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Spatial and temporal distribution of meiobenthos in Cochin backwaters, southwest coast of India

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ABSTRACT

Spatial and temporal variation in the distribution of meiobenthos in relation to various environmental parameters were studied in six selected stations in Cochin backwaters, the west coast of India. Organisms belonging to 14 taxa were identified. Out of this, nematodes, polychaetes, copepods, nemerteans, acari and bivalves were present in all stations. On average, 88% of the meiofauna is composed of nematodes. Meiofauna shows spatial and temporal variation in their qualitative distribution. Turbidity, pH, chlorophyll – *a*, salinity, DO, NO_2-N, NO_3-N, organic carbon and silt principally influenced the abundance and distribution of the meiofauna as per multivariate BIOENV analysis. The southern area of the estuary shows a high diversity of fauna when compared to the northern area. The study suggested that meiobenthos can be used as pollution indicators.

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1. Introduction

Biodiversity assessment is the key to understanding the health of ecosystems (Gingold et al., 2013). Meiofauna is phyletically more diverse and the most abundant metazoa known to science (Marleen et al., 2001; Ptatscheck et al., 2020). Meiofauna has an important role in nutrient recycling, and they link detritus with higher trophic levels (Moens et al., 2014). In estuarine sediments, they facilitate the biomineralization of organic matter and enhance nutrient regeneration (Giere, 2009; Wurzberg et al., 2011). Meiofauna are ubiquitous, have high diversity, occur in very high numbers, have high reproductive rates and short life cycles; most of them have direct benthic development and have limited mobility (Murray, 2006; Moens et al., 2014). These unique features make them sensitive indicators of environmental disturbances (McIntyre-Wressnig et al., 2013). However, the study on the meiofaunal community is almost less despite the important role played by this tiny group of organisms (Moens et al., 2014).

The present investigation will provide a base line data of spatial, temporal and vertical patterns in the distribution of meiobenthos of the Cochin backwaters in relation to various environmental parameters.

2. Materials and Methods

Cochin Estuary (Lat. 09^0 30’-10^{0}10’ N and Lon. 76^0 15’-76^{0}25’ E) is situated on the southwest coast of India. This system is witnessing rapid industrialization and urbanization. At present estuary is subjected to degradation in the water quality by the deposition of heavy metals, pesticides, PCBs, fertilizers etc (Robin et al., 2012). Monthly collection of samples were done from following six stations of the Cochin backwaters from July 2002-June 2003 (Table 1).

Meiofauna was collected using 0.05m^2 van Veen Grab hauls 15 cm long graduated glass corer with an inner diameter of 2.5cm was used to sub-sample meiofauna. Duplicate core samples were vertically subdivided at site into the following depth horizons**:** 0-2, 2-4, 4-6 and 6-8 cm and preserved in 4% neutral formalin. In the laboratory, the organisms were separated and preserved in 4 % neutral formalin. The numerical abundance of organisms was extrapolated into no/10cm^2. The nematodes were identified up to order level. The rest of the organisms were examined up to major taxa. The analysis of various physicochemical parameters and sediment characteristics was also done using standard methods. The BIO-ENV procedure was employed to measure the agreement between the rank correlations of the biological (Bray-Curtis similarity) and environmental (Euclidean distance) matrices such as depth (m), turbidity, temperature (^{0}C), salinity (ppt), pH, DO(ml/l), NO_2-N(mol/l), NO_3-N(mol/l), PO_4-P(mol/l), SiO_3-Si(mol/l),chlorophyll-*a*(mol/l), sand (%), Silt(%), Clay(%), organic carbon C(%), sediment temperature(^{0}C) and interstitial water content (%).

3. Results

The present study reported the presence of nematodes, polychaetes, foraminifera, copepod, turbellaria, nemertea, kinorhyncha, nauplius larva, acarina, amphipoda, tanaidacea, cumacea, ostracoda, bivalves and gastropoda in cochin backwaters . Nematoda was the most dominant component in the collection, followed by foraminifera (Table 2 and Fig. 1).

As an average, 88% of the meiofauna is contributed by nematodes. This study pointed out that Cochin backwaters have representation of nematodes from all three orders; Enoplida, Chromadorida and Monhysterida. Polychaetes were present at all stations. Most of the forms were juvenile stages of *Paraheteromastus* sp, *Heteromastus* sp, *Glycera* sp and *Lumbrinereis* sp. The copepoda and polychaeta form 3% each of the total composition. All other reported taxa were sporadic in occurrence.

