British Journal of Applied Science & Technology
12(1): 1-10, 2016, Article no.BJAST.19467
ISSN: 2231-0843, NLM ID: 101664541

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Spatio – Temporal Variation of Meio-fauna Distribution in Bhavanapadu Creek, Srikakulam District, Andhra Pradesh, India

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Authors' contributions

This work was carried out in collaboration between all authors. Authors AD and SKD have designed the study and managed the analyses. Author RKK conducted the literature searches and improved the final manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJAST/2016/19467
Editor(s):
(1) Sylwia Myszograj, Department of Water Technology, Sewage and Wastes, University of Zielona Gora, Poland.
Reviewers:
(1) Anonymous, Federal University of Paraiba, Brazil.
(2) Ana Maria Antao Geraldes, Instituto Politecnico de Bragança, Portugal.
(3) Alejandro Cordova Izquierdo, Universidad Autónoma Metropolitana, Mexico.
(4) Venkata Seshendra Kumar Karri, GITAM University, Visakhapatnam, India.
Complete Peer review History: http://sciencedomain.org/review-history/11458

Original Research Article

Received 11th June 2015
Accepted 14th August 2015
Published 19th September 2015

ABSTRACT

The present study was conducted to observe distribution of meio-fauna community structure and its variation both spatially and temporally in relation to the sediment temperature, salinity, dissolved oxygen, chlorophyll – a, organic carbon and soil composition. A monthly sampling was carried out during one year of time period at three stations. The meio-faunal density ranged from 27 to 56 no/10 cm^2. Among them harpacticoid copepods were dominant followed by nematodes. The fauna was significantly correlated with environmental parameters like temperature, salinity, chlorophyll, organic carbon and dissolved oxygen.

Keywords: Meio-fauna; spatio-temporal variation; environmental parameters.

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1. INTRODUCTION

The Creek is influenced by a semi diurnal tide in a tidal day. The sea water penetrated up to the distance of 16 km during high spring tide. The importance of the Creek has increased considerably during this decade owing to its contribution to fisheries, salt pans, collection of molluscan shells for various uses, shrimp farms and also shrimp seed collection. Bhavanapadu Creek is associate with the wetlands, providing a livelihood to surrounding areas and being rich in biodiversity [1]. The Creek is influenced by shrimp farms and also fresh water canals [2]. The meio –faunal distribution and abundance is mainly controlled by physico - chemical factors, and by ecological condition. The influencing physico - chemical parameters, are temperature, salinity, desiccation, mean grain size of sediment, redox potential and also tidal exposure and the ecological conditions are biotic interactions, competition and predation [3-5]. Meio-faunal habitat is a good indicator of environmental conditions and the changes in their community, density, diversity, structure. It functioning may indicate the alterations in the system. Meio-benthic community structure provides information of benthic food chains [6,7] and also on their ecological characteristics Their small size, high abundance, rapid generation times and absence of a planktonic phase give them an important role in the decomposition of detritus in the cycle of nutrients and energy flow [8-10]. Therefore, meio-fauna can be a sensitive tool for the assessment of ecological conditions [11-13]. Estuaries are most productive of non-cultivated ecosystems. Although the reduced and fluctuating salinities result in a harsh environment. In contrast to macro-benthic species, which decrease in numbers from the mouth to the head of estuaries, many meio-faunal species have a high tolerance for brackish waters. In estuarine sediments, meio-fauna facilitates bio-mineralization of organic matter and enhances nutrient regeneration, serves as food for a variety of higher trophic levels, and exhibit high sensitivity to anthropogenic inputs, making the fauna an excellent sentinel of estuarine pollution [14]. The present study was focused on the distribution of the meio-fauna in dealing with spatial and temporal variation in-relation to the some physical, chemical and biological parameters.

