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Temporal Variations in the Distribution of Interstitial Meiofauna along the Southwest Coast of India

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Abstract

The present paper depicts the dynamics of meiobenthic assemblages in relation to environmental variables along the coast of Thiruvananthapuram, Kerala on the southwest coast of India. Meiobenthic community consisted of 11 taxa in which nematodes, foraminifers and copepods dominated. Considerable temporal variations are identifiable for all meiofaunal taxa. The ambient physico-chemical conditions of water and physical changes in sediment are responsible for the temporal distribution of meiobenthos. Vertically a downward migration of meiofauna has been observed in the sand column due to better drainage, high atmospheric temperature and exposure.

Keywords: Meiofauna; Seasonal variation; South west coast of India; Macrofauna

Introduction

Studies on benthic populations have been widely accepted as a tool for assessing the health of the environment because of certain unique qualities displayed by benthic invertebrates. Being an important link in the food chain between bacteria and macrofauna of sediments, meiofauna populations are probably suitable indicators of the benthic ecosystem balance. High sensitivity, rapid turnover rate, quick response, life cycles entirely spent in sediments and relative pollution stability makes meiofauna a valid tool to assess the impact of environmental stress. Monitoring of coastal environment is one of the key tools in scientific management of coastal resources.

Studies on interstitial meiobenthic assemblages in relation to environmental variables from the Indian beaches are scanty. Initial meiobenthic studies reported from the Indian coast were from the mud bank region of Kerala coast [1]. Following those a few more studies on the distribution and abundance of meiobenthos have been made off the Indian coast [2-8]. Thiruvananthapuram, the capital district of Kerala on the southwest coast of India, is the southernmost district of the state. Considering the role of meiobenthos as key indicators of environmental stress, the present paper explores the distribution of meiobenthos and its temporal variation in Thiruvananthapuram coast of Kerala in relation to the prevailing environmental parameters as structuring factors of interstitial meiofauna in the sandy beaches.

Materials and Methods

The study was carried out along the Thiruvanandapuram coast of Kerala at two selected beaches, station I, located at Poonthura coast and station II, at Adimalathura coast, lying between latitudes 8020'-8030; North and longitudes 76055'-77003' east. Samples were taken monthly from the 2 stations up to a depth of 25 cm using a graduated steel cover having a length of 25 cm and diameter 5.5 cm. The sediment core was then divided into 5 cm and each segment was immediately removed intact into separate polythene bags. The samples were anaesthetized with 7% MgCl and preserved in 4% buffered formalin 0.1% Rose Bengal was added to the sample for efficient extraction of the fauna and was separated by suspension decantation method [9]. Separated benthic sample were then processed through a set of two sieves with 500 mm and 42 mm mesh sizes for the separation of meiofauna. Meiobenthos was then counted on a higher taxonomic level using a binocular microscope.

Observations of physic-chemical characteristic of sea water were made according to standard methods [10,11]. Bottom sediment was subjected to the analysis of geochemical variables temperature, pH, organic carbon and texture [12]. Monthly values of all parameters analysed were pooled to obtain the seasonal values as pre monsoon (Feb-May), monsoon (June-Sep) and post monsoon (Oct-Jan).

Results and Discussion

The interstices of sandy beaches are profusely inhabited by meiobenthic invertebrates which are of great ecological significance. The taxonomic composition, density and distribution of meiobenthic fauna vary considerably from space to space depending on a wide variety of factors. Exposure, predation, competition, grain size, organic matter and oxygen largely determine the distribution of meiofauna in Indian beaches [13]. Numerically meiobenthic abundance varied slightly in the two beaches. The overall density variation was from 1288 to 8386/100 cm^2 at the Poonthura coast and from 1151 to 10795/100 cm^2 at the Adimalathura coast (Table 1).

