Tectura persona and phototaxis: a hypothesized mechanism for avoiding light

By Matt Hodges

Abstract

An experiment was conducted to determine the temporal habits of the mid- to high rocky intertidal limpet *Tectura persona* (the masked limpet). Three survey sites were examined during the day and again after sunset to determine limpet distribution at these two times of day. An experiment was conducted to determine the potential usefulness of thin portions of *T. persona* shells, hypothesizing that these thin portions were "windows" for sub-shell photoreceptors. *T. persona* specimens were placed under a hot lamp and timed for how long it would take them to find the provided shady area. The same species was painted and tested again, and two other species (*Lottia digitalis* and *Lottia pelta*) were also tested for contrast. Due to the distribution of *T. persona* during the two survey times, it was determined that this species exercises nocturnal feeding habits, probably to help avoid desiccation. Furthermore, reaction time (time to find the shade) for *T. persona* was significantly higher after the shells were painted, indicating that this species can use the thin portions of their shells to detect and avoid desiccating light.

Introduction

The masked limpet, *Tectura persona* (formerly *Notoacmaea persona*) is a gastropod mollusk native to the Pacific coast from Alaska to Monterey, California. This nocturnal species spends its life in the mid- to high rocky intertidal zone, feeding on diatom growth which it scrapes off rocks with its well-developed radula (1). Because of its habitat, this species is often exposed to desiccation threats including sunlight and exposure. Interestingly, the underside of *T. persona*'s shell, when held up to a light

source, shows two thin shell sections to the left and right of the shell apex, which may help the limpet detect encroaching light and avoid it (2). This paper will attempt to answer the question, do limpets show special adaptations, structurally or behaviorally, which help it deal with the rigors of a desiccating environment? I hypothesized that *T. persona* would show adaptive behaviors for dealing with these stresses, such as finding crevices during the hot daylight hours, as well as inactivity during the day and feeding behavior at night. In addition, I hypothesized that the thin shell segments of *T. persona* are mechanisms, perhaps photoreceptors, which can be used by the limpet to avoid getting caught out in the light.

Methods

Three surveys were taken to determine limpet activity at South Cove, Cape Arago. Three 1m2 sites were marked in the high intertidal area, and checked twice, once at noon and once at 9:00 p.m., well after sunset. The results of these surveys are presented in Table 1.

To determine the phototaxic usefulness of the thin sections of the limpet shell, thirty specimens were collected from South Cove, Cape Arago after the surveys were completed. These specimens were kept in the water table in the OIMB Adaptations classroom, and provided rocks with diatomaceous growth for food. A test chamber was constructed using a 20x40 cm Tupperware container with its sides and bottom covered by black plastic. This plastic was used to ensure no ambient light would interfere with the test. One-half of the top of the container was also covered with black plastic to create a shaded area. A desk lamp with a 69-watt bulb was placed over the test chamber, in such a way that the shadow cast by the black plastic created an area of high light, an area

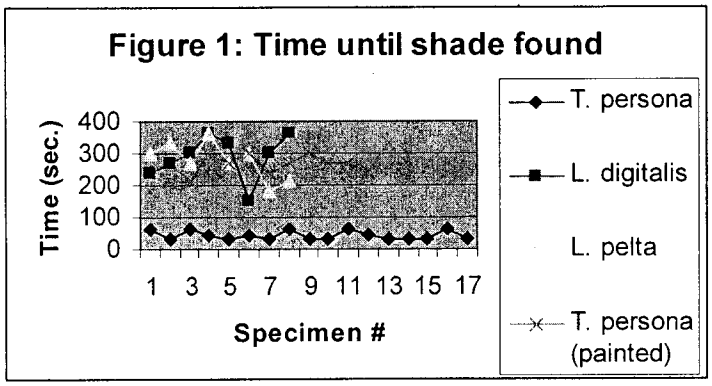
opposite of no light, and an intermediate area between these two of dim light. Specimens of *T. persona* were placed in the intermediately lighted area, with the edge of their shells just over the line into the fully shaded area. Limpet orientation was randomized to ensure the limpets were using the hypothesized photoreceptors under their shells and not some other means of light detection. The limpets were then monitored to determine the time it took them to find the shaded area, defined as the point at which the apex of the shell crossed the line into the shaded area (this point was used because the limpets tended to stop as soon as this point was reached). Seventeen *T. persona* were tested in this way. The test was repeated using specimens of *Lottia digitalis* (finger limpet) and *Lottia pelta* (shield limpet), which do not have the thin shell portions shown by *T. persona*, to determine whether *T. persona* was using sub-shell photoreceptors or detecting light with some part of the foot. Finally, sixteen *T. persona* were painted using black fingernail polish, over the thin portions of the shell, and placed in the test chamber and timed again. The results of these trials are presented in Table 2.

Data

Table 1: Number of *T. persona* counted at three survey sites at noon and 9:00 p.m.

Site	Day Survey (12:00 p.m.)	Night Survey (9:00 p.m.)
1	25	54
2	38	49
3	33	50

Note: Daytime counts were entirely in crevices and other shaded areas, while night counts were found evenly distributed across the boulders.



Note: Of sixteen painted *T. persona* tested, only thirteen found the shaded area.

Discussion

As can be seen in Table 1, *T. persona* is much more active in the evening than in the middle of the day. As predicted, this is no doubt a behavioral adaptation for helping the limpet avoid desiccation in the midday heat and sun. The data from Figure 1 are even more compelling. Not only did *T. persona* find the shaded area of the test chamber better than the two other species tested (often finding the shade within a minute, while the other two species took an average of 5-6 minutes to find the shaded area), but they also did much better finding the shade than the painted specimens of the same species, which took three to four times longer to find the shade (if they found it at all). This indicates that the thin patches on *T. persona*'s shell do in fact aid the limpet in finding shade, or perhaps for avoiding light altogether. This fits with what we know of *T. persona*'s nocturnal behavior, as well as helping to explain why all specimens found in the daytime survey were found in crevices and shadowy areas. Although these results indicate that *T. persona* uses its shell "windows" for detecting different light gradients, it seems likely that in the wild, these windows would only be of use when the limpet sits on the line between shade and sunlight, and probably are used only when the rising sunlight encroaches on the shady crevice *T. persona* is inhabiting at the time. Further

experimentation with these possible photoreceptors, as well as structural examination by dissection, would help to elucidate the roles these thin shell sections play in protecting this species from desiccation by sunlight.

Works cited

1. Kozloff, E.N., 1993. *Seashore life of the northern Pacific coast: an illustrated guide to northern California, Oregon, Washington, and British Columbia.* University of Washington Press, Seattle. pp. 124-125
2. Ricketts, E.F., Calvin, J., Hedgpeth, J.W., Phillips, D.W., 1985. *Between Pacific tides*. Stanford University Press, Stanford, California. p. 34