

The effect of depth on invertebrate colonization patterns on a Caribbean reef

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Abstract: We examined the abundance and taxa richness of invertebrates colonizing unoccupied habitat at two depths on the forereef at Discovery Bay, Jamaica. Abundance and richness increased over five days at both 7 m and 16 m, but were higher overall at 7 m. Increased light availability and primary productivity at shallow depths may provide a larger and more diverse pool of potential colonizers. In addition, invertebrate community structure varied with time and depth, possibly due to differential colonization and competitive abilities of taxa. Further study could reveal the long-term influence of depth on invertebrate colonization.

Key Words: community structure, Discovery Bay, light availability

INTRODUCTION

In marine systems, colonization is an important process in determining community structure. Colonization is influenced by resource availability, taxa pool, and the volume of water that flows by a given substrate. Due to differences in light availability, shallow depths generally support higher rates of primary productivity and a wider resource base for marine organisms, increasing the pool of potential colonizers (Dunne et al. 1996). In addition, greater wave action at shallow depths may increase the rate at which colonizers encounter new substrata.

We examined the relationship between depth and invertebrate colonization of unoccupied habitat on the forereef of Discovery Bay, Jamaica. We predicted that the community composition of colonizing invertebrates would differ with exposure time and depth. We also predicted that the abundance and taxa richness of invertebrates would be higher at a shallow depth. Lastly, we predicted that the abundance and richness of colonizers would increase over time, as more individuals find and settle on the habitat.

METHODS

We conducted this study from 6 - 11 March 2003. At the start of the study, we attached 12 clean bristle brushes to cinder

blocks in an upright position at each of two depths (7 m and 16 m), positioning the blocks on coral and macroalgae substrata with no cover. One, three, and five days after we put out the brushes, we collected 4 replicate brushes from each depth, placing each one in a separate ziplock bag to prevent loss of fauna. We filtered the water in the bags through a 250 μ m mesh, rinsed the brushes in fresh water, and filtered the rinse water. The material retained on the filter was preserved in 10% formalin. Using dissecting microscopes, we counted the number of invertebrates in each taxon (identified to order). We used a G-test to determine if there was a difference between the frequencies of taxonomic groups with depth or time. We used a two-way ANOVA to determine whether exposure time and depth influenced invertebrate abundance and taxa richness.

RESULTS

The frequencies of individuals in each taxon pooled over depth differed significantly with day (Table 1; $G = 71.53$, $df = 18$, $P < 0.001$). Taxon frequencies after five days also differed significantly with depth (Table 2; $G = 31.90$, $df = 7$, $P < 0.001$). Copepods made up the largest proportion of individuals at all depths and times. The proportion of polychaetes increased at both depths over time, while the proportion of amphipods and isopods decreased. Inverte

brate abundance increased over time at both depths, but was lower at the deep site than at the shallow site on all days (Fig. 1; $F = 7.17$, $df = 2, 21$, $P = 0.05$). At both depths, taxa richness increased over time (Fig. 2; $F = 18.18$, $df = 2, 21$, $P < 0.001$). Taxa richness was higher at the shallow site than the deep site (Fig. 2; $F = 5.20$, $df = 1, 22$, $P = 0.03$).

DISCUSSION

The composition of the invertebrate community that colonized bristle brushes differed over time and between depths. Over time, polychaete abundance increased and isopods and amphipods decreased. Polychaetes may be slower to colonize new substrate, but may be better competitors once they arrive, excluding early settlers such as isopods and amphipods.

Invertebrate abundance and taxa richness increased over time at both the shallow and deep sites, perhaps because with time, more organisms were able to find and colonize the new substrate. In addition, early colonization by bacteria and algae may facilitate the later recruitment of invertebrates. As predicted, invertebrate abundance was higher at the shallow site than the deep site on all days, potentially due to greater primary productivity. Light intensity decreases exponentially with depth, thus the

