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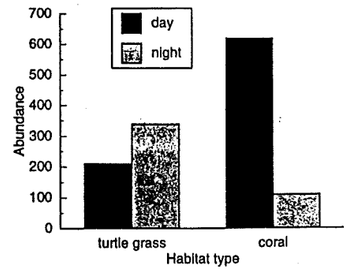

Fig. 1. Fish abundance in coral reef and turtlegrass habitats at Discovery Bay, Jamaica, during day and night. Values represent total fish that were counted during 4 ten minute swims along ~50 m transects in each habitat.

Table 1. Fish observed during four ten-minute swims along 50 m transects in two different habitats in Discovery Bay, Jamaica, during day and night.

Fish type	Feeding group	Turtle grass day	Turtle grass night	Coral day	Coral night	Totals
damselfish	herb	85	0	206	2	293
surgeonfish	herb	8	2	52	2	64
parrotfish	herb	14	0	169	0	183
angelfish	herb	0	0	1	0	1
butterflyfish	pl/inv	0	0	29	0	29
wrasse	pl/inv	20	1	96	0	117
trunkfish	pl/inv	0	0	2	0	2
balloonfish	pl/inv	6	9	2	16	33
soldierfish	pl/inv	10	41	5	64	120
squirrelfish						
grunt	pl/inv	34	0	36	0	70
hamlet	pl/inv	0	0	1	0	1
goatfish	pl/inv	0	0	1	0	1
goby	pl/inv	0	0	2	1	3
cardinalfish	pl/inv	0	51	0	4	55
trumpetfish	pl/inv	0	0	1	0	1
scorpionfish	pisc	0	0	1	0	1
sanddiver	pisc	2	0	0	0	2
jack	pisc	31	0	0	0	31
snapper	pisc	0	2	0	1	3
moray eel	pisc	0	0	1	0	1
unidentified	?	0	234	15	20	269
TOTALS		210	340	620	110	1280

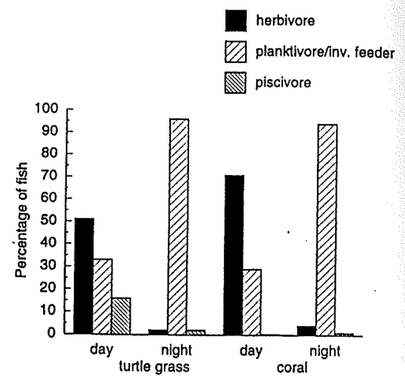

Fig. 2. Shifts in community composition as defined by guild. Percentages represent fish found in each habitat in Discovery Bay, Jamaica, during day and night. Turtle grass day N=210; Turtle grass night N=106; Coral day N=605; Coral night N=90.

DIEL SHIFTS IN DEMERSAL ZOOPLANKTON ABUNDANCE OVER TWO HABITAT TYPES

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Abstract. Demersal zooplankton are key members of the food webs within coral reef communities as both predators and prey which migrate vertically to the water column at night. We measured demersal zooplankton abundance in the water column above two habitat types during the day and the night in an attempt to quantify and examine differences in abundance of zooplankton between turtle grass (Thalassia testudinum) beds and coral/algae dominated areas with respect to refuge availability in the two substrates. We found that abundances were higher at night in both habitats and that zooplankton were more abundant over turtle grass beds than over coral/algae dominated areas, irrespective of time of day. The higher abundance over turtle grass beds may be due to differences in amount of sediment between the two habitats, coral predation on zooplankton and/or more intense wave action in the coral/algae habitat.

Key words: marine invertebrates, predatory defense

INTRODUCTION

The diel migration of demersal zooplankton from the reef substratum into the water column is a well documented phenomenon (Emery 1968; Sale et al. 1976; Alldredge et al. 1977; Ohlhorst 1982). These zooplankton are an important component of marine food webs as a food source for a wide array of planktivorous fish and invertebrates, and their migration patterns can influence the behaviors of these predatory species (Ohlhorst 1982). Zooplankton populations are influenced by a variety of factors; diel, seasonal, and lunar cycles as well as different substrate types have been shown to have a large impact on the density, diversity and abundance of demersal zooplankton (Walters et al. 1986; Jacoby et al. 1989).

Demersal zooplankton can best avoid visual planktivorous predators by seeking refuge in benthic sediment during the day and emerging to feed in the water column at night. We hypothesized that we would find a greater abundance of zooplankton, regardless of substrate type, in the night samples as compared to the day samples. We sampled the abundances of zooplankton during the day and at night along two different substrate types (turtle grass, Thalassia testudinum, and the coral reef). We also hypothesized that we would find a greater abundance of zooplankton in the turtle grass than along the coral reef. We expected that the turtle grass would provide a refuge for the zooplankton from the turbulence and currents found along the coral reef. Additionally, many corals are planktivorous, therefore, the turtle grass represents a refuge from these predators as well.

METHODS

Research was conducted on 27 February 1997 at Discovery Bay Marine Laboratory, Discovery Bay, Jamaica. We collected zooplankton from two locations in the West Back reef: (i) over a turtlegrass bed in 1.5 m of water, and (ii) over the coral and algae dominated area near the reef crest in 1.0 m of water. A 20 m transect was set up over the turtle grass, and a 16 m transect was set up over the coral/algae. We collected three samples at each location during the day (16:00) and at night (21:00) by swimming along the length of the transects lines with a 202 mm zooplankton net (26 cm diameter opening) held 0.3 m below the surface. Samples were brought back to the lab in sample jars where each sample was anaesthetized with CO2 (Alka-Seltzer tablet) and preserved with 50% ethyl alcohol solution. Zooplankton within each sample were counted and identified under dissecting microscopes and were grouped into seven taxonomic groups: mysids, copepods, decapods, fish larvae, isopods, polychaetes and "others" (Newell and Newell, 1977). The "others" category consisted of zooplankton which we could not identify with certainty, as well as uncommon taxa.

