LIGHT AVOIDANCE IN *EUAPTA LAPPA*

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Abstract: Euapta lappa sea cucumbers (class: Holothuria) are unique among sea cucumbers at Discovery Bay, Jamaica in that they are highly mobile, entirely nocturnal, and show a strong aversion to light. We investigated why *E. lappa* avoids light, testing how sensitive they are to UV radiation compared to light-tolerant sea cucumbers, and looking at predation on them in daylight and nighttime hours. We also investigated how they avoid light, hypothesizing that they are able to detect shade refuges from a distance and that they generally remain close to these refuges while foraging at night. We found that substantially more UV radiation passes through its cuticle than the cuticle of a day-active sea cucumber, suggesting UV sensitivity is one reason *E. lappa* avoids light. We also found that *E. lappa* preferentially moved towards shade refuges during the day from 30 cm away but not from 60 cm away, and that nearly half of all cucumbers found in the wild at night stayed within 30 cm of a refuge, which suggests they remain close enough to a refuge to find it easily.

Key Words: Euapta lappa, *Sea Cucumber,* Holothuria*, Discovery Bay, UV radiation, palatability*

INTRODUCTION

Euapta lappa is a nocturnal, deposit-feeding holothurian (sea cucumber) which is strongly averse to light. During the day, it stays concealed in coral, under rocks, or in shells. It has pigmented photoreceptors on its tentacles which may aid in sensing and avoiding light (Hendler et al. 1995). Individuals leave their refuges after dusk to forage, and will rapidly contract and seek shelter when light is shone on them.

We investigated both why and how *E. lappa* avoids daylight. We hypothesized that daytime predation and UV radiation are reasons for light-avoidance. Thus, we evaluated the palatability of *E. lappa* and the effectiveness of its cuticle in blocking UV light. Daylight avoidance necessitates that *E. lappa* move between night-time foraging areas and day-time refuges. The ability to navigate between these areas is important because an undirected search for shelter could prevent an individual from finding shelter before sunrise. We hypothesized that, in the field, *E. lappa* will preferentially forage near potential refuge sites, and, in the lab, they will be able to detect shelter from a distance.

METHODS

We collected 20 *E. lappa* on the nights of 23 February and 25 February, 2006 at the Discovery Bay Marine Laboratory in Jamaica. We observed all individuals in the laboratory both at night and during the day to test for avoidance of light. We also released four individuals into their original habitat during daylight and observed their behavior. Additionally, we attempted to determine where individuals find refuge during the day by tethering individuals both with string tied around their bodies and safety pins affixed to their tissue.

We tested *E. lappa's* palatability to predators by offering them three samples each of *E. lappa, Holothuria mexicana*

(Donkey Dung Sea Cucumber), *Isostichopus badionotus* (Three-rowed Sea Cucumber), and a control (frozen, pre-cooked shrimp). We placed the samples in the water at mangrove and shallow back reef habitats for 20 continuous hours to test for palatability to both diurnal and nocturnal predators.

To test for vulnerability to ultraviolet light, we exposed four *E. lappa* individuals each of both dark and light morphotypes to an ultraviolet lamp and observed how much light passed through each sample by placing a piece of paper that fluoresces under UV behind them and categorizing the amount of florescence. We compared this to the amount of florescence produced by shining a UV light through cuticle samples from *H. Mexicana,* a diurnal sea cucumber.

To test for behavior related to strategies for avoiding light, we surveyed the location of *E lappa* at night with respect to distance from shade refuge. To determine the distance at which *E. lappa* can locate shade refuge, we tested 17 individuals in a 1 m tank in natural sunlight with a shade area located at one end. We placed each individual at 30 and 60 cm from the shade refuge at each end of the tank and observed whether they went towards or away from the refuge. We alternated at which side of the tank we placed the shaded area.

RESULTS

In the lab, all *E. lappa* collected were active at night, but sought shade refuge when a light was turned on. Additionally, all individuals sought shade refuge during daylight in the lab. Of the four individuals released during daylight at the site where they were collected at night, two were not immediately able to grip the substrate due to strong water currents. However, the two that did gain a purchase sought refuge immediately. Both methods of tethering (safety pin and tying) failed, as the cucumber escaped both tethers. Other researchers also experienced this difficulty (Southam 1987 and Hammond 1983).

