

Annual pattern of zooplankton communities and their environmental response in a subtropical maritime channel system in the northern Bay of Bengal, Bangladesh

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Abstract

Zooplankton play an important role in aquatic food webs by fluxing of energy from primary producer to subsequent trophic levels in the food chain. The annual pattern of zooplankton communities and potential environmental drivers were studied in the Kohelia channel, Bangladesh from summer 2014 to spring 2015. Samples were collected using net at a depth of 1 m. A total of 32 species belonged to 18 orders, 27 families and 15 taxonomic groups were identified. Of these species, 22 distributed in all four seasons of which 8 were dominant and highly contributing to the total communities. Species number peaked in summer next to winter and fall in spring while maximum abundance was in summer and minimum in spring. Multivariate analyses showed that there was a clear annual pattern in the zooplankton communities. Species diversity and evenness peaked in spring but fall in autumn while the high value of species richness was found in winter. Biological-environmental best matching (BIO-ENV) analyses conformed that community pattern of zooplankton was mainly driven by transparency salinity, and temperature individually or combined with water nutrients. These results demonstrate that annual pattern of the zooplankton community shaped by channel environmental factors in subtropical channel ecosystems, thus might be used for community-based subtropical coastal water bioassessment.

Key words: zooplankton, trophic levels, subtropical channel, community structure, multivariate approach

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1 Introduction

Zooplankton are heterotrophic non motile/weak swimming aquatic animals living in all types of water bodies like fresh, coastal or marine ecosystems (Ferdous and Mukhtadir, 2009). They are key components in the aquatic ecosystems having effective role in the tropical food web and behave as a linker between the lower and higher levels (Liu et al., 2013; Sahu et al., 2013; Arashkevich et al., 2002). Most significantly they treat as intermediate nexus for fluxes of energy from primary producers like as phytoplankton and microbes to consumer levels of food chain (Iqbal et al., 2014; Madin et al., 2001), and also provide essential indication about the trophic condition of secondary production in the aquatic ecosystems (Abdullah Al et al., 2018). Moreover, the fertility of ecosystems depends on availability of zooplankton while eventually it provides information of fisheries potentiality and sustainability (Abu Hena et al., 2016; Srichandan et al., 2015). Furthermore, it is acquainted that the world richest fisheries directly or indirectly depend on zooplankton availability (Srichandan et al., 2013) because they lead the displacement of

the organisms that depended on them (Savari et al., 2013; Prabhakar et al., 2011). Studies have reported that variation in distribution, abundances and composition of zooplankton greatly influenced the existing aquatic habitats on depending communities like fishes, e.g., pelagic fishes feed on zooplankton for their entire life stages or early life stages (Abu Hena et al., 2016; Iqbal et al., 2014). Therefore, the relationship between zooplanktons and physiochemical parameters directly/indirectly related to monsoonal activity of the bay water especially during monsoon period, e.g., May to July when effective rainfall and nutrients input from upland influence the community patterns like distribution, abundances and composition (Srichandan et al., 2014; Fernandes and Ramaiah, 2009). Moreover, it has widely been used as potential bioindicators for ecological succession of coastal waters, also discriminating environmental status due to short living and quick response to certain environmental changes (Ferdous and Mukhtadir, 2009; Bianchi et al., 2003; Ramaiah and Nair, 1997). Up to date, several studies have been carried out about zooplankton and related environmental parameters in the

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Table 2. Summary of results from biota-environment (BIOENV) analysis showing the ten best matches of environmental variables with spatial variations in the zooplankton abundances during the study period

Rank	Environmental variables	ρ value	P value
1	Trans, NO ₂ -N	0.773	<0.05
2	T, Sal, Trans, TDS, NO ₂ -N	0.770	<0.05
3	T, Sal, Trans, PO ₄ -P, NO ₂ -N	0.767	<0.05
4	T, Sal, Trans, NO ₂ -N	0.762	<0.05
5	Sal, Trans, PO ₄ -P, NO ₂ -N	0.762	<0.05
6	T, Sal, Trans, NO ₂ -N	0.761	<0.05
7	Sal, Trans, NO ₂ -N	0.761	<0.05
8	Sal, Trans, TDS, PO ₄ -P, NO ₂ -N	0.759	<0.05
9	T, Trans, NO ₂ -N	0.756	<0.05
10	Sal, Trans, NO ₂ -N	0.753	<0.05

Note: ρ value is Spearman correlation coefficient and P value statistical significance level. T represents water temperature, Sal salinity, Trans transparency, TDS total dissolved solid, PO₄-P water soluble reactive phosphate-phosphorus, and NO₂-N water nitrite nitrogen.

Table 3. Pearson correlation between average values of the eight dominants zooplankton species with average environmental variables during the study period

Species	T	Trans	pH	Sal	TSS	TDS	DO	NO ₂ -N	PO ₄ -P
<i>Acetes erythraeus</i>	0.355	0.881	-0.842	0.786	0.210	-0.676	0.325	0.702	0.470
<i>Americamysis bahia</i>	-0.471	-0.860	0.906	-0.716	-0.122	0.846	-0.086	-0.677	-0.460
<i>Ampelisca bocki</i>	0.774	-0.427	-0.340	-0.636	-0.824	-0.489	-0.974*	-0.564	0.438
<i>Cyclops bicuspidatus</i>	-0.694	0.747	0.116	0.884	0.973*	0.057	0.774	0.889	-0.553
<i>Mesopodopsis orientalis</i>	-0.614	0.801	0.036	0.896	0.956*	-0.124	0.603	0.942	-0.583
<i>Penaeus indicus</i>	0.678	0.656	-0.973*	0.495	-0.175	-0.763	0.039	0.400	0.749
<i>Scylla serrata</i>	0.512	-0.714	0.049	-0.851	-0.782	-0.136	-0.943	-0.759	0.189
<i>Temora longicornis</i>	0.307	0.854	-0.797	0.783	0.223	-0.572	0.428	0.676	0.487

Note: * Correlation is significant at the $P < 0.05$ level. DO represents dissolved oxygen, TSS total suspended solid, and pH water hydrogen ion concentration. Significant values were in bold text. See Table 2 for other abbreviations.

patterns of the zooplankton communities in such a subtropical channel system. Seasonal cycle and situation of zooplankton species depend on water salinity, nutrients and transparency (Abdullah Al et al., 2018; Hwang et al., 2010; Mohanty et al., 2010; Osore et al., 2004). Based on present study, it has revealed that zooplankton communities of Kohelia channel in the northern Bay of Bengal governed by different hydrological factors of the channel environment where monsoonal activities of the Bay support very suitable ecological niche for mysids as well as other dominant zooplankton groups most prominently for copepods, amphipods and shrimps.

In conclusion, this is one of the pioneer research focusing on annual variation in community patterns of zooplankton with response to environmental changes in the subtropical channel of Kohelia in the northern Bay of Bengal, southeastern coastal zone of Bangladesh. Of these 32 species, 22 distributed in all season of which eight species were found dominant with the highest abundances and composition in the zooplankton communities. Due to strategic location of the Kohelia channel, this place is highly suitable for most of the aquatic animals especially molluscs and shrimps. Besides, the existence of aquatic vegetation like mangroves and salt marshes could also provide the suitable habitats for the presence of pelagic mollusc and shrimp in this channel system. The changing of the salinity, transparency, temperature and nutrients drove the annual pattern in zooplankton community structures. Thus, this finding revealed that the zooplankton community represented structural variation shaped by the environmental drivers in tropical channel system, which might be used as bioassessment of monitoring program for assessing coastal ecosystems. We recommended that further more studies are needed to justify this statement.

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