2. MATERIALS AND METHODS

The present study was examines the on distribution of meio- fauna at Bhavanapadu Creek. The Creek area is represents a livelihood for the surrounding village's people in different

Fig. 1. Study area location

ways. The dwarf mangroves were also occupied along the Creek and act as a good habitat for faunal diversity. The sampling stations were fixed at the joining points of the fresh water canals. The study was conducted during the spatio - temporal distribution of meio-fauna at periods of pre-monsoon (Feb - May, 2014), monsoon (June – Sept, 2014) and post-monsoon (Oct – Jan, 2015). Twenty replicate samples of meio-fauna were collected during low tide mostly near the mid tide level and an additional one for sediment analysis, using a hand corer (3 cm diameter, 20 cm length) to a depth of 10 cm. Samples were collected from a known area using a Quadrate (10 cm X 10 cm) and the sediments of the upper 5 cm were collected. The sediment samples were preserved with a solution of magnesium chloride (7%) isotonic with seawater and meio-fauna was extracted by decantation. The sediment samples were passed through a 0.5-mm-mesh sieve but were retained on a 0.062-mm-mesh sieve. The retained organisms were considered as belonging to the meio-fauna [15] and were stored in a 5% formaldehyde solution. The meio-fauna was identified up to taxonomic level and counted using binocular a microscope. The sediment temperature was measured with the help of a centigrade thermometer with 1ºC variation. The interstitial waters were collected for salinity and dissolved oxygen. The salinity was estimated with a refractometer and dissolved oxygen was measured using D.O meter. The organic carbon was estimated by Walkley and Black method [16] and the chlorophyll –a [17] was estimated in the sediment. The correlation coefficient (r) was used to find the relation between different environmental parameters and meio-faunal density.

3. RESULTS AND DISCUSSION

3.1 Environmental Parameters

The temperature varied from 22.6 to 24.5ºC and it is varied according to the time period of the sampling conditions based on tidal cycle (Fig. 2). The dissolved oxygen levels 5.8 to 7.9 mg/l were observed mostly during the pre-monsoon season (Fig. 3). The salinity was recorded as 35.2 ppt at Station I, being high in summer due to no influxes or dilutions of waters (Fig. 4). The chlorophyll-a gives the primary productivity levels and it varies from 0.28 to 0.35 mg/l (Fig. 5). The levels of organic carbon were 2.1 % to 3.6% lower at Station I due to composition of sediment, mostly sandy in nature and it increased at S III due to mangrove habitat, in which area there is more decomposed materials (Fig. 6). The sand, silt and clay percentages varied according to the seasons due to sedimentation and influxes from the fresh water canals (Fig. 7). The temperature shows a positive correlation to the salinity and chlorophyll (Tables 1, 2 and 3) which indicates that photosynthetic activity of marine species increased when salinity and temperature increased. Chlorophyll-a generally decreased from the poly -hyaline area to the oligo-mesohaline area due to salinity variation. The biomass dynamics was a function of both primary production and re-suspension /erosion-related factors (as temperature, insolation, salinity, hour of sampling, sand content and tide coefficient [18]. The salinity showed positive correlation to the chlorophyll (Tables 1 and 3) which indicates an enrich of the growth of marine species by the increase of salinity [19].

