Diel changes in the zooplankton assmeblage near a caribbean reef crest

P. C. PICKHARDT, A. G. BLUNDELL, AND THE 1999 DARTMOUTH FSP CLASS

Abstract. A diel shift of habitat is a proposed strategy employed by many zooplankton to avoid diurnal, visually feeding planktivores. Consistent with predator avoidance, we found that there was approximately four times more zooplankton in the water column at night along the reef crest at Discovery Bay, Jamaica than during the day. Excluding copepods, the nocturnally active zooplankton were, on average, 2.5 times larger than those collected during the day.

INTRODUCTION

Zooplankton, including the larvae of most species on the coral reef, move through the open water during dispersal. Some species also leave a benthic refuge and enter the water column to feed. To reduce the risk of predation, we hypothesized that some zooplankton will be in the water column only at night, avoiding visual predators that feed during daylight hours. Further, zooplankton that are in the water column during the day will be smaller, on average, than zooplankton that seek refuge during the day.

Specifically, we tested whether the density, size, and species composition of the zooplankton in the water column above the back reef at Discovery Bay, Jamaica, differ between day and night.

METHODS

Zooplankton were collected on 1 March 1999 from approximately 20 m behind the reef crest of Discovery Bay, Jamaica, just East of the canoe channel. Zooplankton tows were taken by snorkelers holding a plankton net (26 cm diameter, 153 µm mesh) at arm's length from the body, 20-40cm below the surface, swimming out and back along a 20 m long transect, parallel to the reef crest. Five replicate day samples were collected from 14:00-15:30 (75% cloud cover) and five night samples were taken from 22:00-23:00 (full moon, clear). Samples were rinsed from the net and immediately preserved in seawater with 10% formalin.

Zooplankton were counted and measured in Petri dishes with an inscribed grid using dissecting microscopes with a clear plastic ruler placed beneath the Petri dish. For all 10 samples (5 day, 5 night) the entire sample was counted. Lengths for all organisms in the following taxa were measured: decapod larvae, fish larvae, polychaetes, isopods, mollusc larvae, cnidaria, amphipods, mysids, and appendicularians. Due to their great abundance, copepods were placed into one of three size categories: <0.5 mm, 0.5-1.0 mm, or >1.0 mm, and for calculating average size, the following sizes were assigned to each of these categories: 0.35 mm, 0.75 mm, and 1.25 mm, respectively. Because of their great abundance and relatively small, consistent size crustacean nauplii were not measured or put into size categories.

RESULTS

Zooplankton density in the water column on the back reef of Discovery Bay, Jamaica, was approximately four times greater at night than during the day ($P = 0.004$; Table 1). Copepods were the most abundant taxon by night, and although only one-tenth as abundant during the day, they still composed almost half of the diurnal zooplankton population (Table 1). Decapoda were also significantly more abundant at night than during the day, whereas nauplii had the exact opposite pattern of abundance—almost six times more common during the day (Table 1). Appendicularia, fish larvae, cnidaria, and mysids were found at night, often in all five samples, but were completely absent from most of the day samples. Given the greater number of individuals collected at night, we suspect that species richness was substantially reduced during the day. Likewise considering that a larger number of taxa were represented at night, we suspect that species diversity was also reduced by day.

The copepods in the day samples were no smaller than those in the night samples (Fig. 1). The average length of night-active zooplankton in the other taxa, however, was more than double that during the day (Table 2).

This is chiefly due to the relatively common polychaeta and decapoda; night-active individuals in these taxa were significantly larger than those active during the day. The maximum length recorded by day was 3.0 mm and by night 9.1 mm.

Table 1. A comparison of zooplankton density (mean m^{-3} (s.e.)) between day (n = 5 tows) and night (n = 5 tows) on the back reef of Discovery Bay, Jamaica. One-way analysis of variance (ANOVA) was used to test for the effect of time of day—where variances between day and night samples were unequal, a Welch's ANOVA was used.

