching for prey due to the abundance of *M californianus*.

This study, though it has some convincing results, has some possible sources of error. The first important source of error is that there was a quite small sample size. Only three test subjects were used which might lead to sampling error. It might simply have been coincidence that *M. trossulus* was preferentially predated. Another possible issue can be brought up about differing handling times of the two prey species. Although both species were chosen to be similar sizes and weights, it is possible that one species requires more energy input to get at the soft tissue. If *M. californianus* is more difficult to open than *M. trossulus*, this might make the test subjects select the latter based upon handling time. Another source of error could be that soft tissue weight does not exactly correlate to caloric value. While it was the best method for testing available to me, bomb calorimetry may have yielded more accurate values. To improve the accuracy of the results I would do more trials, test the force needed to pry open both prey items, and use bomb calorimetry to measure the caloric value of the prey items.

In summary, it can be shown that my hypothesis that *Pisaster ochraceus* feeds in accordance with the optimal foraging theory is supported. The data are convincing but should be repeated with more accurate measuring methods.

Works Cited

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