



Intertidal macroinvertebrate community structure in a subtropical channel is driven by sediment properties across different land-use types

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Received: 3 November 2021 / Accepted: 23 April 2022 / Published online: 2 May 2022
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Abstract

Macroinvertebrate community in the intertidal setup plays an important role in coastal ecosystem functions and biogeochemical cycle. However, different land use pattern may influence on their community structure, diversity, and composition in the coastal ecosystems. Using Van-Veen grab sampler, 60 sediment samples were seasonally collected from mangroves-dominated, aquaculture-dominated, and anthropogenically affected area in the lower intertidal zone of the Kohelia channel of Bangladesh, the Northern Bay of Bengal. We have tested the variation in sediment properties across three land-use types in this intertidal habitat. To understand the patterns of benthic macroinvertebrate distribution, a neutral community model was applied. Our results showed that community composition and biodiversity of the benthic macroinvertebrate communities varied significantly between mangrove-dominated area with anthropogenically affected areas among the four seasons. The neutral community model revealed that community assembly of benthic macroinvertebrates in the lower intertidal habitats is structured by stochastic processes while sediment properties have significant influence on species distribution and interactions. Results suggested that land-use changes altered sediment properties and could change the diversity and distribution of the macroinvertebrate communities in the lower intertidal habitats.

Keywords Community assembly · Neutral model · Stochastic processes · Lower intertidal habitat · Anthropogenic activities · Mangroves vegetation · Northern Bay of Bengal

Introduction

The null and neutral models are powerful tools for understanding the fundamental ecological processes of community assembly and their use has become a core concept in

community ecology (Platt and Lambshead 1985; Chave 2004; Zhou et al. 2014). These models are used to test the pattern of species distribution in the environment (Sloan et al. 2006; Stegen et al. 2013). Previous studies in the field of benthic macroinvertebrates stated that both stochastic and deterministic processes have simultaneous influence on the community assembly of local communities (Quiroz-Martinez et al. 2011; Verberk et al. 2010). Deterministic processes, particularly environmental selection, species

Responsible Editor: V.V.S.S. Sarma

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carbon, $\text{NO}_2\text{-N}$ and $\text{SiO}_3\text{-Si}$ roughly accounted for 49.6% of variation in community structure of the benthic macroinvertebrates (Fig. 4). Consistently with our findings, other studies have previously reported that sediment particle size, salinity, pH, organic carbon and sediment nutrients influence the taxonomic structure and functionality of benthic macroinvertebrate communities (Ysebaert and Herman 2002; Chainho et al. 2006; Otani et al. 2010; Joydas et al. 2011; Silva et al. 2011; Pravinkumar 2013). Overall, the results suggest that sediment properties, particularly the percentage of sand and clay, sediment pore water salinity, sediment temperature and sediment nutrients constitute the main driving forces in shaping the macroinvertebrate communities.

We found that roughly 52% of benthic macroinvertebrates species were neutrally distributed and 35% of communities were changed by dispersal/or ecological drift, which indicated the influence of stochastic processes on macroinvertebrates community assembly. Josefson (2016) reported that dispersal limiting factors such as species shorting and salinity in estuarine habitats were the main drivers of community assembly for benthic macroinvertebrates. Furthermore, the distance between the sampling sites had a significant effect on random distribution of nematodes species (Ptatscheck et al. 2020). The study in the North Sea, English Channel, and Irish Sea shown that water depth and sediment parameters were the main factors affecting the distribution of benthic polychaetes (Quiroz-Martinez et al. 2011). Our results showed that sediment temperature, sediment pore water salinity, percentage of sand and clay, and sediment nutrients had significant effect on benthic macroinvertebrate community assembly. In comparison to previous studies using neutral model analysis (Platt and Lambshead 1985), our results provided a better explanation of macroinvertebrates assembly and distribution in the intertidal habitats than marine benthic species diversity. In addition, co-occurrence-based network analysis revealed that variability of sediment properties has a negative influence on species-species interactions of benthic macroinvertebrate communities in the intertidal habitats. Altogether, these findings suggest that variability of sediment properties and limited dispersion drove the community assembly of benthic macroinvertebrate communities in this intertidal habitat.

Conclusion

The intertidal habitats of the Kohelia channel exhibited diverse communities of macroinvertebrates. Overall, the phylum Arthropoda dominated the communities showing significant seasonal and spatial variations in composition. Macroinvertebrate biodiversity was higher in monsoon in the mangrove-dominated area than those of anthropogenically affected areas. Our study demonstrated that the community structure of the macroinvertebrates significantly differed between the

four seasons and across three land-use types. The seasonal and spatial variability of sediment properties, especially sediment temperature, sediment pore water salinity, percentage of sand and clay, bulk density, porosity, particle density, $\text{NO}_2\text{-N}$ and $\text{SiO}_3\text{-Si}$ were proven to be the influential variables for benthic macroinvertebrate community structure. Importantly, majority of the species were neutrally distributed; however, sediment properties were responsible for increasing the diversification of the macroinvertebrates in these intertidal habitats. In our study, land-use-driven changes in sediment properties resulted in benthic macroinvertebrate community structure and species interactions. However, how historical land-use changes can alter the functional structure of macroinvertebrates communities in such habitats is one of the interesting topics highly recommended for a further in-depth study.

Acknowledgements We thank Prof. Alexander I. Muir (The Natural History Museum, London SW7 5BD, UK) for providing the taxonomic list of Indian Ocean Basin benthic fauna for cross-checking the identified species. We also would like to thank to fisherman and local community who helped during sample collection and field preservation in such remote area especially, Mr. Abu Bakkar, Md. Shahdat Hossain, Md. Saiful Islam Sajjad and Md. Saybal. Especial thanks to David Marioni for English corrections and two anonymous reviewers for their constructive suggestions and valuable comments for improving the understanding and interpretation.

Author contribution MAA and AA: conceived the idea, formal analysis, validation and wrote the first draft. MAA, AA, AHMK and HB: sample collection and processing. HB and AA: processed the sediment samples and measured the sediment parameters. MAA and AA: performed the microscopic observation. AHMK, SAU, MSI and MHA: critically review, validation and revised the manuscript. LM, MHI and MHA: research collaboration and manuscript revision. Finally, all authors approved the final version of the manuscript and agreed to submit.

Funding This work was financially supported by Bangladesh Nature Foundation (BNF, Cox's Bazar) (1st author) and the University Grants Commission, Bangladesh (UGC) (2nd author).

Data availability Not applicable.

Declarations

Ethics approval Not applicable.

Consent to participate Not applicable.

Consent for publication Not applicable.

Conflict of interest The authors declare no competing interests.

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