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Studies on anthropogenic and climatic changes to meiofaunal communities in Chettuva mangrove with reference to hydrological parameters

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Abstract
An attempt was made to study anthropogenic and climatic changes to meiofaunal communities in Chettuva mangrove with reference to hydrological parameters. Monthly sampling was done in two stations (station I- non polluted, station II- polluted) for a period of seven months from January 2015 to July 2016. Meiofauna in the Chettuva mangrove was represented by six taxa in varying proportions. Nematodes, poly chaetes, copepods were the most abundant groups. Nematode alone contributed more than 40% of total meiofauna and represent high abundance during all seasons and all stations. All the meiofaunal groups exhibited seasonality in their abundance with relatively high density during the pre-monsoon season. Maximum diversity and species richness was recorded during pre-monsoon and minimum during monsoon. Hydrological parameters also show seasonal variation. In the present study maximum meiofaunal density was recorded in station two this might be due to high organic carbon induced by pollution.

Keywords: Mangrove, meiofauna, diversity, species richness

1. Introduction

Mangroves are unique intertidal ecosystem of tropics and subtropics mainly between latitude of 250c which support genetically diverse group of aquatic and terrestrial organisms. These are one among the world's most productive ecosystem. There may be no other group of plants that have developed such adaptation to extreme conditions of salinity, extreme tides, strong winds, high temperature and muddy anaerobic soils. The plants and animals comprising mangrove ecosystem forms golden asset of coastal marine resources. Regarding environmental significance, the mangrove protect the coastal communities from cyclones, storms, flood and prevent soil erosion. Moreover they filter sediments and nutrients out of terrestrial runoff and prevent them from reaching other ecosystem such as sea grass and coral reefs. Regarding economic benefit, the mangrove promote coastal and marine fisheries, forest products and provide site for eco-tourism.

The word mangrove is derived from Portuguese word "Mangrove" or Spanish "Mangle" in association with English word "Groove". Mangrove forest is also called as "marine tidal forest",

Mangroves possess unique characteristics, they have "Breathing roots" or "Prop roots", viviparous germination etc. They are one of the most productive vegetation community with capacity for high rate of primary productivity (24 tones /ha/yr). The total number of mangrove inhabiting species in Indian mangrove are 311 which include prawns, mollusk, fish, insects, reptiles, mammals. Indian mangrove approximately comprising 59 species on higher plants belonging to 41 genera's and 29 families (Kathiresan and Bingham, 2001). Mangroves in Kerala are distributed in eight coastal district of which Kannur (755ha); has largest followed by the district of Kozhikode (293), Ernakulam (260ha), Alapuzha (90ha), Kottayam (80ha) and Thrissur (22ha). Major mangrove species are *Avicennia officinalis, Avicennia maraina, Rhizophora mucronata, Bruguiera cylindrica, Exocoecaria agallocha, Acanthus ilicifolius, Premnalatfolila* etc.

The type of organism constituting the meiofauna include a broad range of invertebrate phyla dominated by those phyla that normally have small enough size to fit between the sediment

Grains. Meiobenthos, also called meiofauna are small benthic invertebrates that live in both marine and fresh water environments. The terms meiofauna loosely defines a group of organism by their size, larger than micro fauna but smaller than macro fauna. Studies on meiofaunal biodiversity and distribution in mangrove ecosystems have been conducted previously in many countries (Zhou *et al*., 2015) [17]. Benthic fauna in general have been used as an indicator on environmental change during a long time, although mainly macro fauna have been targeted due to it can readily be counted and identified. Less attention has been focused on the smaller meiobenthic fauna (Liu *et al*., 2011) [7]. However, Zeppelli *et al*. (2015) [16] propose that meiobenthic fauna can be particularly valuable as bio indicator compared to other benthic communities due to the variety and high abundance, although it is cost-effective and remains a challenge in taxonomic identification. Thus in present study an attempt was made to study anthropogenic and climatic changes to meiofaunal communities in Chettuva mangrove with reference to hydrological parameters.

2. Materials and methods

The study area, Chettuva mangrove located on the eastern side of the Chettuva highway bridge in the estuarine area formed by the rivers, Karuvannur River and Kechery River. It comes under the Orumanayur Grama Panchayat of Chavakkad Taluk (10^0 32'14.5" N and 76^0 03'01" E). It is located at a distance of 25 km from Thrissur town. The common species of mangrove are Avicennia officinalis, Avicennia marina, Rhizho phora mucronata, Excoecariaa gallocha etc.

