Diet and color polymorphism in the sea star, *Pisaster ochraceus*

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Introduction

Pisaster ochraceus occurs in a variety of colors; the major hues being orange, brown, and purple. Harley *et al.* (2006) found that in areas on the open Pacific coast, where *Mytilus californianus,* was present, less than 10% of the population of *Pisaster* were purple whereas in areas of the San Juan Archipelago and the southern Strait of Georgia, where *M. californianus* was absent, approximately 95% of the *Pisaster* found were purple. This pattern suggests that the expression of the orange and brown pigmentations may be dependent on the consumption of *M. californianus* (Fox and Hopkins 1966). The pigments responsible for the color change are mytiloxanthin and astaxanthin which can only be obtained through the consumption of mussels. (Fox and Scheer 1941).

The purpose of my research was to investigate whether color is controlled by diet. In the lab, I hypothesized that by feeding purple individuals *M. californianus* they would undergo a slight change in color as they began to express orange/brown pigmentation. An accompanying field study was also performed to search for patterns between color and diet.

Laboratory Experiment

I collected 20 sea stars—ten orange and ten purple—and randomly divided them so that I had two tanks containing five purple sea stars and two tanks containing five orange sea stars. One tank of each color was fed *Pollicipes polymerus* and one tank of each color was fed *Mytilus californianus*. I put colored rubber bands on each sea star to keep track of individuals within a tank. Pictures were taken of each individual twice a week to track any observable color changes over a period of four weeks.

Results

Beginning of Week 1

End of Week 4

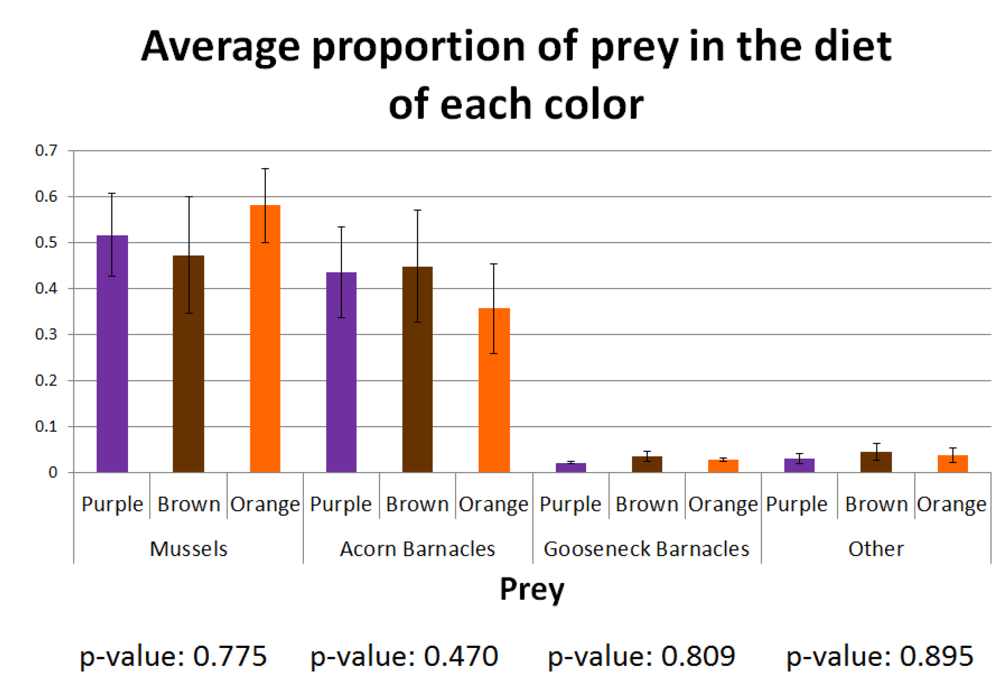
The images above are of a purple individual who was fed *Mytilus californianus.* In the photo on the left the lower arms appear to have a slightly different color and texture. This difference has been attributed to the extension of the papulae.

No significant changes in color were observed in any individual however observation over a longer time period may have achieved different results.