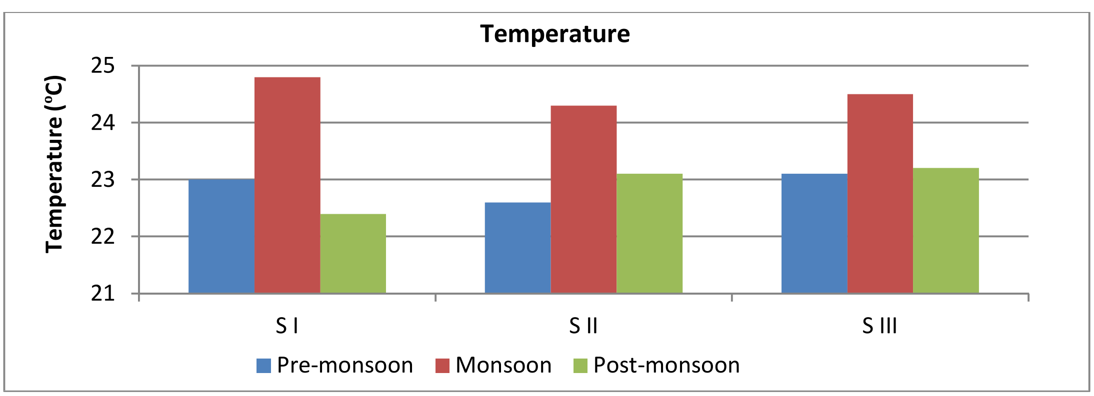

Fig. 2. Temperature during Pre- monsoon, monsoon and post – monsoon

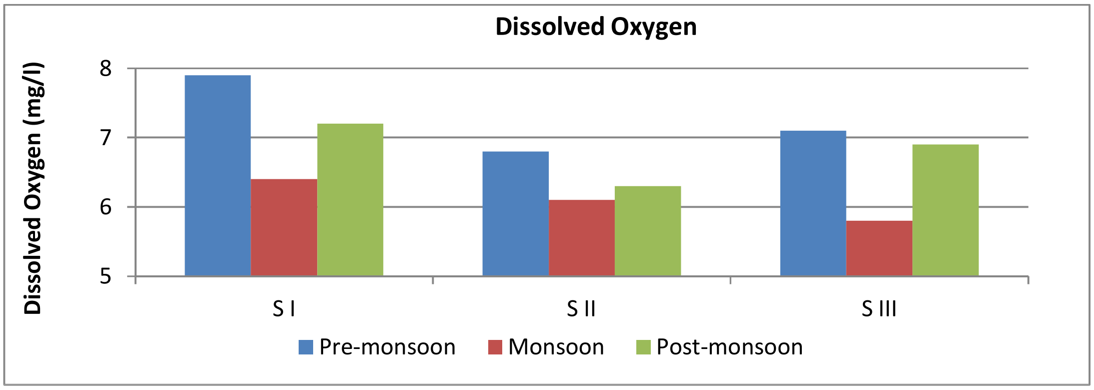

Fig. 3. Dissolved oxygen during Pre- monsoon, monsoon and post – monsoon

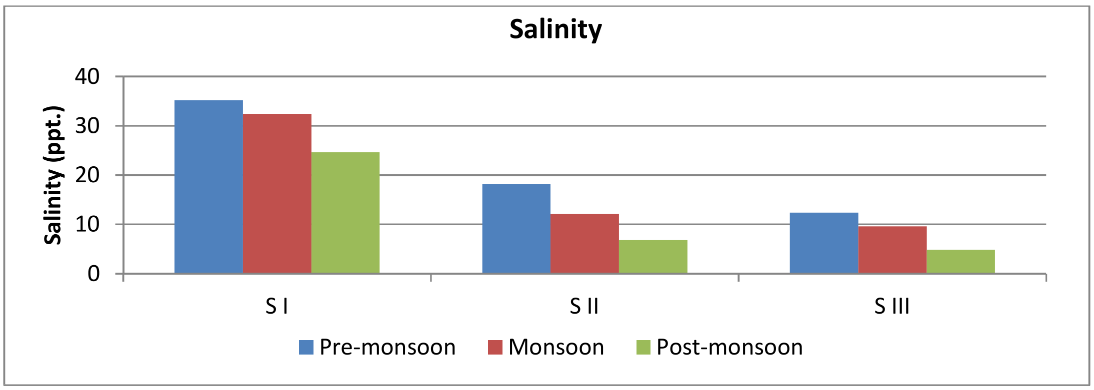

Fig. 4. Salinity during Pre- monsoon, monsoon and post - monsoon

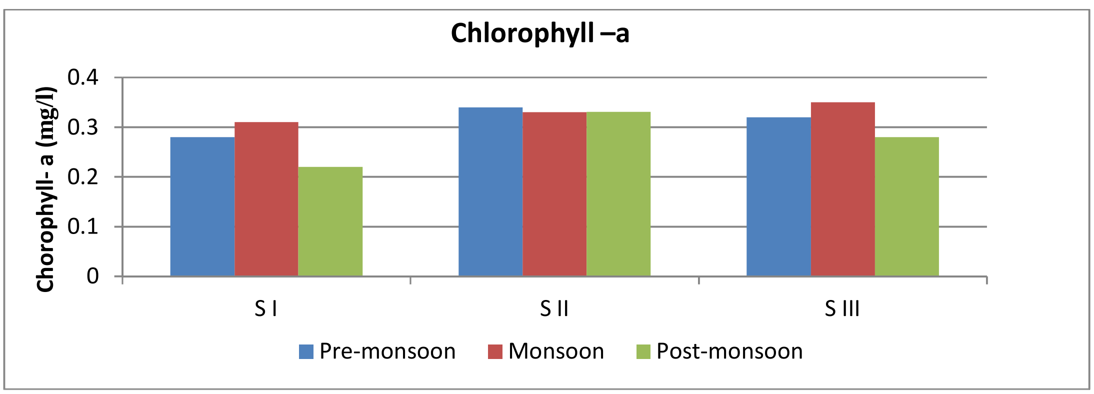

Fig. 5. Chlorophyll –a during Pre- monsoon, monsoon and post – monsoon

3.2 Spatial Variation of Meio-Fauna

The meio-fauna abundance was varied from 27 to 56 no/10 cm^2. The lower values occurred in the mud flat region (S I) and higher values occurred towards the mangrove region (S III). Foraminiferans were the most dominant group at S I (48%) and the nematodes (54.2%) were most dominant at S III (Fig. 9). Other forms such as ostracods (6%) were prevalent at S I due to estuarine rocky shore environment. Crustacean nauplii (8.1%) more abundant at S I. The amphipods (9.8%) predominated slightly in S III. The environmental factors such as temperature and granulometry are the main factors influencing the spatial distribution of the meio-fauna in tropical mangrove systems [20]. In our studies the foraminiferans were more abundant towards creek the mouth region. Which is has high saline and a sandy nature of the soil.

Nematodes were mostly observed in clay regions of mangrove areas. The research locations have low densities of meio-fauna due to the poor nutritional quality of the environment [21-23]. The seasonal inflow of freshwater from side channels and from the Vamsadhara river gives raise to a large amount of terrigenous material. The sedimentation arising from these inputs generates a sediment distribution gradient