Our results for palatability were inconclusive. We did not observe any feeding on pieces of *H. mexicana*, *I. badionotus*, *E. lappa* or the control shrimp in the floating buffet. More ultraviolet light passed through the entire body of *E. lappa* than through one layer of the cuticle of *H. mexicana*. We found high UV penetration for dark morphotypes of *E. lappa* and very high penetration for light morphotypes.

E. lappa individuals generally moved towards and into the shade refuge when placed 30 cm away (24 towards, 11 away; $\chi^2 = 4.83$, $p = 0.02$) but did not show this trend from 60 cm away (16 towards, 18 away; $\chi^2 = 0.118$, $p = 0.73$). From our night observations we found that nearly half the individuals foraged within 30 cm of a shade refuge and over 95% were within one meter of a shade refuge (Fig. 1).

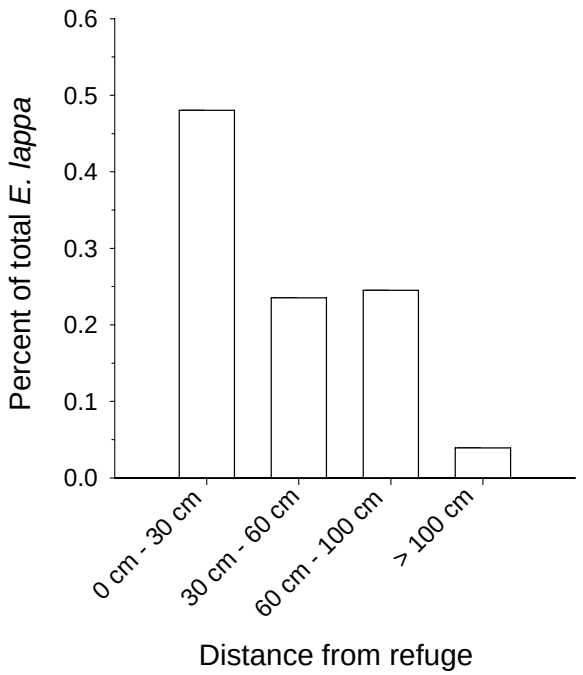

Figure 1: Distribution of *E. lappa* with respect to distance from a shade refuge, based on 102 individuals observed at night at Discovery Bay, Jamaica.

DISCUSSION

E. lappa shows a strong, predictable light avoidance. In both the lab and the field, individuals retracted and sought shelter when exposed to light. UV light easily penetrates its body, suggesting that its aversion to light may have evolved to prevent the harmful effects of this radiation.

The alternate hypothesis that predation drives *E. lappa*'s aversion to light seems less likely, although we cannot exclude it as none of the sea cucumbers or control food we tested were eaten. There could be several explanations for this result. Firstly, the shrimp control was rotten and may have been unpalatable. Secondly, the food was placed in the water column, and this may not have been readily detected by fish or invertebrates who feed at the bottom. Placing the food on the substrate may have been more realistic. Thirdly, predators in the heavily fished area may have been scarce. However, a past study did show *E. lappa* to be unpalatable; Southam (1987) performed a similar buffet experiment in which the control (urchin) was readily eaten, but *E. lappa* was not.

Higher water currents during the day might also contribute to *E. lappa* avoiding light. Flow speed at Discovery Bay is on average 61% greater during the day than at night (Genovese and Witman 2004), and individuals released during the day had difficulty adhering to the substrate because of water movement.

E. lappa likely finds refuge from light both because it can detect a refuge from a distance and because it forages near refuges at night. It can sense the direction of a refuge from at least 30 cm away, and half the individuals observed at night were within 30 cm of refuge. However, past studies have found that *E. lappa* finds refuge before sunrise (Hammond 1982). This means they may use cues other than light, such as chemical trails, to find cover. Alternatively, *E. lappa* may have an internal clock which triggers refuge-seeking without being prompted by light. Further studies could evaluate the relative importance of visual versus other cues for finding refuge.

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