THE GREAT ZOOPLANKTON DIE-OFF OF 2004

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Abstract: Many zooplankton exhibit diel vertical migration; they seek refuge from planktivorous fish in the benthos during the day, but rise into the water column at night to feed. We studied a zooplankton community during day versus at night and compared abundances and size classes of various taxa. Surprisingly, there was no difference between day and night zooplankton abundance. Furthermore, total abundances were significantly lower than those found in previous studies. Zooplankton were approximately two times larger at night than during the day, driven by the larger abundance of decapod larvae at night. The largest and smallest size classes of copepods, however, were more abundant during the day. These results contradict the diel pattern of zooplankton abundance found in previous studies. We speculate that zooplankton have patchy distribution horizontally in the water column. Habitat heterogeneity of zooplankton resources such as refuge and food could cause spatial variance in abundance. It is also possible that there has been a large decrease in zooplankton abundance in the back reef in the past year.

Key words: demersal zooplankton abundance, diel vertical migration, habitat heterogeneity

INTRODUCTION

Many zooplankton exhibit diel vertical migration; they are found in the benthos during the day, but rise into the water column to feed at night. This migratory behavior is thought to provide protection from predation by planktivorous fish that rely on vision to locate food during the day, but are less active and efficient at night. In addition, zooplankton size may influence their vulnerability to visual predators, such that predation risk increases with the size of the individual. In this study, we explored diel patterns of abundance, composition, and size structure of the zooplankton community in Discovery Bay, Jamaica. We predicted that we would find a lower abundance of zooplankton in the water column over a tropical coral reef during the day than during the night. We also predicted that we would find a greater abundance of larger individuals and taxa at night.

METHODS

We collected five replicate zooplankton samples both during the day (1330 to 1430) and at night (2200 to 2300) on 28 February 2003 near the reef crest in the West back reef of Discovery Bay, Jamaica. Samples were collected by towing a plankton net (153 μm mesh, 26 cm diameter) for 40 m back and forth along a 20 m transect at a depth of 20 - 40 cm. The volume of water filtered in each replicate sample was ~1.06 m^3. Collected samples were preserved in 10% formalin in the field and zooplankton taxa were later identified and counted in the lab using dissecting microscopes. We categorized the zooplankton into copepods, amphipods, isopods, decapod larvae, mysids, polychaete larvae, fish larvae, medusae, arrow worms, larvaceans, and cumacean shrimp. We assigned size classes for copepods (< 0.5 mm, 0.5 - 1 mm, > 1 mm), amphipods (< 1 mm, 1 - 2 mm, > 2 mm), isopods (< 1 mm, 1 - 2 mm, > 2 mm), decapod larvae (1 - 2 mm, 2 - 3 mm), mysids (2 - 4 mm, 4 - 6 mm), polychaete larvae (< 1 mm, 1 - 2 mm, > 2 mm), and fish larvae (< 2 mm, 2 - 4 mm, > 4 mm).

We analyzed the differences in zooplankton abundance and size between day and night using an ANOVA model, with sample nested within time (sample as a random effect).

RESULTS

There was no difference between day and night zooplankton abundance ($F_{1,8}$ = 0.64, P = 0.43). We found a total of 656 zooplankton during the day and 399 zooplankton during the night. There was little variance in abundance between samples of the same time of day ($F_{8,60}$ = 0.27, P = 0.97). There was no difference in abundance for any of the taxa sampled (all P > 0.007; with Bonferroni correction for multiple tests, α = 0.05, critical P = 0.0007), although copepods tended to be more abundant during the day ($F_{1,8}$ = 12.2, P = 0.008; Fig. 1).

Overall average zooplankton size was approximately two times larger at night than during the day; night zooplankton had a mean size of 1.52 mm ± 0.21, and day zooplankton were 0.78 mm ± 0.19 ($F_{1.8}$ = 6.87, P = 0.02). This result was driven by increased decapod abundance during the night (182 at night, 2 during the day), as decapods are large (1-3 mm). There was no difference overall in zooplankton size between samples at the same time of day ($F_{8,60}$ = 0.44, P = 0.88).

Copepods, a relatively small zooplankton category(< 1.5 mm), showed diel differences in size-class distributions. Copepods smaller than 0.5 mm ($F_{1.8}$ = 18.3, P = 0,003) and larger than 1 mm ($F_{1.8}$ = 12.2, P = 0.008) were more abundant during the day, while the abundance of zooplankton in the middle size class was similar day and night ($F_{1.8}$ = 1.64, P = 0.24; Fig. 2).