characterized by a reduction in fine sediment fractions in the Creek. The granulometry also increases the meiofaunal abundance. The distribution pattern of the meio-fauna provides a better reflection of recent dynamic sedimentary processes [24]. The spatial distribution of the meio-fauna has been attributed to various factors such as, the food resources and the attraction of meio-fauna to these sources [25-32]. Stimulating the foraging behaviour of various predator species [33]. The more motile copepods may be more affected by wave- and current-induced dispersal processes, especially since they actively emerge from the benthos [34-36] and also to influxes. The terrestrial freshwater inputs and anthropogenic activities regulate the distribution of surface sediment at S II and III. S I is mainly influenced by current and wave pattern. Even these inputs were not continuous throughout the year.

3.3 Temporal Variation of Meio-Fauna

A comparison of meio -fauna data analysed in different seasons indicates influence of seasonal variability, because of the timing, amount and composition of the annual sedimentation. The present study area shows slight variations in the meio-faunal densities due to the change in the environmental conditions. The foraminiferans were generally the dominant group at S I due to the tidal impact and also to a more sandy bottom. Nematodes were generally more dominant in all the periods at S III (Fig. 8, 9 and 10) because of the influences of allochthonous materials, which are derived from Desigadda and Garibulagadda channels and of autochthonous which is derived from mangroves and also from shrimp farms. The meio-faunal density was higher in pre-monsoon (Fig. 8) than