Monthly field sampling was conducted at the Chettuva mangrove for seven months (January 2015 to July 2016). Two stations with varied ecological characteristics were selected in the mangrove for monthly field sampling. Water samples were collected using Niskin water sampler. Samples for dissolved oxygen (DO) were fixed onboard and the remaining water samples were collected in 1-L plastic bottles kept in ice boxes and brought to the laboratory at the earliest possible time. Temperature and pH of water sample were determined in the field by using thermometer and pH meter. Salinity, dissolved oxygen and carbon dioxide were analyzed by titration methods.

Sediment samples were collected from each of the selected stations, namely polluted zone, non-polluted zone by using grab. After sieving, all the organisms are carefully fixed in 5% formalin. Subsequently, the organisms were stained with Rose Bengal solution for easy identification. The meiofauna was then counted into major groups under a stereoscopic microscope. The diversity index was calculated by using the Shannon – Wiener diversity index (1949). Margalef's index was used as a simple measure of species richness (Margal ef, 1958). For calculating the evenness of species, the Pielou's Evenness Index (e) was used.

3. Result

3.1 Environmental entities

The environmental parameters recorded in two stations are given in Table 1. Water temperature is controlling factor for all aquatic life. The water temperature varied from 25.3- 33 and 27.5 - 34.5 in station 1&II. Temperature was higher during pre-monsoon with peak value in both stations, show lowest value during monsoon. The discernible spatio-temporal variation was observed in the pH values. It was generally on alkaline side in most of the months. But during peak monsoon marked by heavy rain, values were tended to fell in all the stations. Higher pH values were observed in station I when compared to the station II. pH show peak value during post monsoon and lowest value in monsoon in both stations. Monsoon season showed highest DO content as compared to post monsoon period and pre monsoon period. Do concentration was always high in station I (nonpolluted) than station II (polluted). CO2 values in the station II showed comparatively high value than station I. The CO2 values were high in pre monsoon as compared to monsoon period and post monsoon period in the Chettuva mangrove. Average salinity of estuary showed mesohaline nature. During the monsoon period salinity values were comparatively low; however, salinity enormously increased during pre-monsoon period; but, salinity tends to decreased during post monsoon period.

Table 1: Seasonal and station wise changes in environmental parameters at Station I, II.

Season	Temperature	pH	Salinity	Dissolved	Dissolved	Stations
				oxygen	carbon dioxide	
	(^{0}C)	(ppm)	(mg/l)	(mg/l)		
Post	28.9	8.18	34.1	3.53	1.33	Station I
Monsoon	30	7.36	34.1	2.84	2.20	Station II
Pre	33	7.33	34.6	3.75	2.5	Station I
Monsoon	34.5	6.59	35.5	3.61	2.43	Station II
Monsoon	25.3	6.91	23.5	5.53	1.53	Station I
	27.5	6.31	25	4.34	1.58	Station II

3.2 Biological entities

Among 6 class of meiofauna recorded from two stations, nematoda were found to be the dominant group; polychaeta emerged as next dominant group. In Station I, a total of 146 organisms of meiofauna were recorded. Among these, there were 69 organisms of nematoda, 45 organism of polychaetes, 13 organisms of copepod, 7 organisms of ostracoda, 6 organisms each of tuebellaria and oligochaeta (Figure 1). With respect to Station II, a total of 258 meiofauna were recorded. Among these, 111 meiofauna belonged to nematoda, 87 meiofauna to polychaetes, 18 to copepoda, 16 to ostracoda, 7 to turbellaria and 19 to oligochaeta (Figure 2). Regarding the percentage composition of meiofauna, in Station I, nematoda were found to be the dominant group by constituting 47.3% of the total benthic organisms recorded. Polychaete formed next dominant group with 30.82%. Copepoda and ostracoda formed third & fourth dominant group with 8.9 & 4.8% respectively. Turbellaria and oligochaeta came next in the order with a percentage contribution of 4.1% (Figure 3). With respect to Station II, nematode topped the list with 43%. Polychaetes ranked second with contribution of 33.72.7%. Oligochaeta ranked third with 7.4%. Copepoda formed next dominant group with 7%. Ostracoda and turbellaria contributed 6.2 and 2.71%, respectively to the total benthic organisms (Figure 4).