Faunal composition of meiobenthos obtained from the two sandy beaches of Thiruvananthapuram coast consisted of 11 taxa coprising foraminifera, Turbellaria, Kinorhyncha, Nematoda, oligochaeta, Polychaeta, Archiannelida, Ostracoda, Copepoda, Amphipoda and Arachnida. Over all abundance of meiobenthos has been in the order Nematoda, Copepoda, Foraminifera, Oligochaeta and Ostracoda at the Poonthura coast and in the order Nematoda, Foraminifera, Copepoda, Archiannelida and Oligochaeta at the Adimalathura coast (Figure 1). In general nematodes dominated the meiobenthic community of Thiruvananthapuram coast. Nematodes are the most abundant

meiofaunal community of Indian beaches which often represents more than 80% of benthic meiofauna [5,14-18].

Season	Poonthura coast	Adimalathura coast
Pre monsoon	Range 3465-6073	Range 2579-4631
	Mean 4945	Mean 3592
Monsoon	Range 1288-4590	Range 1511-5677
	Mean 2511	Mean 2508
Post monsoon	Range 1559-8386	Range 4540-10795
	Mean 6617	Mean 7884

Table 1: Temporal variations (No/100 cm^2) in meiofaunal density along Thiruvananthapuram coast, Kerala.

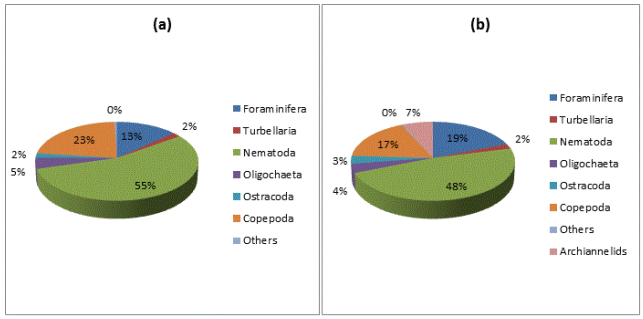

Figure 1: Composition of meiofauna along Thiruvananthapuram (a-Poonthura, b-Adimalathura) coast.

The study revealed distinct temporal variation in the interstitial meiofaunal components along the coast of Thiruvananthapuram (Figure 2). Faunal abundance was higher during the post monsoon period followed by pre monsoon. A distinct feature of the Indian beaches is the influence of monsoon rains that adversely affect the density of the fauna. During the monsoon period (June-Sept) the beach configuration changes drastically at short term intervals due to severe erosion or heavy deposition. Strong wave action during the monsoon has the capacity to completely remove or deposit the substratum. During the high turbulence period sediment particles get rearranged affecting the interstitial spaces and the living space available for the organisms that get shifted continuously. This phenomenon might uproot the benthic fauna and expose them to the risk of predation [19,20].

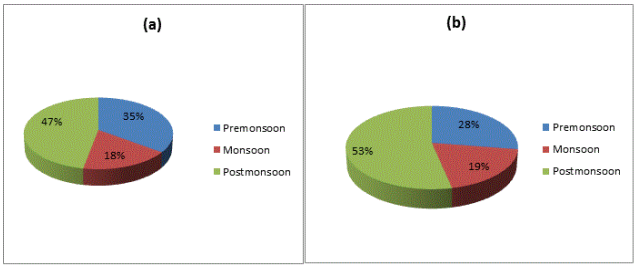

Figure 2: Seasonal variations in the distribution of meiofauna along Thiruvananthapuram (a-Poonthura, b-Adimalathura) coast.