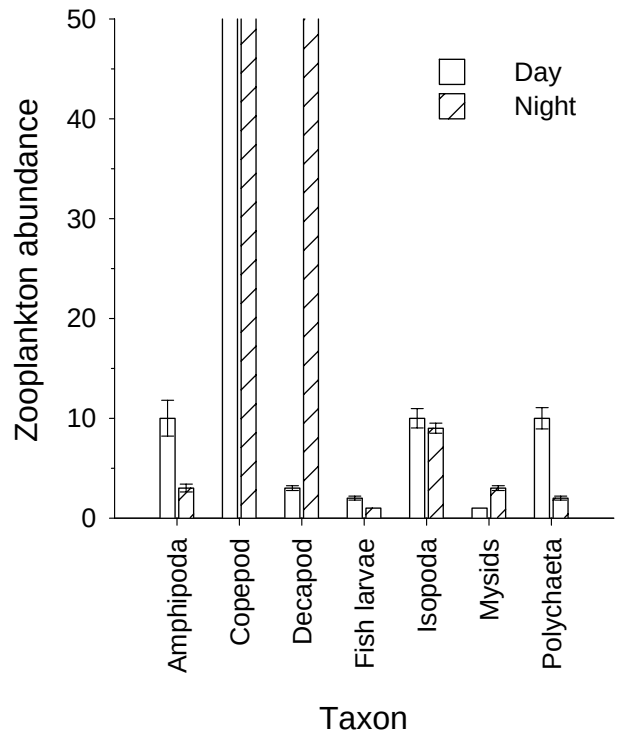

Figure 1. Zooplankton abundance between taxa in the day versus the night. Copepod day abundance was 627 ± 11.96 and night abundance was 205 ± 21.04. Decapod night abundance was 183 ± 11.96. Graph was capped to allow comparison between less abundant zooplankton.

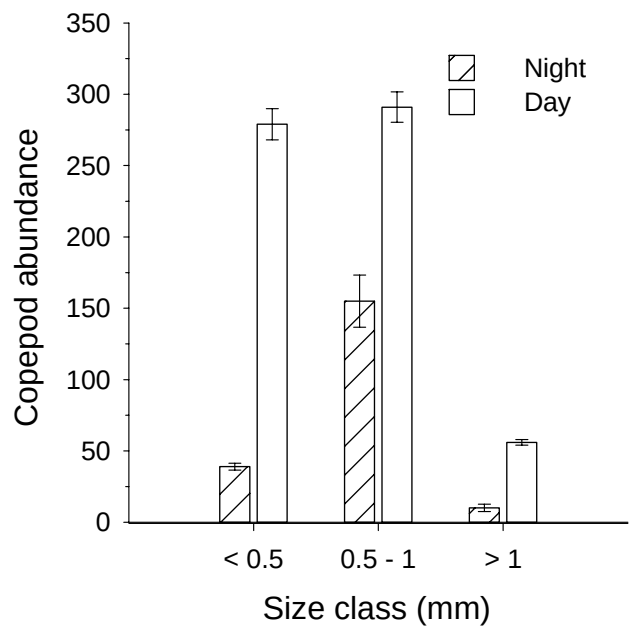

Figure 2. Copepod size class abundance during the day versus at night.

DISCUSSION

We found very low overall zooplankton abundance (orders of magnitude less than in three previous years; Fagan et al. 2002, Iwamoto et al. 2003, Pickhardt et al. 1999), with no significant difference between day and night abundance. The trend of greater zooplankton abundance during the day than at night is inconsistent with the findings of other diel zooplankton pattern studies. This is especially surprising as

there was little moonlight (four days waxing past the new moon), and we expected that zooplankton would be more abundant in darker night conditions when visual predators are disadvantaged.

We speculate that zooplankton have a patchy distribution horizontally in the water column. This may be caused by habitat heterogeneity of zooplankton resources, such as refuge and food, that could lead to spatial variance in abundance. Perhaps we saw low zooplankton abundance because there was little refuge available to zooplankton in our sampling area. Further studies should look for horizontal patchiness in zooplankton abundance, and determine if local abundance is affected by available refuge, or other factors that vary spatially across their range.

The average zooplankton size was larger at night versus the day. This pattern was driven by decapod larvae, which are large and much more abundant at night. Copepods, the most abundant and smallest zooplankton, had a higher abundance of the largest and smallest size classes during the day versus the night, while the middle size class did not change. The largest copepod size class was smaller than all the other zooplankton taxa. Therefore, we expected them to be more abundant during the day, as they are not easily seen by visual predators. The increased abundance of large copepods during the day, however, may be an artifact of low sample size. Perhaps there were such low levels of abundance overall that finding a few of the largest copepods could lead to a statistically significant result.

The results of this study suggest that there may have been a large decrease in zooplankton abundance in the back reef in the past year. Alternatively, zooplankton abundance may experience endogenous population fluctuations on some temporal scale, or fluctuate in response to some exogenous perturbation.

LITERATURE CITED

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