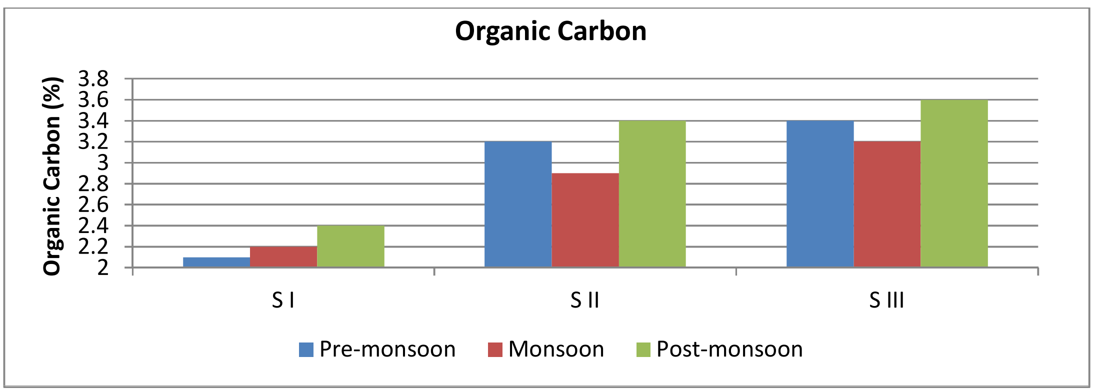

Fig. 6. Organic carbon during Pre- monsoon, monsoon and post - monsoon

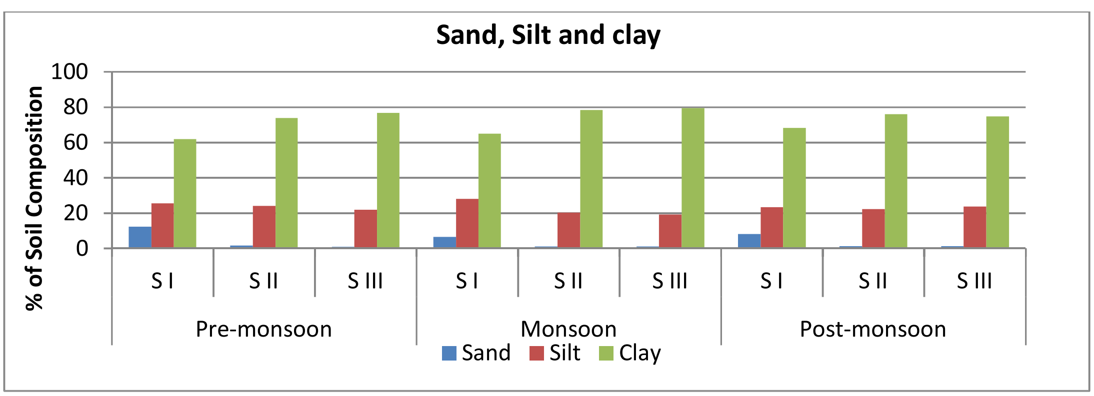

Fig. 7. Sand, silt and clay during Pre- monsoon, monsoon and post – monsoon

in post – monsoon (Fig. 10) and monsoon (Fig. 9) conditions. During the pre-monsoon season the nematodes showed a positive correlation with organic carbon (Table 1). which indicates that nematodes population density showed favourable growth at high organic carbon levels, which in turn also shows an anoxic condition. During monsoon period the nematodes showed positive correlation (Table 2) with chlorophyll. Yet nematodes might not depend on the primary production itself, but on the accompanying bacteria or on the benthic plankton or algal biomass. The foraminiferans showed a positive correlation with salinity (Table -1, 2 and 3) which indicates that high saline conditions were favourable for the growth of foraminiferans and the salinity induces the pH and calcification of the foraminiferans [37]. The copepods showed a positive correlation with chlorophyll content during monsoon and post-monsoon periods (Tables 2 and 3). Which is indicates that copepods abundance was controlled by chlorophyll [38]. The abiotic factors affected the change in the distribution of meio –fauna and also influenced factors like channels and anthropogenic activities.

