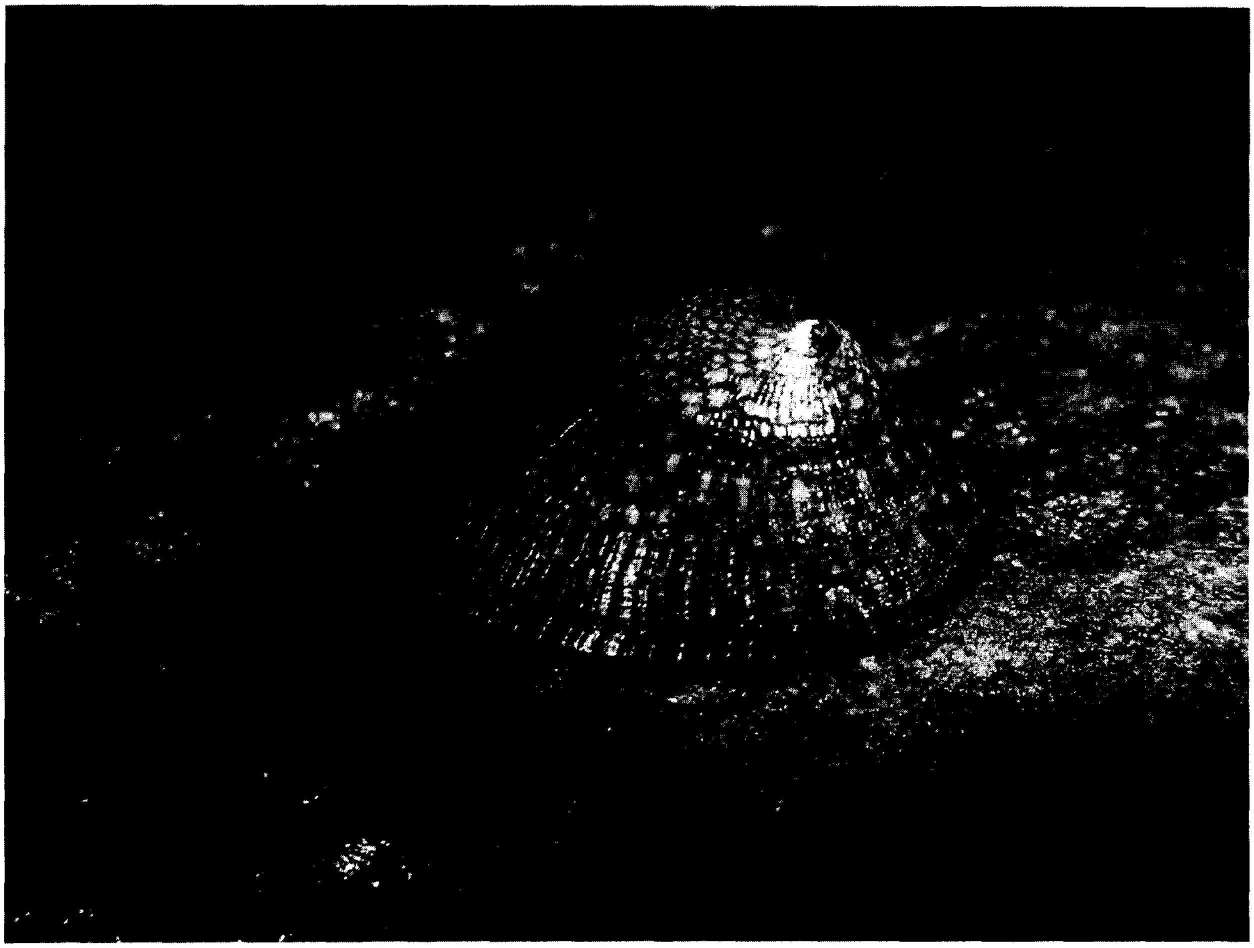

Negative Phototaxis and Obstruction of Eye Spots of *Lottia persona*

Exploratory 3
BI 457

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BI 457

Phototaxis in the Masked Limpet *Lottia persona*

Introduction

The Masked Limpet, *Lottia persona* is abundant on rocks in the high and middle intertidal zones along the Northeastern Pacific coast. It is a nocturnal species, resting by day in cracks, caves, crevices, and other places away from the sun. By night, it trails along rocks to feed on algae and diatoms until dawn, in which it ceases to eat and moves away from the impending sun (Lindberg, 1975, Adams, 2006). This behavior is indicative of negative phototaxia, movement away from a light source (Lindberg, 1975, Page, 2002).

