



Baseline

Assessment of benthic macroinvertebrates as potential bioindicators of anthropogenic disturbance in southeast Bangladesh coast

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ABSTRACT

Many human activities can greatly influence and alter the health of aquatic ecosystems. In this regard, the quantitative analysis of macroinvertebrates and their relationships with ecological variables is an effective method in environmental monitoring programs. Here, we used the benthic macroinvertebrate community as bioindicators for assessing anthropogenic impacts on coastal waters in southeast Bangladesh. Sediment samples were collected seasonally from three different sites influenced either by mangrove forests, aquaculture activity or sewage input. The indicator value index (IndVal) analysis revealed 23 species of benthic macroinvertebrates as potential bioindicators namely *Enigmonia aenigmatica*, *Macra chinensis* and *Pharella javanica* of the class Bivalvia; *Tubifex tubifex* of the class Clitellata; *Lithopoma brevispina*, *Bullia vittata*, *Pomacea maculata* and *Umbonium vestiarium* of the class Gastropoda; *Gammarus roeselii* of the class Malacostraca; and *Amphiteis gunneri*, *Amphitrite ornata*, *Aricidea simplex*, *Cirratulus cirratus*, *Heterospio catalinensis*, *Hypereteone foliosa*, *Lopadorhynchus henseni*, *Neanthes chingrighattensis*, *Micronephthys oligobranchia*, *Nephtys hombergii*, *Nereis jacksoni*, *Nereis zonata*, *Poliodontes maxillosus* and *Stygocapitella subterranean* of the class Polychaeta. Their composition across three sites varied significantly ($P < 0.05$) due to influence of environmental conditions as inferred from redundancy analysis. Polychaeta, Gastropoda and Malacostraca were susceptible to sewage input, while Bivalvia and Clitellata were susceptible to aquaculture effluent. The results of this baseline study suggest that the identified benthic macroinvertebrate species can potentially be used to monitor anthropogenic disturbances in the marine environment.

Human activities like an increased use of fertilizers and manures, and discharge of sewage and untreated industrial wastes into the aquatic ecosystems can lead to degradation of water quality and eutrophication of groundwater, rivers, lakes and coastal waterbodies (Tepe et al., 2022; Yuksel et al., 2022; Sims et al., 2013; Merlo et al., 2011). Therefore, effective watershed management is a key challenge due to insufficient information and related techniques (Abdullah Al et al., 2022; Tepe et al., 2022; Yuksel et al., 2022). Recently, community-based techniques such as indicative value analyses of eukaryotes (i.e., diatoms, ciliates and invertebrates) are extensively used because of accuracy and effectiveness that allow an integrated bioassessment (Xu et al., 2018; Hering

et al., 2018; Gosset et al., 2016; Fechner et al., 2014). Studies have reported that using such approaches (i.e., fidelity and relative abundance of species) have the highest consistency to determine bioindicators belonging to different habitat types (De Cáceres et al., 2012, 2010).

For describing long-term environmental changes and ecological status, choosing a species subset or indicator species (i.e., bioindicators, which include a small subset/group of species living in a particular habitat) is particularly useful rather than studying community attributes (i.e., species composition and diversity) (Milisa et al., 2022; De Cáceres et al., 2010, 2012). Such an ideal species subset can provide sufficient information about the entire community in a particular habitat (De

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Table 3

Relationship between sediment physicochemical parameters and first axis of dBRDA.

Variables	All	Bivalvia	Clitellata	Gastropoda	Polychaeta	Malacostraca
ST	−0.187	0.136	−0.034	−0.021	0.325	0.545
pH	0.422	−0.564	−0.450	−0.702	−0.276	0.321
Salinity	−0.596	−0.280	0.754	0.043	0.433	0.352
BD	−0.165	−0.061	−0.088	−0.380	0.374	−0.181
PD	0.004	−0.057	−0.016	0.011	0.023	−0.422
Porosity	0.081	0.278	−0.007	0.393	−0.170	0.312
OM	−0.477	0.254	0.293	0.206	0.555	0.327
OC	−0.246	0.310	0.168	0.313	0.249	−0.138
TN	−0.015	0.088	−0.035	0.069	0.036	0.029
TP	0.073	0.147	−0.231	−0.069	0.046	0.124
SiO ₃ -Si	−0.323	0.558	0.226	0.238	0.296	−0.160

Boldface indicates statistically significant at $P < 0.05$.

ST = sediment temperature; BD = bulk density; PD = particle density; OM = organic matter; OC = organic carbon; TN = total nitrogen; TP = total phosphorous.

Furthermore, recent studies using metabarcoding (Kuntke et al., 2020) and microscopy (Sabha et al., 2022) had shown that the sensitivity and tolerance of macroinvertebrates was related to stream water quality, and passively indicated water quality status. Therefore, habitat characteristics have significant impact on shaping benthic macroinvertebrate communities and they can indirectly reflect environmental quality status.

To conclude, the indicator value index analysis of benthic macroinvertebrates revealed to be a suitable method to identify bioindicators of anthropogenic disturbance in the marine environment. This is a novel approach of testing the community tolerance, as compared to the commonly used benthic macroinvertebrate biodiversity indices, that extends the mathematical or theoretical concept of indicator-based bioassessment. Therefore, the present study improves our understanding about locally adapted species and their shifts in response to anthropogenic influences. Further research is necessary to fully understand and apply this approach for the environmental monitoring of different aquatic ecosystems.

CRediT authorship contribution statement

MAA: Conceived the idea, formal data analysis, and wrote the first draft. **MAA, AHMK, and AA:** Sampling, validation and processed sediment. **MAA and AA:** Measured the environmental variables both in situ and laboratory. **MAA:** Performed the microscopic observation. **AHMK and AA:** Supervision. **SAU, SMS and MSI:** Critically review, validation research collaboration and revised the manuscript. All authors approved the final version of the manuscript and agreed to submit.

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Declaration of competing interest

The authors declare no competing financial interests. The authors alone are responsible for the content and writing of this article.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.marpolbul.2022.114217>.

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