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Meiofauna of Pitchavaram mangroves along southeast coast of India

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Abstract

A study on the benthic meiofaunal density of Pitchavaram mangrove, along with environmental variables like temperature, salinity, dissolved oxygen, organic carbon and sediment characteristics was made during September 2000 to August 2001. The monthly variation was pronounced for the different taxa with peak abundance in June (summer) and minimum in November and December (monsoon). The meiofaunal density was highest in sediments with *Avicennia* cover (44-7275 No./10m^2) followed by *Rhizophora* cover (152-4400 No./10cm^2). The taxa with no mangrove cover recorded the lowest density (109-1198 No. /10cm^2). Meiofauna was represented by nematodes, copepods, kinorhynchs, foraminiferans, oligochaetes, polychaetes, ostracods, turbellarians and allogromiids of which nematodes were the most dominant (9-99%). The mangrove regions harbour a very high density of meiofauna though not very diverse. The plant cover may have some impact on the meiofaunal population densities present in the substrate, and further studies needs to be undertaken to determine the cause for maximum abundance observed in sediments with *Avicennia* cover compared to *Rhizophora*.

Introduction

Mangroves are characteristic forest ecosystems that exist in tropical and subtropical intertidal region of the world that support rich faunal resources. The mangals play an important role in the estuarine and coastal food webs (Alongi, 1990a). The importance of meiofauna to trophic dynamics and nutrient recycling in estuarine ecosystem is being increasingly emphasized (Warwick and Price, 1979). Studies on meiofauna of mangrove regions have been made from the east (Sultan Ali *et al.*, 1983; Krishnamurthy *et al.*, 1948; Kondala Rao and Ramanamurty, 1988 and Sarma and Wilsanand , 1994), and west coast of India (Ansari *et al.*, 1993; Ingole *et al.*, 1987 and Goldin *et al.*, 1996). Present investigation was undertaken to study the effect of mangrove cover on density and distribution of meiofauna at Pitchavaram.

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Material and methods

Pitchavaram mangrove (Lat.11° 27'N; Long. 79°47'E) is situated along the southeast coast of India; about 230 km south of Chennai in Tamil Nadu (Fig.1). It is spread over an area of about 1,100 hect-

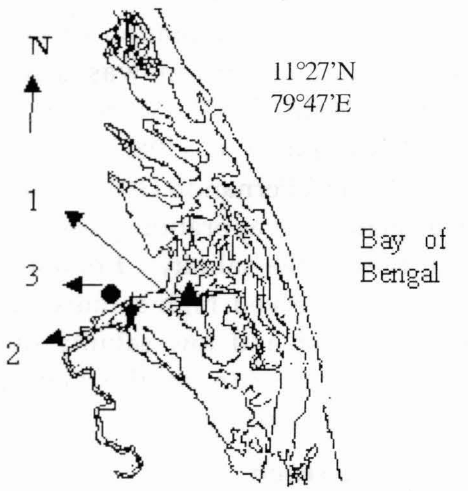

Fig. 1. *Pitchavaram showing station position*

ares, consisting of 51 islets, ranging in size from 10 m^2 to 2 km^2. About 50% of total area is covered by the forest, 40% by water ways and the remaining filled by sand and mud flats (Krishnamurthy and Jeyaseelan, 1983). It lies in between the Vellar and Coleroon estuarine system. Maximum depth in the mangrove area is approximately 3m, and minimum being 30-50 cm. The tidal amplitude ranges between 0.15m and 1.0 m.

Station I is situated about 2 km from the sea mouth where *Rhizophora apiculata* was present in large numbers with fewer *Avicennia marina*. Station II, opposite to the tourism jetty, is about 1.5 km away from station I. *A. marina*, unlike in station I, was present in large numbers while *R. apiculata* occurred sparsely. In this station also the mangrove was dense. Station III is situated adjacent to the tourism jetty, approximately opposite to station II, and has no mangrove cover. Aforestation is being undertaken in this area to preserve the ecosystem. Monthly samples for meiofauna and environmental variables were collected for one year from September 2000 to August 2001 from all three stations.

Water temperature was measured using a Celsius thermometer with ± 0.5 accuracy and salinity by a refractometer (Atago Co. Ltd., Japan). Dissolved oxygen was estimated by modified Winkler's methods (Strickland and Parsons, 1968). Dry sieving was carried out to analyse the sediment samples, after they were air-dried. Total organic carbon was estimated by conventional methods (El Wakeel and Riley, 1956).

Quadruplicate samples were collected at the low tide level at each station by pushing a 0.1m^2 quadrate into the substrate to a depth of 10cm. The sediment samples were sieved and the organisms that passed through 0.5 mm but retained on a 63μm mesh sieve were preserved in 5% formalin and stained with Rose Bengal. The samples were further sorted and counted under a binocular microscope. From actual counts, densities of meiofauna per 10 cm^2 were extrapolated.

Results and discussion

Temperature

In general, maximum water temperature was observed during summer (May) at all the three stations (21-34°C, 22-36°C and 23-37°C at stations I, II and III respectively) (Fig.2a). Among the three stations studied, the maximum temperature was recorded throughout the year at station III probably due to the fact that unlike stations I and II it had no plant cover. Ansell *et al.* (1972), McLusky *et al.* (1975), and Achuthankutty *et al.* (1978) have made similar observations from sandy beaches of the west coast and Fernando (1987) from an estuarine beach of the east coast of India. Ansell *et al.* (1978) was of the opinion that such small variations as observed in the tropics may not affect the fauna as in temperate beaches.