The shell of *L. persona* is ovoid and colored with circular brown or black bands, and an apex that is well offset from the center toward the anterior margin (Adams, 2006). There are white markings on the posterior, and on the anterior two symmetrical streaks of speckled white spots pointing to the point of the shell. When held to a light source, the two symmetrical rays are revealed to be translucent, while the rest of the shell remains opaque. This is the result of shell layering, much like human skin is layered (Lindberg, 1982). The posterior region consists of white pigment in the outermost layer and in parts of the second (next down) layer, but also has a dark, underlying shell in that second layer. The translucent parts of the anterior region have the same cross sectioning, but lack the dark, underlying shell, giving the limpet its "eye spots" (Lindberg, 1982). As its body is sandwiched between its shell and its substrate, these "eye spots" appear to be the only means by which *L. persona* is able to detect light, assuming that it goes into hiding in response to visual cues. I hypothesize here that *L. persona* moves (goes into hiding) in response to light coming through its eye spots, and if they are obstructed, the masked limpets will not go into hiding.

Methods/ Materials

Over a period of 4 days, 35 limpets were marked at Middle Cove, Cape Arago in Coos County, OR early in the morning (after daybreak, low light). The limpets were chosen randomly from five different rocks of varying shapes, sizes, and percent limpet and periwinkle covering. Each limpet was randomly marked to represent 1 of 3 different plate coverings using opaque nail polish as the marking medium (Figure 1). Limpets were either fully covered with nail polish (6 total), had the posterior half of their shelf painted (14 total; not touching eye spots area), or the anterior half of their shell painted (10 total; fully covering the eye spots).

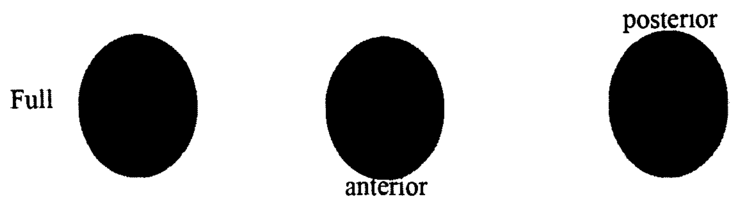

Figure 1: Limpet Markings; brown (darker shade on B&W) represents unpainted areas of the limpet, while pink (lighter shade on B&W) represents the parts painted with nail polish. For simplicity, the white markings were omitted.

Five limpets were not painted, except for a small identification mark on the posterior tip of the shell. This served as the first control by eliminating any environmental factor, to make sure the limpets in this population were behaving normally by moving out of the light (if the limpets were not moving out of the light under typical conditions, the results would have been skewed). The posteriorly painted limpets served as the second control on the effects of the nail polish (as a comparison to the anteriorly painted limpets, in which the eye spots were manipulated), as these limpets should move out of the light like the unpainted limpets according to my hypothesis.

Three to four hours after painting, once the sun had risen enough to encase Middle Cove and limpets had sufficient time to hide, I found the location of the marked limpets and recorded their movement as follows. A limpet that had not moved from its original spot and remained exposed was marked as not moving and given a "0" in distance moved. If the limpet had moved out of the light, whether underneath the rock, into a crevice, or otherwise, it was marked as moved and its distance from the painting point to its hiding place was measured in cm.

Results

Thirty-five limpets were painted, but only thirty-three were found upon return. One of six (16.7%) limpets 'fully' marked moved (43cm.), while the other 83.3% showed no movement. Two of ten (20%) limpets covered on the anterior moved (mean = 66cm), while seven of fourteen (50%) limpets covered on the posterior moved (mean = 53cm). All the unmarked limpets (100%) moved (mean = 36.4cm) (See Figure 3)