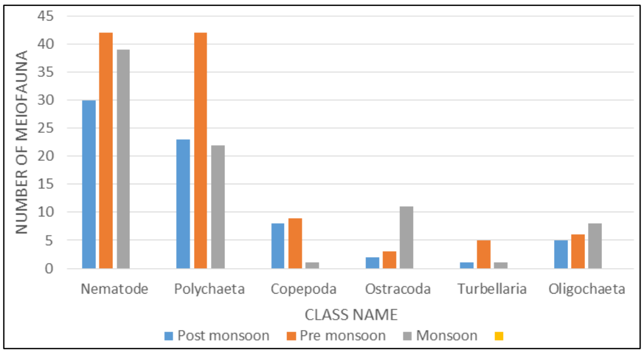

Fig 1: Graph showing seasonal variation in abundance of meiofauna at station I

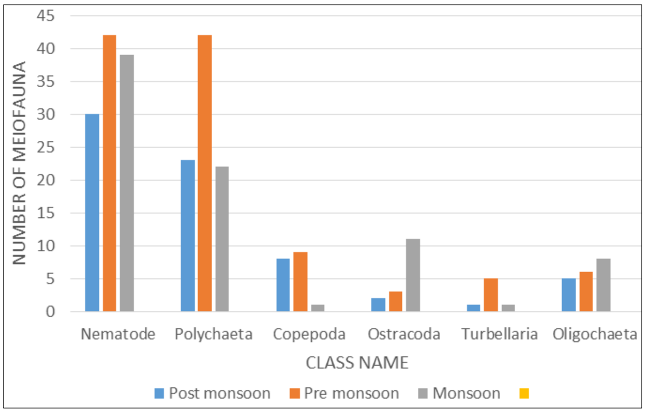

Fig 2: Graph showing seasonal variation in abundance of meiofauna at station II

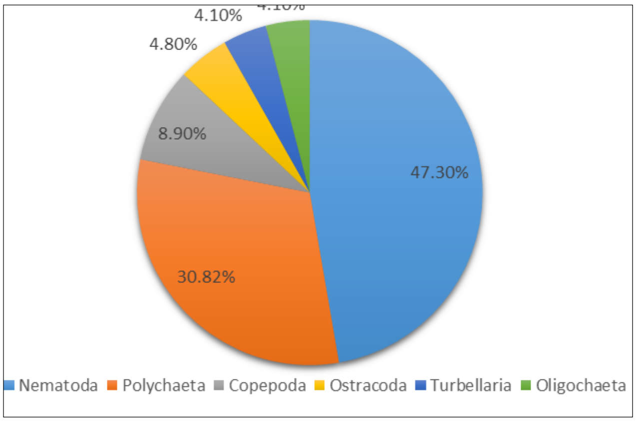

Fig 3: Percentage composition of meiofauna at station I.

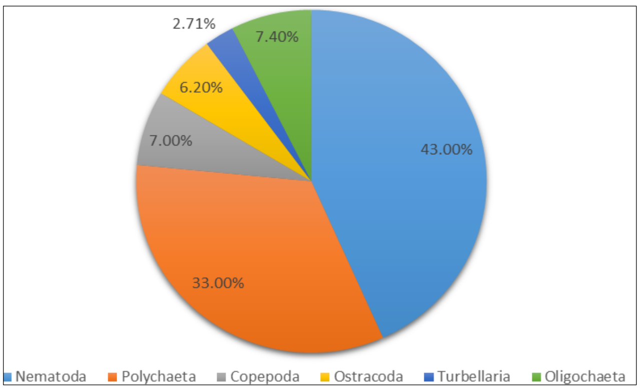

Fig 4: Percentage composition of meiofauna at station II

3.3 Diversity indices

The diversity indices calculated for two stations are given in Table 2. In Station I, the species diversity (Shannon-Weiner index) ranged from 1.16 to 1.38; species richness fluctuated between 1.298 and 1.47 and species evenness (Pielou's evenness) from 0.72 to 0.77. At Station II, the species diversity ranged from 1.3 to 1.37; species richness fluctuated between 1.07 and 1.18 and Pielou's evenness varied from 0.73 to 0.76. Minimum species diversity value was recorded during monsoon season and maximum value was recorded during pre-monsoon.

Table 2: Showing seasonal variation in diversity indices at station I& II.