Taxa	Density (m^{-3})					
	Day		Night		$F_{1,8}$	P
Copepoda	234.7	(26.5)	2318.2	(313.3)	43.9	0.003
Nauplii	282.7	(26.3)	49.5	(12.5)	64.2	<0.0001
Decapoda	2.8	(1.1)	116.4	(15.4)	54.0	<0.0001
Polychaeta	28.4	(15.7)	7.2	(1.9)	1.8	0.22
Isopoda	7.7	(1.8)	7.7	(4.7)	0	1.0
Fish larvae	0.2	(0.2)	3.6	(3.1)		dn
Mollusca larvae	0.8	(0.4)	0.2	(0.2)		dn
Cnidaria	0.9	(0.6)	3.0	(1.1)		d
Amphipoda	1.9	(1.1)	2.8	(1.4)		dn
Mysids	0	(0.0)	0.4	(0.4)		d
Appendicularia	0.2	(0.2)	21.1	(6.0)		d
Totals	**560.3**	**(54.3)**	**2530.1**	**(341.5)**	**32.5**	**0.004**
Totals*	322.8	(38.5)	95.5	(20.5)	27.2	0.008

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

Table 2. A comparison of the length (mm) of zooplankton (mean (s.e.)) between day (n = 5 tows) and night (n = 5 tows) on the back reef of Discovery Bay, Jamaica. A t-test was used to test for the effect of time of day.

Taxa	Length (mm)							
	Day			Night				
	r	Mean	(s.e.)	n	Mean	(s.e.)	T	P
Nauplii		N/A			N/A			
Decapoda	15	0.85	(0.15)	663	1.23	(0.02)	6.1	0.01
Polychaeta	141	0.52	(0.03)	38	0.98	(0.07)	38.4	<0.0001
Isopoda	41	0.81	(0.07)	41	0.80	(0.14)	0.006	0.94
Fish larvae	1	2.00	..	4	2.58	(1.03)		dn
Mollusca larvae	4	0.35	(0.05)	1	0.90	..		dn
Cnidaria	6	0.57	(0.15)	15	0.85	(0.12)	1.77	0.20
Amphipoda	10	0.53	(0.10)	15	0.75	(0.10)	2.37	0.14
Mysids	0			2	5.55	(3.55)		dn
Appendicularia	1	2.00		112	1.30	(0.06)		dn
Totals*	219	0.46	(0.03)	891	1.21	(0.67)	27.2	0.008

* excluding Copepoda and Decapoda
[dn] day (d) or night (n) samples contained fewer than 5 individuals and therefore, a statistical test was not conducted

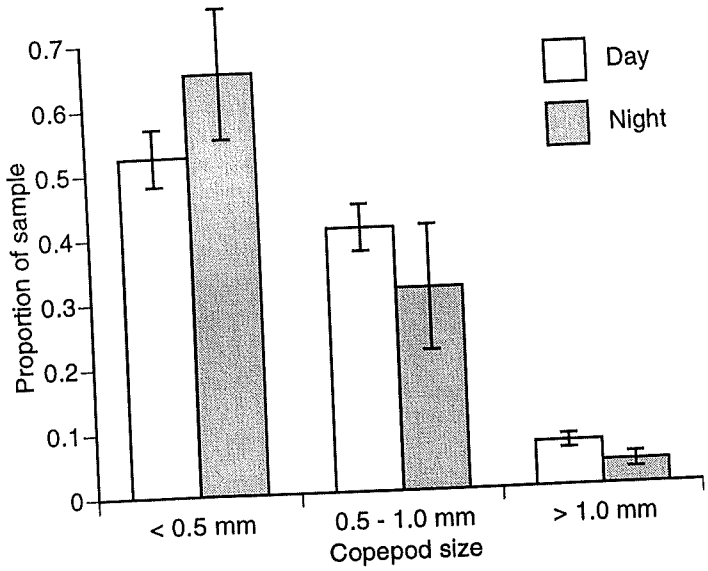

Fig. 1. A comparison of the size distribution (length; mm) of copepods (mean (± 1 s.e.)) between day (n = 5 tows) and night (n = 5 tows) on the back reef of Discovery Bay, Jamaica. No contrasts were significant by a t-test.

DISCUSSION

As predicted, zooplankton on the back reef of Discovery Bay were both larger and more abundant during the night than the day. It is likely that the night zooplankton community was also more diverse and species rich. Presumably the changes in community composition reflect predator avoidance behavior. By day zooplankton move deeper into the water column or seek refuge among corals and other substrate on the reef. At night fishes and other predators that use visual cues to capture prey are less common, or at least less efficient, and the predation risk decreases for the zooplankton. The absence or low occurrence of large zooplankton such as mysids, cumaceans, and fish larvae in the night samples compared to previous studies (Chiavelli et al. 1998) could be due to the entirely full moon and bright conditions during the night sampling. It is suggested that succeeding studies make note of light conditions during sampling as moonlight (Alldredge and King 1980; Jerling and Wooldridge 1992) affects movement into the water column for particular zooplankton taxa.

LITERATURE CITED

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