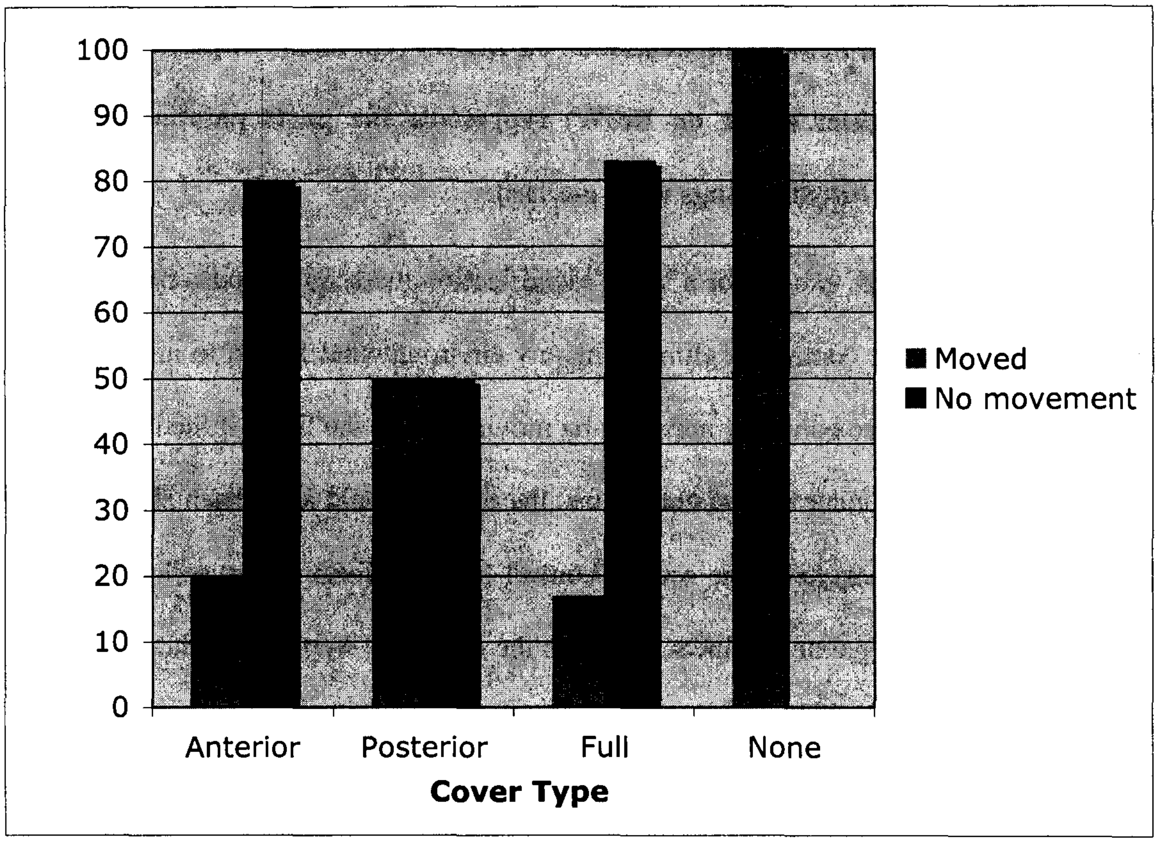

Figure 2: Percent *L. persona* showing movement for the 3 types of painted limpets. A fourth bar shows amount of movement in the unpainted control.

Discussion

Limpets that were not marked did move out of the sun as expected. Based on my hypothesis I expected that fully painted limpets would not move out of the sun because their eye spots were covered and therefore wouldn't detect the light (display negative phototaxia) (Lindberg, 1975). One fully painted limpet did move, meaning that either the limpet was able to detect the light other than through its shell, or the layer of paint was not thick enough to block out light coming through the shell. If it were the former, then all the other limpets should have moved too, however since they didn't, this paper will assume the latter hypothesis. The same can be said for the two anteriorly painted limpets that moved, as pieces of the eye spots might also have been missed when painted, suggesting how sensitive to light the masked limpet is. However, when you look at those that were painted posteriorly there is equal movement and no movement, which suggests that there may be variation in the population, so this could disprove this latter comment. The limpets could be affected not only by where they are painted, but also in variations of their shell construct, their original location, their sensitivity to the paint, and if any paint touched their bodies, as suggested by the equal numbers of posteriorly painted limpets that moved and didn't move.

The posteriorly marked limpets that did move indicate that they are still capable of recognizing the sun and hiding. However, for the ones that did not move, this could mean that they either had part of their eye spots or other visual apparatus covered, or they were affected behaviorally by the paint (for example, they might clamp down thinking they were being attacked by a predator). If it were the former hypothesis, then the idea that the anteriorly painted limpets moved because they had a small enough amount of light to know to hide would need to be questioned.

On the second weekend out, the limpets had already gone into hiding, which presented a problem on how to mark them and test whether they would move. Instead of disturbing them by detaching them from their rock, I turned a small rock with 6 limpets underneath it over so the limpets were exposed to the light. I painted two anteriorly, two posteriorly, one fully, and left one unmarked (to test whether limpets would go into hiding again or if they follow a rhythm and would not retreat as they had hidden themselves once that morning already). When I returned, all but the unmarked limpet remained on the rock, which proposed an anomaly, as the posteriorly marked limpets should have gone into hiding according to my hypothesis. One could surmise that these two posteriorly painted limpets did not move for reasons mentioned above, or due to my flipping the rock after they had moved (disrupting their schedule). If it is because of the latter theory, then one could postulate that when limpets go into hiding in the morning, they might "shut down" (clamp down and sleep). However, if that were so, the unmarked limpet would have to be accounted for.

In conclusion, the data collected by this experiment lends itself to verify my hypothesis. When anteriorly painted (covering eye spots), the amount of movement when exposed to light decreases by a significant amount (30%) over the posteriorly painted (not covering the eye spots), even despite sensitivity to paint and discrepancies in shell shape and size that would lead me to paint the limpet incorrectly (missing eye spots on the anteriorly painted ones or painting over parts of the eye spots on the posteriorly painted ones). More studies would need to be conducted not only to limit the amount of error, but also to discern why *L. persona* moves in the first place. It could be that *L. persona* evolved its eye spots because it cannot resist temperature changes or withstand desiccation, but that is currently unknown and the subject for further experimentation.

Works Cited

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