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Diel variation in abundance and size distribution of zooplankton taxa over a coral reef

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Abstract: Many zooplankton, including the pelagic larvae of benthic invertebrates, face imminent challenges avoiding visually feeding predators. As a result, many have evolved mechanisms to aid in survival. One of these is diel variation in behavior, where zooplankton seek refuge in the benthos during the day and feed in the water column at night. Thus, we hypothesized that zooplankton abundance and species richness would differ between day and night on a Jamaican coral reef, and specifically predicted that abundance, diversity of taxa and size would be greater at night. Our results supported both of these predictions. Therefore, many zooplankton are demersal and follow the predator avoidance hypothesis by entering the water column only at night.

Key Words: copepods, diel migration, vertical migration

Introduction

Many zooplankton, including the larval stages of many benthic organisms associated with coral reefs, have evolved a mechanism to protect themselves from planktivorous predators, especially visually feeding diurnal fish. To become less visible to these fish, zooplankton often seek refuge in the benthos during the day and ascend into the water column to feed only at night.

Thus, we hypothesized that zooplankton abundance and species richness would differ between day and night hours on the backreef of Discovery Bay, Jamaica. Specifically, we predicted that these two measures would be higher at night than during the day. Additionally, we predicted that, on average, species would be larger at night than during the day, since larger sized zooplankton should be especially vulnerable to visual predation.

Methods

Zooplankton were collected on 26 February 2002 near the reef crest in the west back-reef of Discovery Bay, Jamaica. Day samples were taken from 15:00 to 16:00, and night samples were taken from 22:00 to 23:00. Four replicate samples were taken at each time by snorkeling twice (forward and back) along a 20 m transect while holding a plankton net (26 cm diameter, 153 μm mesh) out from the side of the body. The volume of water filtered in each replicate sample was calculated to be about 1.06 m^3. Collected samples were immediately preserved in seawater and 10% formalin. Zooplankton were counted in gridded Petri dishes using dissecting microscopes and measured using a clear plastic ruler placed under the Petri dish. The following organisms were counted: copepods, isopods, amphipods, decapods, mysids, fish larvae, medusae and polychaete worms. All organisms except medusae were placed in one of several size classes. The categories were <0.5 mm, 0.5 - 1 mm and >1 mm for copepods; <1 mm, 1 – 2 mm and >2 mm for polychaetes, isopods and amphipods; 2 – 4 mm and 4 – 6 mm for mysids; 1 – 2 mm and 2 – 3 mm for decapod larvae; and <2 mm, 2 – 4 mm and >4 mm for fish larvae. Abundances were expressed as numbers/m^3. We calculated mean total zooplankton size by assigning the median size to each size class of organism (e.g., 0.25 for 0 – 0.5 mm, 1.25 for >1 mm), and used a t-test to examine differences in total size between the day and night. We used ANOVAs to test the effect of time of day on total zooplankton abundance, abundance by taxa and the proportion of in-

dividuals in each size class of the most abundant taxa (copepods and polychaetes). Some values were log transformed to equalize variances.

Results

We found a much greater abundance of zooplankton taxa in the night sample than in the day sample (Fig. 1). Copepod and polychaete abundance both followed this pattern ($F_{1,6} = 84.8$, $P < 0.001$; $F_{1,6} = 23.7$, $P = 0.003$ respectively) and the other taxa were found only at night

Larger copepods were found in the night sample than in the day sample (Fig. 2). The proportion of copepods in size class of <0.5 mm was higher in the day sample than at night ($F_{1,5} = 33.35$, $P = 0.002$). The proportion of copepods in size class of 0.5 – 1.0 mm was higher in the night sample than in the day sample ($F_{1,5} = 59.7$, $P < 0.001$). The proportion of copepods in size class of >1.0mm was not significantly different between day and night ($F_{1,5} = 1.4$, $P = 0.29$). Polychaetes did not show any trends in size class distribution between day and night ($F_{1,5} = 0.04$, $P = 0.86$). Total zooplankton size was larger at night (means ± SE; Day = 0.55 ± 0.04, Night = 0.75 ± 0.04; $t = 3.5$, $df = 5$, $P = 0.02$).