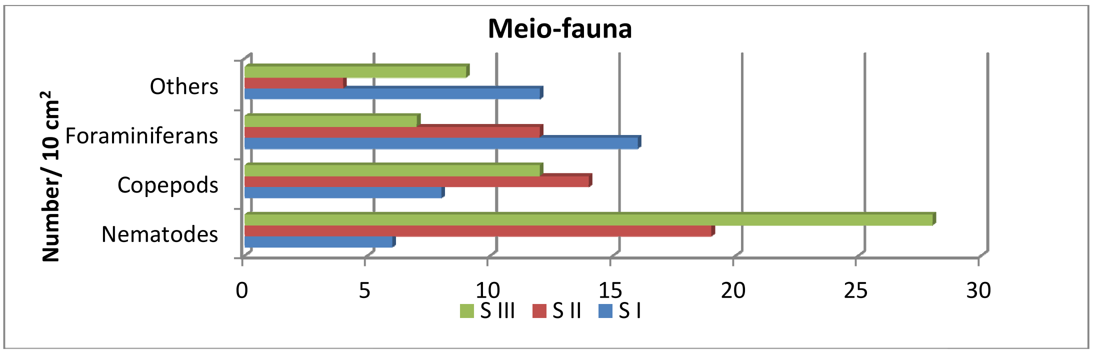

Fig. 8. Meio-fauna during Pre- monsoon

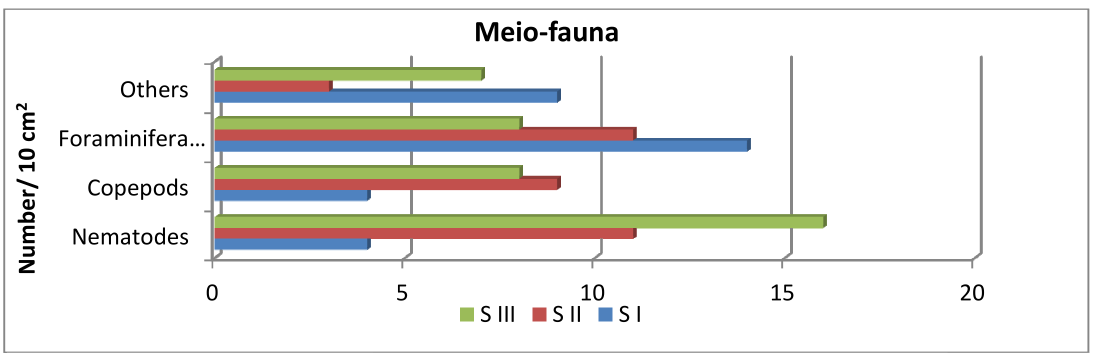

Fig . 9. Meio-fauna during Monsoon

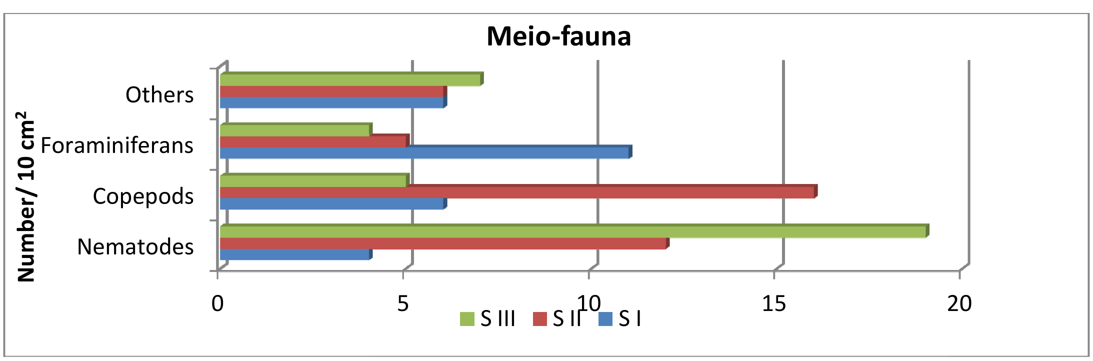

Fig. 10. Meio-fauna during Post – monsoon

Table 1. Correlations during Pre-monsoon

	Temperature	**Salinity**	**D.O.**	**Chlorophyll**	**Organic carbon**	**Nematodes**	**Copepods**	**Foraminiferans**	**Others**
Temperature (ºC)	1.	*	*	*	*	*	*	*	*
Salinity (ppt.)	**0.6497***	1.	*	*	*	*	*	*	*
D.O. (mg/l)	-0.6007	0.2175	1.	*	*	*	*	*	*
Chlorophyll (mg/l)	**0.9631***	**0.8303***	-0.3634	1.	*	*	*	*	*
Organic carbon (%)	-0.5903	-0.9971	-0.2907	-0.7857	1.	*	*	*	*
Nematodes (10 cm^2)	-0.3304	-0.9322	-0.5561	-0.5722	**0.9569***	1.	*	*	*
Copepods (10 cm^2)	0.4039	-0.433	-0.974	0.1429	0.5	**0.73***	1.	*	*
Foraminiferans (10 cm^2)	0.4841	**0.9797***	0.4087	**0.7017***	-0.9921	-0.9858	-0.6049	1.	*
Others (10 cm^2)	-0.0822	**0.7042***	**0.8462***	0.189	-0.7559	-0.9135	-0.9449	**0.8322***	1.

Table 2. Correlations during monsoon

	Temperature	**Salinity**	**D.O.**	**Chlorophyll**	**Organic carbon**	**Nematodes**	**Copepods**	**Foraminiferans**	**Others**
Temperature (ºC)	1.	*	*	*	*	*	*	*	*
Salinity (ppt.)	-0.3247	1.	*	*	*	*	*	*	*
D.O. (mg/l)	-0.8889	**0.722***	1.	*	*	*	*	*	*
Chlorophyll (mg/l)	**0.7269***	-0.8856	-0.9608	1.	*	*	*	*	*
Organic carbon (%)	-0.7656	-0.3599	0.3857	-0.1147	1.	*	*	*	*
Nematodes (10 cm^2)	0.3766	-0.9985	-0.7592	**0.9099***	0.3076	1.	*	*	*
