Diel variation in predation on the brittle star *Ophiocoma echinata*

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Abstract: The brittle star *Ophiocoma echinata* is a highly palatable prey item for many fish and crustaceans. We tested the hypothesis that predation pressure would be higher during the day than at night with a tethering experiment. As these brittle stars employ self-amputation when attacked by a predator, we used arm loss as a measure of predation pressure. Predation rates were higher during the daytime, but predation intensity (amount of damage) was much higher at night. Our results suggest that *O. echinata* experiences increased predation pressure during the day, and therefore, behave cryptically. An increase in brittle star activity at night may leave them more vulnerable to potential attackers, resulting in more severe predation when encounters occur.

Key Words: autotomy, Echinodermata, ophiuroids

Introduction

Brittle stars belong to the Ophiuroidea, a cryptic and very palatable class of echinoderms that inhabit coral reefs. They live in benthic microhabitats, such as sponges, coral recesses, or crevices between rubble, presumably to avoid predation. The blunt-spined brittle star, *Ophiocoma echinata*, occurs on coral reefs, seagrass beds and mangroves and is especially abundant in coral rubble (Hendler 1995). *Ophiocoma echinata* is preyed upon by several diurnal and nocturnal fish as well as crustaceans. To mitigate the effects of predation, they employ autotomy, or self-amputation and subsequently regenerate lost arms. When a predator grasps an appendage, the brittle star can simply let go of it, confusing the predator long enough to escape (Aronson 1987).

We examined differences in predation rate and intensity on *O. echinata* between day and night. We hypothesized that there would be differences in predation rate and intensity due to different diurnal and nocturnal predators. Specifically, we predicted that there would be greater predation rate and intensity on brittle stars during the day due to increased foraging activity of visual predators.

Methods

On 26 February 2003 we tethered 20 *O. echinata* to small weights by passing a needle and thread through the center of each brittle star and tying a loop around the disk. We selected two study sites in the rubble zone of the back reef at Discovery Bay, approximately 80 m north of Discovery Bay Marine Laboratory. At 11:00 we placed 10 undamaged brittle stars at each site and marked the sites with buoys. Refugia under rubble were available to all *O. echinata*. At 19:00 we brought the brittle stars back to the laboratory to assess predation damage. For the night treatment, we repeated this process using 20 new *O. echinata*. We set out these brittle stars at 22:00 and collected them eight hours later. Predation rates and intensity were quantified on a scale of 0-5 to indicate the number of arms missing (where 0 = no damage, 1 = one arm missing, 2 = 2 arms missing, 3 = 3 arms missing, 4 = 4 arms missing and 5 = complete predation). Arms lost due to collection and handling of brittle stars were not considered predation, and subtracted from our final arm loss records. However, this did not limit any brittle stars to certain damage classes because all of our experimental brittle stars were initially undamaged and the arm loss due to handling occurred after the predation experiment. Ultimately, we only used 18 out of 20 brittle stars from our daytime trials in our analysis because one could not be located and one escaped during recovery.

Results

Predation rate and intensity differed between day and night trials. Although the difference was not statistically significant, predation rate on *O. echinata* was higher during the daytime (Chi-square = 1.6, df = 1, P = 0.21). In the day trials, 8 of the 18 brittle stars (44.4%) recovered were missing one or more limbs, while in the night trials only 5 of the 20 brittle stars (25%) showed evidence of predation. However, the extent of predation on the brittle stars was much higher in night trials than in day trials. Brittle stars preyed upon during the day lost less than 1.63 limbs on average, which was significantly lower than the average of 4 limbs lost by brittle stars preyed upon at night (Fig. 1; t = 2.95, df = 11, P = 0.01). Brittle stars were always found under refugia when they were collected.