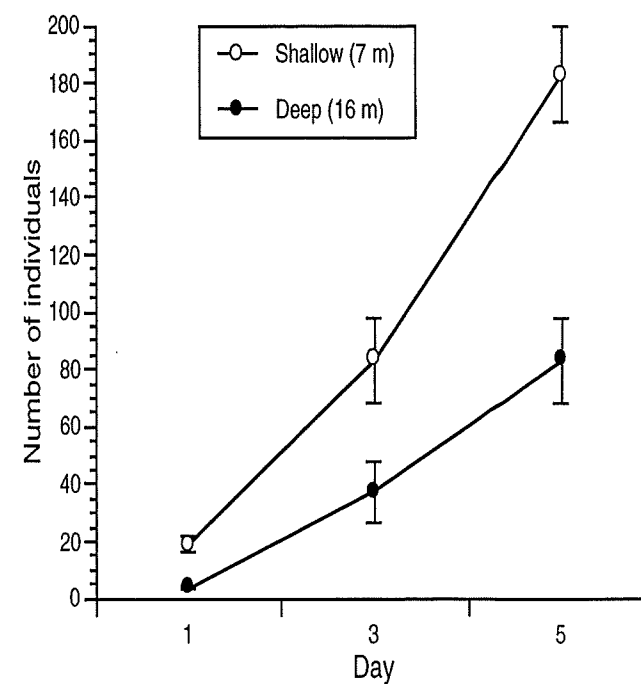


FIG. 1. Abundance (mean \pm SE; $n = 4$) of invertebrates over time at both shallow (7 m) and deep (16 m) sites. Data were collected from the forereef of Discovery Bay, Jamaica.

shallow site received more light and probably had higher rates of primary productivity. Areas with higher productivity provide more resources for invertebrates and can support more individuals. Therefore, taxa richness and abundance of potential colonizers may be higher at shallow depths. This effect of pool size may be magnified because intense wave action at shallow depths increases flow rates and the number

TABLE 1. Abundance of invertebrates in each taxon that colonized bare substrate after 1, 3 and 5 days pooled over depth in Discovery Bay, Jamaica ($n = 8$).

Taxa	Day			Total
	1	3	5	
Amphipod	13	34	25	72
Chaetognath	0	1	0	1
Copepod	46	299	725	1070
Cumacean	1	13	9	23
Decapod	1	11	11	23
Echinoderm	0	0	1	1
Isopod	2	27	33	62
Oligochaete	3	2	2	7
Polychaete	12	94	244	350
Sea Cucumber	0	1	0	1
Total	78	482	1050	1610

TABLE 2. Abundance of invertebrates in each taxon that colonized bare substrate after five days at shallow (7 m) and deep (16 m) forereef sites in Discovery Bay, Jamaica ($n = 8$).

Taxa	Depth		Total
	20 feet	50 feet	
Amphipod	20	5	25
Copepod	474	251	725
Cumacean	3	6	9
Decapod	5	6	11
Echinoderm	1	0	1
Isopod	27	6	33
Oligochaete	1	1	2
Polychaete	195	49	244
Total	726	324	1050

of potential colonizers that encounter available substrate.

The patterns we observed in taxa richness over time suggest that after five days the richness of the shallow site was still increasing, but richness of the deep site may have reached a plateau after three days. Future studies of invertebrate colonization could reveal whether depth influences long-term community composition and the saturation points of richness and abundance.

LITERATURE CITED

Dunne, R. P. and B. E. Brown. 1996. Penetration of solar UVB radiation in shallow tropical waters and its potential biological effects on coral reefs; results from the central Indian Ocean and Andaman Sea. *Marine Ecology Progress Series*. 144. Pp. 109-118.

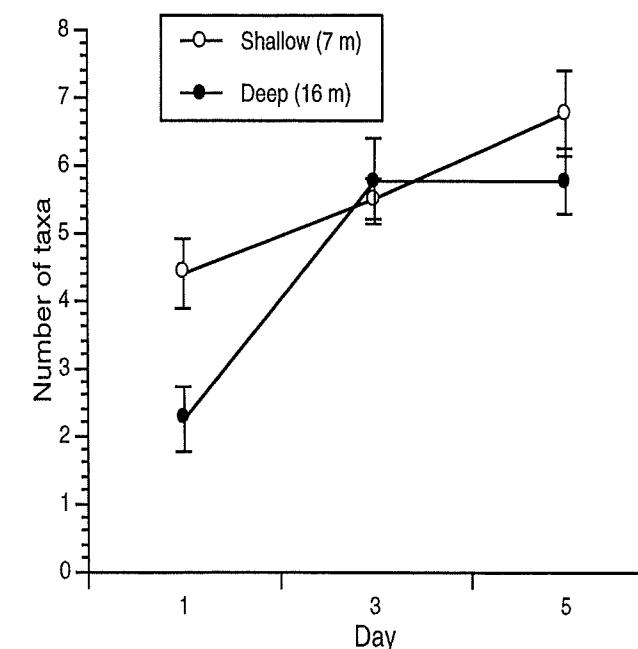


FIG. 2. Richness (mean \pm SE; $n = 4$) of invertebrate taxa over time at both shallow (7 m) and deep (16 m) sites. Data were collected from the forereef of Discovery Bay, Jamaica.