Copepods (10 cm^2)	**0.8436***	-0.7818	-0.9959	**0.982***	-0.3004	**0.8152***	1.	*	*
Foraminiferans (10 cm^2)	-0.2861	**0.9992***	**0.6934***	-0.866	-0.3974	-0.9954	-0.7559	1.	*
Others (10 cm^2)	-0.9991	0.3653	**0.9078***	-0.7559	0.737	-0.4163	-0.866	0.3273	1.

Table 3. Correlations during post-monsoon

	Temperature	Salinity	D.O.	Chlorophyll	Organic carbon	Nematodes	Copepods	Foraminiferans	Others
Temperature (ºC)	1.	*	*	*	*	*	*	*	*
Salinity (ppt.)	0.0811	1.	*	*	*	*	*	*	*
D.O. (mg/l)	-0.9969	-0.0019	1.	*	*	*	*	*	*
Chlorophyll (mg/l)	**0.7839***	**0.6825***	-0.7322	1.	*	*	*	*	*
Organic carbon (%)	-0.8322	-0.6201	**0.7857***	-0.9966	1.	*	*	*	*
Nematodes (10 cm^2)	0.1024	-0.9832	-0.1808	-0.5375	0.4663	1.	*	*	*
Copepods (10 cm^2)	**0.9893***	0.2256	-0.9747	**0.866***	-0.9042	-0.0438	1.	*	*
Foraminiferans (10 cm^2)	-0.4396	**0.8596***	0.5094	0.2131	-0.1321	-0.9385	-0.304	1.	*
Others (10 cm^2)	-0.4435	-0.9293	0.3712	-0.9042	**0.866***	**0.8462***	-0.5695	-0.61	1.

*(P=0.05, * showing significant)*

4. CONCLUSION

The main meio-fauna groups were mainly copepods, nematodes and foraminiferans. Other groups such as amphipods, ostracods and polychaetes being less abundant. The meio-fauna is known to be a sensitive indicator of pollutants. Because of their large numbers, relatively stationary life habitats and short lifecycles. They assess the effects of contaminants within short period of time.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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