Discussion

Our results indicate that there is diel variation in predation pressure on *O. echinata*, with a slightly higher predation rate during the day than at night. This may explain why *O. echinata* is more active at night. We also found differences in predation intensity between day and night. Of the brittle stars that were preyed upon, those attacked at night suffered more severe damage than those attacked during the day. In accordance with our results, Hendler et al. (1995) reported that the arm tips of *O. echinata* are rarely seen during the day, but suspension feeding individuals are known to expose several arms at night (Hendler et al. 1995). Our results suggest that increased nighttime activity by brittle stars may leave them more vulnerable to potential attackers, resulting in more severe predation damage

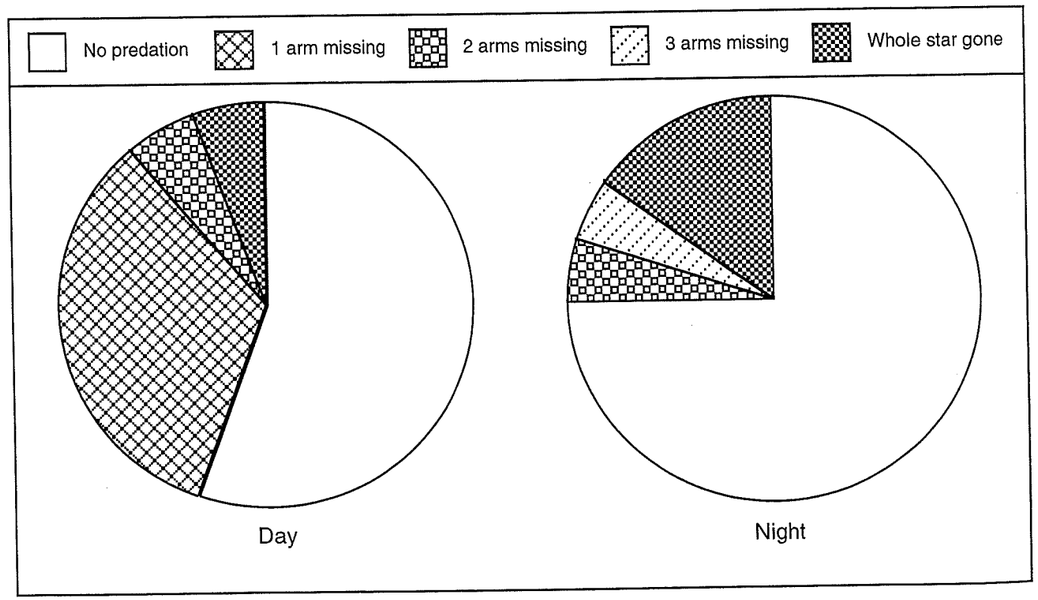

FIG. 1. Predation intensity (amount of damage) on brittle stars during the day and night in Discovery Bay, Jamaica. Data were collected on 26 Feb. 2003.

when encounters occur. Additionally, predation intensity may be less severe during the day because brittle stars are more cryptic at this time. When brittle stars were experimentally denied refuge, previous studies found no difference in predation rate or intensity between day and night trials (Eckert and Jones, 1989). However, potential differences may have been obscured due to unnaturally high predation on fully exposed brittle stars, since all brittle stars were eaten regardless of time of day.

An alternative explanation for the predation patterns we observed may be that daytime and nighttime predator populations are composed of entirely different species. Variation in size or foraging strategies across these predator species may account for the differences in predation rate and intensity between day and night trials.

Regardless of time of day, we found very high predation pressure on brittle stars. At such high rates, it is unlikely that the population could sustain itself, indicating that predation may have been artificially enhanced by our experimental design. Although our experimental brittle stars immediately found cover when placed in the rubble zone, it remains possible that the tethering process negatively affected the speed or maneuverability of brittle stars in ways that we could not readily assess. If so, this may have increased predation values above those normally occurring on the reef, thus contributing to the high predation levels across treatments. It is also possible that injury as a result of the tethering may have attracted predators via odor. However, we believe that the differences between day and night trials remain valid, since our design did not differentially influence day and night trials. Our findings of high predation rate during the day and high predation intensity at night suggest that predation pressure on brittle stars is always high. Thus, brittle stars need to employ cryptic behavior during the day and night in order to cope with such high predation pressure across times.

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