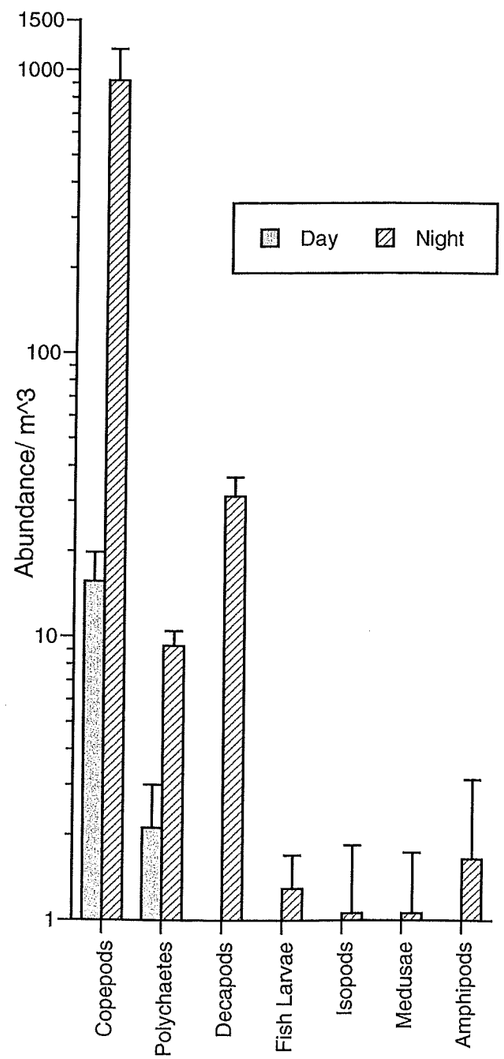

FIG. 1. Zooplankton taxa abundance per m^3 between day and night.

Discussion

As predicted, zooplankton were larger, more abundant and more diverse at night than during the day. This can be explained by a diel migration of demersal zooplankton into the water column at night. This behavior is in accordance with the predator avoidance hypothesis. Zooplankton reduce the risk of predation from visually-oriented planktivores by seeking refuge in the benthos by day, when diurnal planktivorous fish are most abundant, and then emerge at night to feed when nocturnal planktivorous fish are less active and/or less efficient. Although the abundance of polychaetes was greater at night, these worms did not exhibit diel variation in size. Perhaps diurnal polychaete taxa have adapted morphological or physiological predator avoidance tactics.

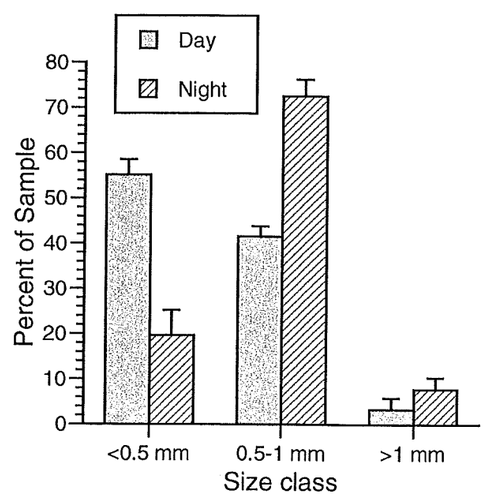

FIG. 2. The average percentage of each sample that each size class (<0.5mm, 0.5-1.0mm, >1.0mm) of Copepods comprises, between day and night.

The zooplankton diel migration observed likely affects other organisms in the reef ecosystem. For example, the failure of many corals to extend their tentacles during the day probably reflects the very low availability of zooplakton during the day.

An FSP study by Chiavielli (1998) used similar sampling methods, but in contrast to their study, we found no mysids and a low abundance of fish larvae in our nighttime samples. Pickhardt et al. (1999) also observed a comparatively low abundance of certain taxa at night, and hypothesized that high levels of moonlight may have inhibited a nocturnal ascent. Indeed, we sampled zooplankton during a full moon, and this could contribute to the decreased diversity of the largest taxa. High levels of moonlight may facilitate visually-oriented predation, and this increased predation could cause zooplankton to remain lower in the water column. Alternatively, the interannual variation in abundance and diversity could be due to different sampling sites, or to large-scale population fluctuations, perhaps due to climatic variation. Future studies could investigate the plasticity of diel migration in zooplankton to determine if these behaviors are modified in response to changes in light levels.

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