Meiobenthos showed considerable spatial variation in distribution. Nematodes showed special affinity to station

Table 1. Details of stations

Stn No.	Name	Latitude	Longitude
1	Thevara	Lat 9^0 55' 35 N	76^0 17' 53 E
2	Mattancherry	Lat 9^0 56' 47 N	76^0 15' 52 E
3	Barmouth	Lat 9^0 58' 26 N	76^0 14' 39 E
4	Marine Science Jetty	Lat 9^0 57' 39 N	76^0 16' 40 E
5	Bolghatty	Lat 9^0 58' 52 N	76^0 15' 50 E
6	Varapuza	Lat 10^0 4' 30 N	76^0 16' 48 E

Table 2. Occurrence of Meiobenthos at different stations

	station 1	station 2	station 3	station 4	station 5	station 6
Foraminiferans	P	P	P	P	P	A
Turbellarians	P	P	P	P	P	A
Nematodes	P	P	P	P	P	P
Nemerteans	P	P	P	P	P	P
Polychaetes	P	P	P	P	P	P
Kinorhynchs	A	P	A	A	A	A
Nauplius	P	P	P	P	P	A
Copepods	P	P	P	P	P	P
Acari	P	P	P	P	P	P
Cumaceanes	P	A	A	P	A	A
Amphipods	P	P	P	P	P	A
Tanaidaceans	A	A	P	A	P	A
Ostracods	P	P	P	P	A	A
Bivalves	P	P	P	P	P	P
Gastropods	P	P	A	P	A	A

*P-present, *A-absent

2. Foraminifera had a fairly good representation at station 3. Polychaetes had a special affinity to station 4 . Polychaetes showed less affinity to stations 2 and 6. Copepods furnished high affinity towards station 5. Faunal diversity was least at station 6 in all collections. Nematodes, polychaetes copepods, nemertians, acari and bivalves were reported from all stations. All other taxa had sporadic occurrence. The study on vertical distribution pattern of meiobenthos indicated that the major concentration of the fauna was restricted to 0-2 cm layer regardless of the sediment type. The numerical density decreased with increasing depth and dropped sharply below 2 cm of the sediment. The taxa below 6 cm layer were mainly composed of nematodes and polychaetes.

Meiobenthos shows remarkable seasonality in the distribution pattern (Fig:2). In the majority of stations, pre-monsoon showed the highest density of organisms(stations 2,3,5 &6), and monsoon reported the least density(stations 1,2,4,5 &6). seasonality is well expressed by the dominant group nematodes. Abundance of polychaetes was rather higher during post-monsoon period and that of copepods during pre-monsoon period. Pre-monsoon and post-monsoon period presented high numerical abundance of foraminifera. However, at Station 3 highest population count for foraminifera (1735 /10 cm^2) was obtained during monsoon.

4. Discussion

In the present study, a total of 14 taxa of meiobenthos were recorded from Cochin backwaters. The meiofauna showed the highest average density of 2440/10cm^2 (station 2), which was higher than recent reports from India (Punniyamoorthy et al., 2019). Nematodes were the dominant meiofaunal group at stations 1, 2,3, 4 and 5. The dominance of nematodes in the meiobenthic community was reported from different parts of the world (Ptatscheck et al., 2020). Ingels et al. (2012) suggested nematode abundance may be stimulated by high concentrations of CO_2 and low O_2. Polychaetes constituted the second major group in the current study. Anzari and Parulekar (1993) reported copepods as the second dominant group. The reduction of the harpacticoid population may be due to the altered environmental conditions currently existing in the study area. Harpacticoid copepods are unable to tolerate low O_2 concentrations (Wells, 1988). The reduction of the harpacticoid population may affect the existence of many other estuarine species (Richmond et al., 2007). Zeppilli et al. (2015) demonstrated that harpacticoid density alone can be used as an indicator of the extent of pollution in the benthic environment. Generally, representation of foraminifera was rather poor in the study area. The stations that located in the northern region of the estuary are either devoid of foraminifera (station 6) or with sporadic occurrence (station 5). This may be due to the heavy discharge of industrial waste into this area. The northern part of the backwater is much more polluted by heavy metals when compared to southern part of the backwater (Robin et al., 2012).

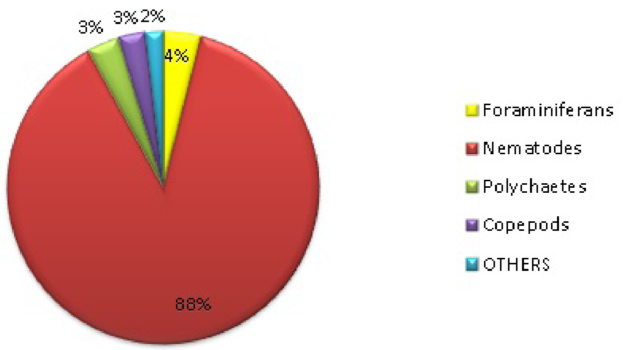

Fig. 1. Composition of meiobenthos (average)