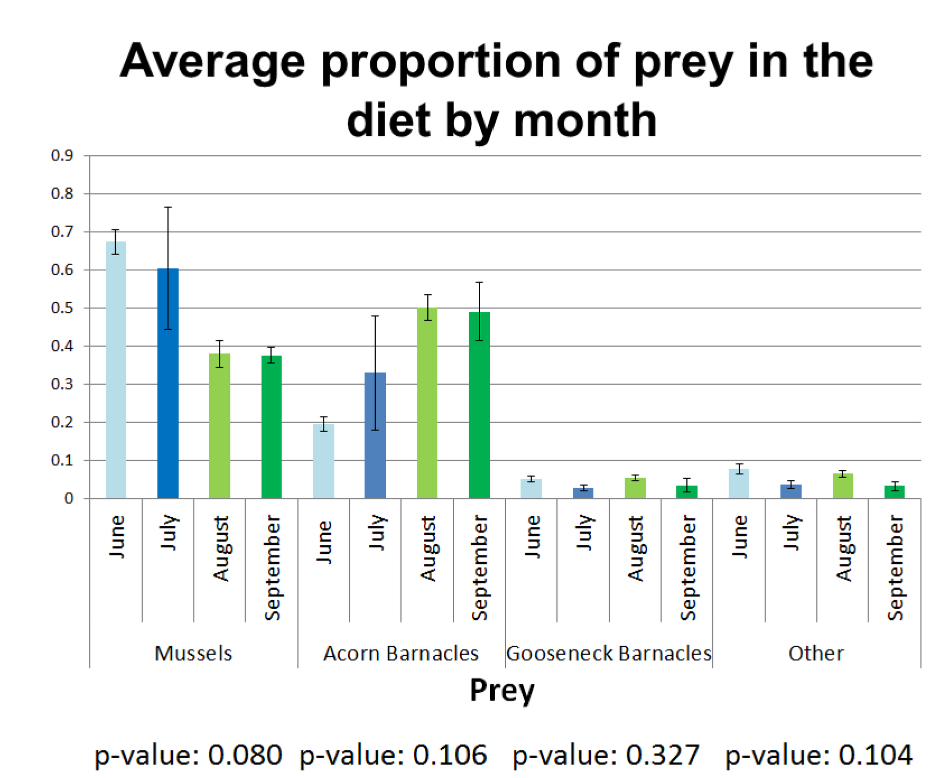
Field Study

Surveys were done once a month from June through September at three sites: Strawberry Hill, Boiler Bay, and Yachats Beach. At each site I sampled as many sea stars as possible in 1.5 hours. The purpose of the field-work was to search for patterns between color morphs and diet but other variables were examined as well. The color and size of an individual were recorded, along with any prey items it was feeding on, and the presence of any injuries.

Results



The graph above explores the similarities in diet between color morphs. Mussels and acorn barnacles comprised the greatest proportions of the diet of all colors. No significant differences were found in the dietary composition between colors for any prey types. The lack of statistically significant differences between color morphs suggests that their diet is essentially the same.



The graph above displays the average proportion each prey group comprised of the diet of all sea stars each month. The noticeable trend is the change in the proportion of mussels and acorn barnacles consumed over time. The difference in acorn barnacles is not significant and while the difference in mussels is statistically significant it only provides suggestive evidence that there is a difference (p-values: 0.106 and 0.080, respectively.)

Discussion

No changes in color were observed in the lab although there have been documented cases where *Pisaster* in captivity have changed color (Raimondi *et al.* 2007). Due to limited access to lab space, my time period for this experiment was brief. A longer observation period may yield different results.

In the field, no statistically significant difference was found in diet of *Pisaster* between colors. This pattern suggests that the diet of all color morphs is essentially the same. Thus, color morphs are ingesting comparable amounts of pigments from mussels. This raises the question, "If diet is the same, what is controlling color expression?" It is likely that diet plays a role in color determination but is mediated by other ecological or ontogenetic variables. Harley *et. al.* (2006) proposed that although color is most likely controlled by diet, there may be an underlying genetic component. The extent to which polychromatism is genetically based is not yet known.

An interesting trend observed in the field was the change in proportion of mussels in the diet over time. Previous studies have shown that mussels are the preferred prey of *Pisaster* (Landenberger 1968, Paine 1980), however *Pisaster* have also been shown to be size selective in their predation on mussels (McClintock and Robnett 1986). It is possible that when preferred size mussels are not available *Pisaster* will prey more upon less preferred prey. The effect that the decrease in mussel consumption may have on color expression is not yet known. Further research is needed to understand the biology of this keystone predator.

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