DIEL ZOOPLANKTON ACTIVITY IN THE BACK REEF AT DISCOVERY BAY, JAMAICA

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Abstract: For many zooplankton populations, abundance in the water column increases at night, which is thought to maximize energy consumption in the water column while minimizing exposure to visual predators during the day. We predicted that zooplankton would have an increased abundance in the upper water column at night and that larger zooplankton, which are more subject to visual predation, would be proportionally more abundant at night. After sampling in the early afternoon and after sunset, we found both of our predictions to be correct.

Key Words: copepods, diel vertical migration, size distribution

INTRODUCTION

Many zooplankton populations exhibit diel vertical migration (DVM), a behavioral adaptation whereby zooplankton ascend into the water column at night to feed and then retreat to the benthos during the day (De Robertis et al. 2000, Jacoby and Greenwood 1988, Fagan et al. 2002, Iwamoto et al. 2003, Madhupratap et al. 1991, Pickhardt et al. 1999). This tradeoff probably maximizes zooplankton energy gain and provides protection from visual predators when the risk of attack is highest. If larger zooplankton are more vulnerable to predation because of their size, they may face greater pressure to engage in DVM behavior than smaller zooplankton (Iwamoto et al. 2003).

The stimulus for DVM is believed to be diel variation in light intensity (De Robertis et al. 2000). If light serves as a proximal cue for migration, it is possible that lunar irradiance may also affect the likelihood for DVM to occur (Jacoby and Greenwood 1988).

We hypothesized that the zooplankton population in the back reef of Discovery Bay, Jamaica exhibits DVM. We predicted that zooplankton would be more abundant in the surface water during the night than the day, and large zooplankton would be more likely to engage in DVM than small zooplankton. We also predicted that the presence of a full moon would decrease DVM behavior.

METHODS

A transect of 20 m was demarcated on 25 February 2005 approximately 12 m south and parallel to the reef crest in the west back reef of Discovery Bay, Jamaica. At 1400 and 2000 we collected samples for less than one hour. Five replicate samples were collected by swimming at a leisurely pace toward the west and then toward the east along the transect, for a total of 40 m. Zooplankton were captured with a 153 μm mesh net (26 cm diameter) held directly

beneath the water's surface (transect water depth was ≈0.8 m). The total volume of water filtered for each sample was calculated to be 2.12 m^3. Samples were preserved on site in 10% formalin.

All zooplankton in each sample were identified, counted, and measured within 24 hours, using dissecting microscopes. One-way ANOVAs were used to determine differences in abundance, average zooplankton size between night and day samples, and the dominant taxa for each time period. One night sample was accidentally destroyed, creating unequal sample sizes, but our abundance data met the assumptions of normality and homogeneity of variance after a log transformation, so we used standard F-tests to analyze our data.

RESULTS

There were more zooplankton in the samples collected during the night (1167 ± 101 organisms/m^3) than during the day (220 ± 91 organisms/m^3, $F = 48.42$, df = 1, 8, $P = 0.002$). The average size of the zooplankton in the night samples was larger (1.15 ± 0.02 mm) than in the day samples (0.71 ± 0.02 mm, $F = 192.8$, df = 1, 8, $P < 0.0001$). For decapods (Fig 1a) and copepods (Fig 1b), the abundance at night was greater than the abundance during the day in all size classes (decapods, $F = 50.47$, df = 1, 13, $P < 0.001$, copepods, $F = 38.10$, df = 1, 21, $P < 0.001$). The zooplankton collected were not uniformly abundant across all taxa (Table 1). There were significantly more copepods than any other group of organisms in the day samples, and at night both copepods and decapods comprised the majority of observed zooplankton (day, $F = 13.38$, df = 11, 119, $P < 0.0001$; night, F =