The ambient physico-chemical conditions and the physical change in the sediments are responsible for the temporal distribution of meiofauna. There were considerable fluctuations in the density of all taxa from month to month. Increased temperature, high salinity, stable beach conditions and the probable greater food availability favored the rich post and pre monsoon populations. Seasonal variations in hydrobiological and geological variables are presented in Tables 2 and 3 respectively. The periods of high density of interstitial meiobenthic community in the present study is coincided with increased water and sediment temperature, pH, dissolved oxygen and increased organic carbon in the sediment together with higher proportion of silt and clay. Seasonal breeding is characteristic of meiofauna [21] and the increased meiobenthic density is coinciding with intense breeding activities of meiofauna during the high temperature period [22,23]. Temperature may also influence population increase indirectly by controlling supply of bacterial and diatom food. Size of sand grains was reported to be a major factor influencing meiofaunal abundance [5,13,24-27]. Interstitial fauna develop best in sands with medium diameter [9] and moderate organic enrichment [21]. Sandy beaches of Kerala in general have extremely low organic matter in sediment. Faunal abundance was higher during the post and pre monsoon months (Figure 2) with nematodes recording maximum abundance followed by copepods in the Poontura beach and foraminifers at the Adimalathura beach. On average nematode contributed 57.96% (pre-monsoon), 47.4% (monsoon) and 49.25% (post monsoon) of the total meiobenthic fauna. Prevalence of nematode fauna in meiofaunal community of Indian beaches was reported earlier [15,16,28]. Abundance of foraminifera in sandy substrata was also reported from Indian beaches [1,15].

Variable	Poonthura coast			Adimalathura coast		
	Pre monsoon	Monsoon	Post monsoon	Pre monsoon	Monsoon	Post monsoon
Temperature (°C)	30.30 ± 0.337	24.10 ± 0.447	28.20 ± 0.561	29.80 ± 0.719	23.80 ± 0.137	28.40 ± 0.666
pH	8.21 ± 0.088	7.642 ± 0.026	7.91 ± 0.018	8.21 ± 0.031	7.54 ± 0.073	8.14 ± 0.003
Salinity (S.10-3)	33.88 ± 0.113	32.14 ± 0.831	32.21 ± 0.192	34.24 ± 055	32.18 ± 0.512	33.90 ± 0.522
Dissolved oxygen (ml/l)	5.64 ± 0.696	4.32 ± 0.768	5.98 ± 0.632	5.72 ± 0.631	4.92 ± 0.731	6.01 ± 0.610
Nitrite-nitrogen (µmol/l)	0.211 ± 0.018	0.182 ± 0.016	0.202 ± 0.022	0.198 ± 0.022	0.21 ± 0.003	0.23 ± 0.061
Nitrate-nitrogen (µmol/l)	0.31 ± 0.086	0.23 ± 0.014	0.28 ± 0.136	0.33 ± 0.046	0.28 ± 0.029	0.31 ± 0.14

Phosphate-phosphorus (µmol/l)	0.21 ± 0.07	0.161 ± 0.072	0.27 ± 0.056	0.28 ± 0.008	0.21 ± 0.013	0.29 ± 0.017
Silicate-silicon (µmol/l)	0.23 ± 0.03	0.106 ± 0.008	0.181 ± 0.06	0.21 ± 0.061	0.091 ± 0.007	0.198 ± 0.012

Table 2: Temporal variations (mean) in hydrological variables along Thiruvananthapuram coast, Kerala.

Parameter	Poonthura coast			Adimalathura coast		
	Pre monsoon	Monsoon	Post monsoon	Pre monsoon	Monsoon	Post monsoon
Temperature (°C)	30.00 ± 0.61	25.10 ± 0.88	29.10 ± 0.58	29.70 ± 0.701	24.2 ± 0.515	29.50 ± 0.412
Organic carbon (%)	0.31 ± 0.28	0.23 ± 015	0.56 ± 0.13	0.70 ± 0.14	0.45 ± 0.09	0.64 ± 0.09
Sand (%)	77.76 ± 5.03	96.45 ± 3.65	96.62 ± 4.32	73.61 ± 3.12	98.75 ± 1.01	84.86 ± 6.15
Silt (%)	14.16 ± 2.92	2.76 ± 1.22	1.33 ± 0.92	16.1 ± 4.46	0.62 ± 03	3.51 ± 1.25
Clay (%)	8.08 ± 3.30	0.79 ± 0.63	2.05 ± 1.16	10.29 ± 3.50	0.62 ± 0.03	11.63 ± 1.25

Table 3: Temporal variations (mean) in geological parameters along Thiruvananthapuram coast, Kerala.

