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Diel variation in the zooplankton community of a Jamaican reef

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Abstract: Diel vertical migrations commonly found to occur among marine and freshwater zooplankton are typically thought to result from visual predation pressure by fish. Here we examined diel changes in the zooplankton community of the back reef of Discovery Bay, Jamaica, hypothesizing that zooplankton would be larger bodied, more abundant and more diverse at night. All taxa collected by 20 m plankton net tows were identified to order, and copepods — the most abundant taxon — were categorized into four size categories. As predicted, zooplankton were more diverse and abundant at night and larger copepods were found more at night than during the day. The diel differences common to many unrelated taxa in this study and others suggest that diel vertical migration is a tactic broadly employed to persist under conditions of high visual predation pressure.

Key Words: Caribbean, invertebrates, juvenile fish, predator avoidance

Introduction

Demersal zooplankton are an important food source for other invertebrates and for planktivorous fishes in coral reefs (Alldredge and King, 1985). Many zooplankton are large-bodied and are readily seen by visually orienting predators in the water column. The diel vertical migration frequently exhibited by marine and freshwater zooplankton may be a predator avoidance mechanism. Diel vertical migration allows zooplankton to seek cover in the substratum during the day, to escape visual detection by predators, and feed in the water column at night when they will be less conspicuous to visual predators (Robertson and Howard 1978, Ohlhorst 1982, Jacoby and Greenwood 1988).

Here we hypothesized that diel vertical migration would produce higher numbers of zooplankton in the water column at night than during the day in Discovery Bay, Jamaica. Since 75% of total zooplankton abundance in the Caribbean is comprised of copepods (Webber and Roff 1995), we expected to find significantly more copepods than any other taxonomic group of zooplankton during both day and night, and consequently focused greater attention on them. Assuming that susceptibility to predation is influenced by size of the prey, we predicted that those copepods found in the water column at night would be smaller than those found during the day.

Methods

Zooplankton were collected on 27 February 2001 from an area approximately 10 m behind the reef crest of the west back reef, Discovery Bay, Jamaica. Our site differed from those of previous years (Chiavelli et al. 1998, Pickhardt et al. 1999), in that the substrate was sand and turtle grass rather than reef. Snorkelers holding a plankton net (28.5 mm diameter, 153 μm mesh) at arm's length from their sides swam out and back on a 10 m transect. Five replicate samples were collected during the day (14:00-16:00) and five were collected during the night (22:00-23:00). Each collected sample was immediately preserved in seawater with 10% formalin.

All zooplankton in each sample were identified to order and counted without subsampling under a dissecting microscope. All copepods, excluding nauplii, were classified into size categories (< 0.5 mm, 0.5 – 1.0 mm, 1.0 – 2.0 mm, > 2.0 mm). Abundances of individuals and taxa between day and night were compared using ANOVA. Where variances could not be equalized with transformation, Welch's ANOVA was employed. A

chi-square test was used to compare copepod sizes.

Results

We found significantly more individuals per sample at night (312.6 ± 54.9) than during the day (79.2 ± 54.9) (ANOVA, F = 9.05, df = 1, 8, P = 0.017). Significantly more taxa were found at night (8.6 ± 0.8) than during the day (5.0 ± 0.8) (ANOVA, F = 9.53, df = 1, 8, P = 0.015; Table 1). Copepods made up an average of 55.9 (± 0.1)% of the samples, and there was no difference between the proportion of copepods during day and night (Welch's ANOVA, F = 1.43, df = 1, 8, P = 0.29). The size distribution of copepods was significantly different between day and night (χ^2 = 91.20, df = 3, 1001, P < 0.0001; Fig. 1). The day sample had a greater percentage of small copepods (< 0.5 mm) and a much smaller percentage of large copepods (1+ mm) than the night sample.

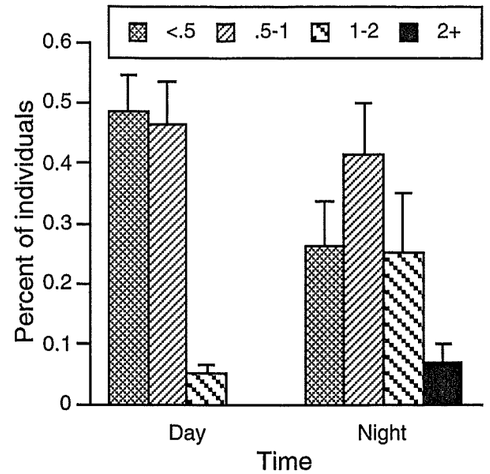

Fig. 1. Percent of individuals (± 1 SE) in each of four zooplankton size classes in the East Back Reef, Discovery Bay, Jamaica.

Discussion

Greater nocturnal abundance, body size, and diversity of the back reef zooplankton is likely due to vertical migration up from the substratum, a phenomenon frequently reported in coastal waters (Robertson and Howard 1978, Ohlhorst 1982, Alldredge and King 1985, Jacoby and Greenwood 1988, Pickhardt et al. 1999). Under conditions of high predation pressure from visually feeding fish, zooplankton may find refuge near the bottom during the day but feed relatively safely in the water column at night when they are less likely to be visually detected. Such a behavior would be particularly more advantageous for larger bodied and thus more conspicuous organisms. Accordingly, our data are consistent with the hypothesis that larger copepods are more likely to undergo migration than smaller copepods (Fig. 1). Additionally, the greater diversity of our night-time samples suggests that diel vertical migration is undergone by a wide range of unrelated taxa. While copepods showed the clearest differences between day and night abundance, such a pattern was also striking for decapods, fish, and polychaetes (Table 1) — all relatively large bodied organisms. The generality of this behavior across disparate taxa may suggest that diel vertical migration is one of the few mechanisms by which large bodied planktonic organisms can persist under high visual predation pressure.

Table 1. Differences in zooplankton density (mean m^{-3} (SE)) between day and night on the back reef of Discovery Bay, Jamaica. One-way ANOVA was used to determine the effect of time on density.

	Density (m^{-3}) / (SE)					
Taxa	Day		Night		$F_{1,8}$	P
Amphipoda	0.2	(0.2)	3.4	(2.5)		dn
Coil	0	(0)	0.0	(0.1)		dn
Copepoda	16.3	(7.5)	72.2	(10.8)	17.90	0.003
Cumacean Shrimp	0	(0)	0.9	(0.6)		dn
Decapoda	11.8	(11.6)	44.9	(10.4)		d
Fish	0.6	(0.7)	2.5	(0.9)		d
Foraminifera	0.1	(0.1)	1.9	(1.3)		dn
Gastropoda	0	(0)	3.4	(1.0)		d
Isopoda	1.0	(0.5)	1.9	(1.1)		d
Cnideria	0.1	(0.1)	0	(0)		dn
Nauplii	6.0	(5.3)	8.2	(3.9)	0.12	0.74
Nematoda	0.1	(0.1)	0.1	(0.1)		dn
Ostracod	0.1	(0.2)	0.3	(0.3)		dn
Polychaeta	1.5	(1.2)	11.5	(4.5)		d
Total	48.6	(33.5)	203.6	(31.4)	11.39	0.0097

[dn] 2 or more of the day (d) or night (n) samples contained 0 individuals and therefore a statistical test was not conducted.

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