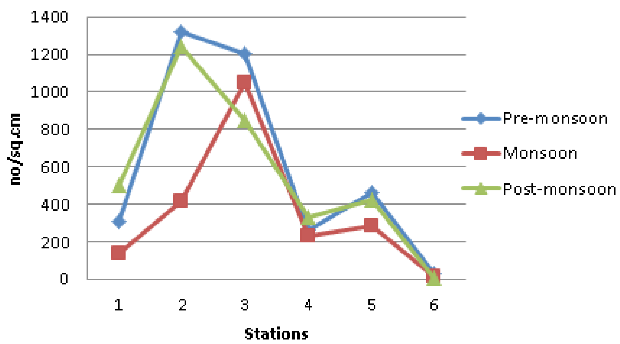

Fig. 2. Seasonal variation of meiobenthos

The investigation showed that the meiofauna distributed throughout the 8 cm long sediment layer. Vertical migration enables them to adapt to their changing environment (Gorska et al., 2014). The vertical distribution of species will reduce the number of competitive and predatory interactions (Reise,1985). Damodaran, 1972, related the vertical distribution to the biogeochemical characteristic of the sediment. In muddy substratum, 78% of the organisms was concentrated at 0-2 cm sediment layer . Whereas in sandy substratum, only 63 % of the organism was concentrated at 0-2 cm sediment layer. Aerobic organisms prefer surface sediments because oxygen diffusion into the deeper sediment is limited (Gontikaki et al. 2011). Having less porosity and small interstitial space the exchange of food and oxygen to the deeper layers may be impoverished in muddy substratum.

The hydrographical characters followed seasonal cycle in the study area. The population density and diversity of meiofauna declined considerably with the advent of heavy rains. Similar conditions were reported from the Sundarban estuarine system, by Moumitha et. al. (2018). Heavy precipitation and land run off during monsoon resulted drastic changes in various physicochemical parameters and substratum characteristics. Monsoonal flood may physically remove large amount of surface sediment along with the meiofaunal organisms living in it (Eldose et al., 2008; Ragukumar et al., 2001). Meiofaunal communities rapidly recolonized in sediments after the termination of the monsoon (Bolam et al., 2006).

The observed spatial and temporal variation in the distribution of the meiobenthos may be due to the influence of various physicochemical parameters. BIOENV analysis highlighted the positive influence of chlorophyll, turbidity, NO_2-N, NO_3-N, pH, salinity, DO, organic carbon and silt content on the distribution of meiofauna. Benthic communities are highly subjected to increasing rates of fertilizer input, which may trigger phytoplankton blooms. This enhances bacterial activity and can subsequently cause a significant increase in the abundance and diversity of meiofauna (Heip *et al*. 1985; Ansari and Parulekar,1993; Garcia and Johnstone, 2006).

Salinity was the principal factor correlated with assemblage structure. The species diversity was highest at the high saline stations. A progressive decrease in the meiofaunal density along the salinity gradient, from higher to lower salinity was reported by Ingels,2011. pH, oxygen availability, and granulometry of the substrate are also known to affect meiofaunal abundance (Gray, 1974; Heip *et al.,* 1985; Palmer, 1988). The present observations are also in agreement with above reports.

In the present survey high diversity was observed in the coarse sediment while highest population density was obtained in fine sediment. The results suggested that the variation in meiofaunal density and structure are influenced by sediment texture and availability of organic matter. A positive correlation between sediment characteristics and trophic structure of meiobenthos was investigated by Giere (2009) and Anzari and Parulekar (1993). Sajan (2007) was not able to deduce positive influence of organic carbon in the distribution of meiobenthos along the shelf waters of west coast of India. In addition to these factors macrobenthos may also be influence the population density of meiofauna. Juvenile macrobenthos might be important competitors to meiofauna and filter feeding macrofauna enhances the available trophic resources by sedimentation of suspended organic materials, which promotes meiofaunal abundance (Piot et al., 2014)

5. Conclusion

The meiobenthic community of Cochin backwater is composed of nematodes, polychaetes, foraminifera, copepod, turbellaria, nemertea, kinorhyncha, nauplius larva, acarina, amphipoda, tanaidacea, cumacea, ostracoda, bivalves and gastropoda. Nematodes governed the patterns of total density of meiofauna in the study area. Foraminifers and copepods are very susceptible to altering environmental conditions, while nematodes are compatively tolerant to stress. A single factor alone cannot be held responsible for spatial, vertical and seasonal variation in the distribution of meiofauna. Disribution of meiobenthos are affected by different environmental and biological factors. Species level identification of meiobenthos were not yet attempted in the study area. More studies in ecosystem functioning research can be conducted using meiofauna. Further studies including the adoption of molecular methods can make a very good contribution to biodiversity. Meiobenthos can be used as model organisms that may help to predict the future of Cochin backwaters, a part of Ramsar site.

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