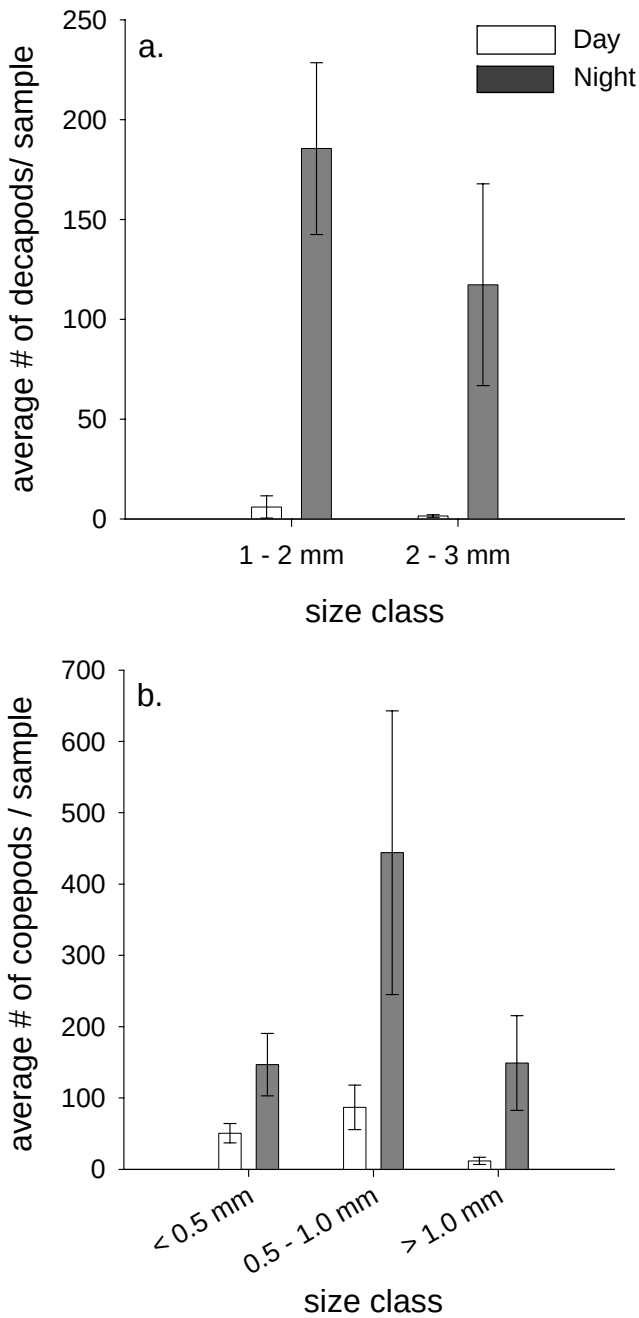

Figure 1. The average abundance per sample of decapods and copepods of different size classes between the day (clear bars) and the night (dark bars) (decapods, $F = 50.47$, df = 1, 13, $P < 0.001$; copepods, $F = 38.10$, df = 1, 21, $P < 0.001$)

13.18, df = 11, 95 , P < 0.0001, means compared with Tukey HSD test, $\alpha = 0.05$).

DISCUSSION

The increased abundance of zooplankton in the water column during the night indicates that zooplankton in the back reef at Discovery Bay are under pressure to partake in DVM. The presence of larger zooplankton at night is also consistent with the prediction that larger zooplankton are more vulnerable to visual predation, and thus are more likely to engage in DVM.

Copepods made up 63% of our night samples while in a past study they constituted 94% of the night samples (Iwamoto 2003), suggesting a shift in zooplankton taxa composition in two years. Although sampling occurred under a full moon, it was cloudy on sampling nights, so it is unlikely that lunar irradiance had any inhibitory effect on the zooplankton ascent. It would be interesting for future studies to investigate the effects of moonlight on zooplankton DVM. Future studies could test if zooplankton emerges earlier with heavy day cloud cover, as would be predicted if light intensity is the stimulus for DVM.

Table 1. Abundance of zooplankton taxa at day and night

Taxa	Day	Night
Copepods (<0.5 mm)	253	587
Copepods (0.5-1 mm)	434	1776
Copepods (> 1mm)	59	596
Decapods (1-2 mm)	24	742
Decapods (2-3 mm)	3	469
Amphipods (< 1 mm)	58	38
Amphipods (1-2 mm)	31	55
Amphipods (> 2 mm)	10	17
Isopods (< 1 mm)	46	28
Isopods (> 1 mm)	31	27
Fish larvae (< 2mm)	1	47
Fish larvae (> 2 mm)	2	151
Polychaetes	159	79
Other (Gastropods, Ostracods, Formanifera)	33	57
Total	1144	4669

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