Vertically, the majority of meiobenthic organisms are confined to the upper 10 cm depth (Figure 3). Mostly nematodes are found to penetrate the deep layers and found in the entire 25 cm depth. Foraminifera are the other group in the deeper layers of the sediment. 21% of foraminifera and 25% nematoda penetrate the deeper (more than 10 cm) layer. Of all the other groups only oligochaeta and archiannelida were recorded from the deepest (20-25 cm) layer. Decrease in faunal density in the deeper layers has been attributed to the reduction in interstitial space, oxygen content and food material [29]. One of the reasons for the successful penetration of nematodes into deeper layers could be attributed to their capacity of anaerobic existence [1]. Seasonal variations were evident in the vertical distribution meiobenthos with highest density in the surface section (0-5 cm) during the monsoon period at both the beaches and maximum density in the 5-10 cm layer during other seasons (Figures 4 and 5). Meiofauna in sandy sediments generally appear to be concentrated at those levels where desiccation is not too severe and oxygen availability is not too low [30,31]. Because of better drainage of sand and higher temperature at the surface layer the fauna found penetrated to the deeper layer during pre and post monsoon seasons.

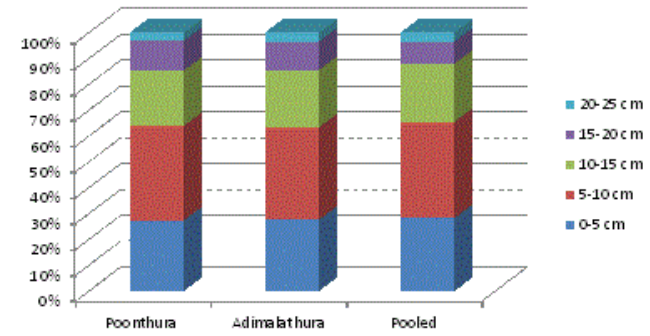

Figure 3: Vertical distribution of meiofauna (annual%) along Thiruvananthapuram coast.

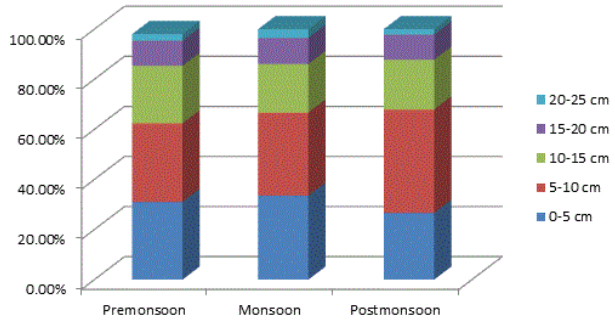

Figure 4: Seasonal variation in the vertical distribution of meiofauna (Poonthura coast).

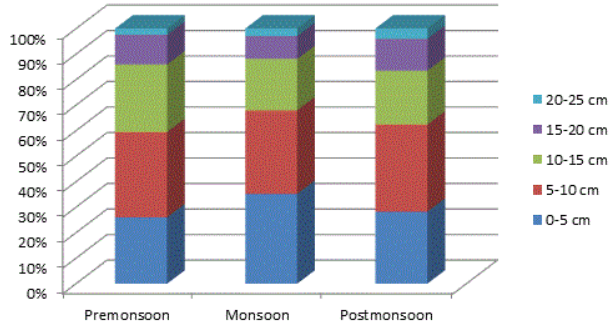

Figure 5: Seasonal variations in the vertical distribution of meiofauna (Adimalathura coast).

The study revealed distinct seasonal variation in interstitial meiobenthos along the coast of Thiruvananthapuram, Kerala on the southwest coast of India. The meiobenthic abundance in general was

found in accordance with sediment granulometry and physico-chemical characteristics of water prevailing along the coast. Temperature, pH, salinity, dissolved oxygen, sediment composition and % of organic carbon in the sediment are proved to be important descriptive parameters related to the abundance and distribution of meiobenthos. Different meiofaunal components showed difference in vertical movement. A downward migration of meiofauna has been observed in the study area due to better drainage, high temperature and exposure.

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