Stations	Seasons	Shannon Wiener Diversity (H)	Evenness (J)	Richness (D)
I	Post monsoon	1.32	0.74	1.29
	Pre monsoon	1.38	0.77	1.18
	Monsoon	1.16	0.72	1.47
II	Post monsoon	1.33	0.74	1.18
	Pre monsoon	1.37	0.76	1.07
	Monsoon	1.3	0.73	1.13

4. Discussion and conclusion

Extensive sampling in Chettuva has allowed us to provide an evaluation of relationship between meiofauna, climatic change and anthropogenic activity. Deekae and Henrion (1993) [3] and Guerreiro *et al*. (1996) [6] were also reported the distribution of mangrove fauna in relation to water quality. In the present study, the temperature level varied from 25.3 to 34.5°C. All the stations showed a similar trend in seasonal variations with minimum in monsoon and maximum during pre-monsoon as reported earlier by Vinitha *et al* (2016) [14]. According to Pravinkumar *et al* (2013) [18] fluctuations in pH values during seasons of the year are attributed to factors like removal of CO2 by photosynthesis through bicarbonate degradation, dilution of seawater by freshwater influx, reduction of salinity and temperature, and decomposition of organic matter. Lowest pH value reported from station II may be due to pollution. Salinity act as limiting factor of meiofaunal distribution, showed a significant positive correlation with temperature. The maximum value was observed in pre monsoon and minimum in monsoon. The maximum salinity is due to the salt water dominance and high rate of transpiration. The minimum salinity is due to the monsoon rain. The similar observations are reported by Nedumaran and Ashok Prabu (2009). In the present investigation, dissolved oxygen showed high during monsoon at both stations which might be due to the cumulative effect of higher wind velocity and, it varied from 3.53 to 5.53 mg/L. Similar observation with high value during monsoon and low during summer was reported earlier by Fernando (1987) [4] and Tripathy *et al*. (2005) [11]. The seasonal variations in dissolved oxygen mainly due to the freshwater influx. It is well known that the temperature and salinity affect the dissolution of oxygen (Vijaya kumar *et al*., 2000) [13]. The dissolved CO2 content maximum during pre-monsoon season, it may be due to relatively high temperature which accelerate bacterial decomposition of organic matter and results the liberation of carbon dioxide. In the present study an inverse correlation between carbon dioxide and oxygen are evident and such relationship also observed by Vinitha *et al* (2016) [14].

Generally, in a benthic sample, nematodes constitute more than the other faunal groups. The dominance of nematodes in diverse ecological niches is due to their high adaptability to wide range of fluctuation in environmental factors. Nematodes are adapted to extreme environments through detoxification strategies and high anaerobic capacity (VeitKohler *et al*. 2009; Vopel *et al*. 1998) [12, 15]. Ansari and Parulekhar (1998) [2] reported that nematodes were the most dominant group in Zuari estuary of Goa west coast of India. Maximum percentage composition observed in station 2 due to the enrichment of organic materials.

Polychaetes were the second the dominant group in the study site. Their dominance might be due to high organic carbon content in the sediments. Food acts as a factor in the distribution and abundance of meiobenthic fauna (Ingole *et al*., 1987; Harriague *et al*., 2012). Guadros *et al*., (1996) stated that organic matter would enhance the density of meiobenthic faunal assemblage. Brenda Healy and Kathrya Coates (1997) reported the Enchytraeids (Oligochaetes) were limited by shortage of organic matter. Schrijvers *et al*., (1996) found that denude density of meiobenthos due to the decrease of organic materials. High density of meiofauna was observed with maximum occurrence of organic matter in Mahanadi system, east coast of. In the present study, the organic matter produced in the late monsoon is being converted into food which would further enhance the meiobenthic faunal assemblage in post monsoon and pre monsoon.

According to Pravinkumar *et al* (2013) [18] species diversity is the simple and useful measure of a biological system. Redding and Cory (1975) [9] found a high level of agreement between species diversity and nature of the environment and hence, regarded the measure of species diversity as an ecologically powerful tool. Moreover, Pearson and Rosenberg (1978) [8] proposed that the use of diversity indices is advantageous for the description of fauna at different stages in the succession. Sanders (1968) [10] also postulated that the species diversity is mainly controlled by the fluctuations in the environment that lead to low diversity. In the present study maximum diversity and species richness was recorded during pre-monsoon and minimum during monsoon. This result is also supported by Chandran, 1987; Murugesan, 2002; Ajmal *et al*., 2005; Devi, 1994. [19, 20, 21, 22]

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