RESULTS

Zooplankton density in the water column was significantly greater during the night (247.9+92.2 individuals/m3) than during the day (7.3+1.4 individuals/m3; t-test, t=2.61, df=16, P=0.026). This difference in zooplankton density was observed for both of

the two substrates that we examined. Zooplankton abundance was greater during the night (54.9+11.8 individuals/m3) than the day (5.1+2.1 individuals/m3) in the water column over the coral substrate (t-test, t=4.15, df=4, P=0.014). Significantly more zooplankton also occurred in the water column over the turtlegrass during the night (440.8+71.5 individuals/m3) than during the day (9.4+0.94 individuals/m3; t-test, t=6.03, df=4, P=0.004).

Combining both day and night samples, we found a greater density of zooplankton over the turtlegrass substrate (225.2+101.6 individuals/m3) than the coral substrate (30.0+12.4 individuals/m3; t-test, t=1.91, df=10, P=0.086). The difference between turtle grass and coral was significant during the night (t-test, t=5.33, df=4, P=0.006) and a trend during the day (Fig. 1; t-test, t=1.90, df=4, P=0.13).

The large increases in abundance of mysids from day to night reflect the trend of greater abundance of all zooplankton at night versus day (Table 1). The relative proportions of mysids to all other groups increased from day to night, while the relative proportions of copepods and isopods decreased. In addition, the polychaetes, decapods, and fish larvae were found only at night.

Discussion

Our results showed that the total number of zooplankton in the water column was greater during the night than during the day in both the turtlegrass and coral habitats. This is likely a result of visually seeking fish predators removing zooplankton from the open water during the day and vertical diel migrations by the zooplankton to and from the sediment. Since zooplankton are preyed upon by visual predators, they spend the day in the sediment and feed at night when they are less conspicuous to their predators.

In a comparison of zooplankton abundance between the coral habitat and the turtle grass habitat, more zooplankton were in the water column above turtle grass. This overall greater abundance in turtle grass versus coral may be because the turtle grass habitat offers more sediment for the zooplankton to escape predation than the coral habitat provides. The coral habitat is at the reef edge and subject to more intense wave action, and may therefore experience a higher turbulence which moves both the zooplankton and the zooplankton's food sources out of the area. In addition, there are potentially more predators closer to the reef, which would lower the relative abundance of zooplankton in the water column above the coral habitat.

TABLE 1. Zooplankton density (individuals/m^3) and relative proportions of the major classifications found in samples.

	Coral Substrate				Turtle grass substrate			
	Day	% Day	Night	% Night	Day	% Day	Night	% Night
Mysids	0.39	7.6	29.8	54.3	4.72	50	392.5	89.1
Polychaetes			1.17	2.1			6.29	1.4
Decapods			14.5	26.4			6.60	1.5
Copepods	2.75	54.0	5.09	9.3	3.46	36.6	9.44	2.1
Isopods	1.17	23.0	4.31	7.9	0.63	6.7	0.94	0.2
Fish Larvae							15.09	3.4
Other	0.78	15.4			0.63	6.7	10.02	2.3
Totals	5.09	100	54.87	100	9.44	100	440.88	100

The overall lower abundance of zooplankton in the coral habitat could also be due to predation upon zooplankton by the corals (Yonge 1930). In addition, the greater difference in abundance between habitats at night may be influenced by nocturnal feeding behavior of corals which could further lower the abundance of the zooplankton in the coral habitat.

The pattern of higher abundance of zooplankton during the night compared to during the day was due to the general increase in all classification groups at night, including three groups which were not found during daytime sampling. Most striking are the large increases in the number of mysids collected at night. It may be that this substantial increase in mysid abundance was caused by sampling in a mysid swarm. Mysids exhibit a schooling behavior and aggregate in clumped distributions in the water column (Emery 1968). Thus, if we came across one of these swarms in our sampling, we would expect to see large increases in both the total number and relative proportion of mysids. In addition, the three groups found only at night (polychaetes, decapods, and fish larvae) may be more vulnerable to daytime predation and might derive the greater benefit from diel vertical migration as a defensive behavior than other zooplankton groups.

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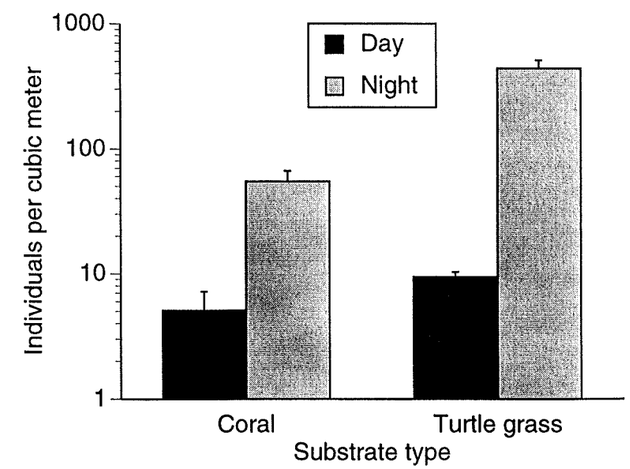

FIG. 1. Zooplankton density of day versus night samples over two different substrate types in Discovery Bay, Jamaica. N=3 for each bar.