Salinity

Salinity was maximum (35‰) during late summer and early premonsoon seasons (Fig. 2b) and decreased to the annual minimum (0‰) during monsoon. High salinity values during summer, compared to other seasons may be due to low rainfall and rise in atmospheric temperature resulting in high evaporation of surface water. Similar condition was also observed by Nair (1978), Murugan *et al.* (1980), Chandran *et al.* (1982), Sultan Ali *et al.* (1983) and Fernando (1987) observed that in general evaporation plays a vital role in raising the salinity. Kondala Rao (1984) also observed high salinity values during summer and low salinity during southwest monsoon in the Gautami-Godavari estuarine system.

Dissolved oxygen

Dissolved oxygen content fluctuated widely ranging between 2.2 ml/l and 8.1 ml/l during summer and monsoon (Fig.2c). Similar observations of high dissolved oxygen content during monsoon and low values during summer has been

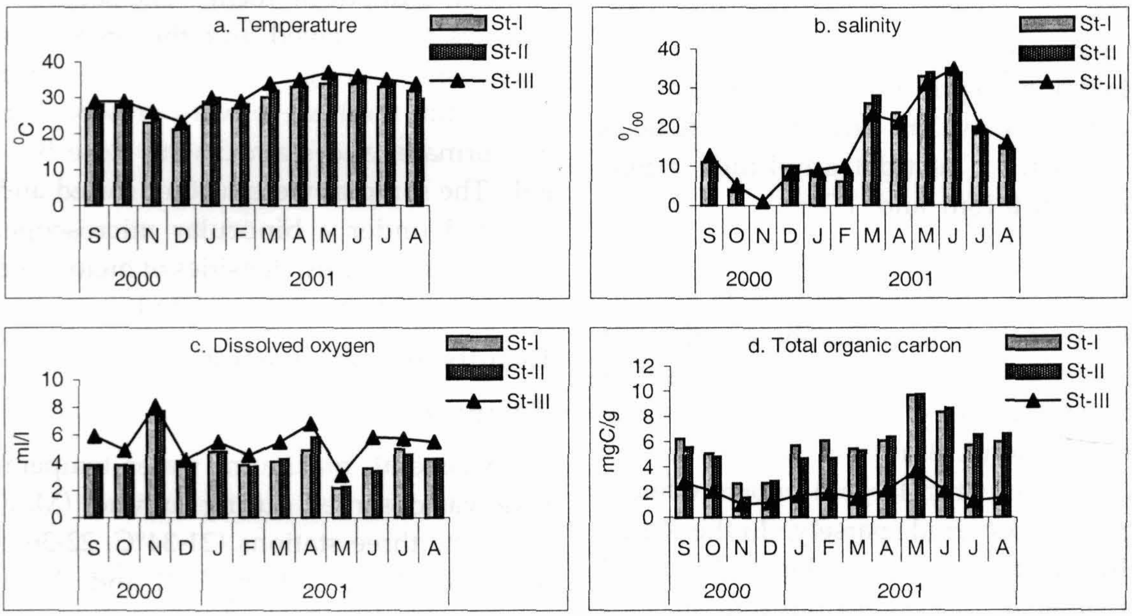

Fig. 2. *Monthly variation of environmental variables at stations I, II and III*

made by Fernando (1987) and Chandran (1987) in Vellar Estuary.

Total organic carbon

Sediment organic carbon at all three stations ranged between 1.0 and 9.76 mgC/g. Organic carbon content was observed to increase through the post monsoon to reach maximum during summer (Fig. 2d). Ansell *et al.* (1972) reported that organic carbon of sand was low during monsoon and reached peak values in sand and surf water at the southwest coast during June/July due to heavy rain, resulting in erosion of organic material in sand getting washed into the water. The high bacterial activity could also be another factor by which the organic matter becomes reduced with respect to particle size and gets embedded in the sediment (Rao and Sarma, 1982). Chandran (1987) also observed maximum values in summer (June and May) and low values during NE monsoon (Oct-Dec.) and post-monsoon seasons.

High organic carbon content was recorded in station I and II compared to a low value in station III. This was mostly due to the mangroves and thereby the leaf litter at the former two stations. Similar condition was observed by Kondala Rao (1984) and Ramanathan (1997). Ingole *et al.* (1987) have suggested that the dead organic carbon in the sediment increased the availability of food for meiobenthos. The organic carbon provides ideal food for selective and non-selective deposit feeders such as oligochaetes, polychaetes and nematodes. It is reported that the number of meiofaunal taxa are greatly dependent on the availability of the particulate organic matter in the sediment (Faubel and Meyer Reil, 1981).

Sediment characteristics

The percentage composition of sand in the substrate was high during summer (80-98%) and low during premonsoon at all three stations. It was observed that station III, which had no plant cover, had a greater percentage of sand throughout the period of study compared to the other two stations. The presence of mangroves may have increased the deposition of silt and clay brought by the freshwater inflow which resulted in maximum values during summer. Though a similar increase was also observed at station III, it was much lesser than stations I and II. Earlier observations at Pitchavaram (Ramanathan, 1997) showed that the sand and silt together constituted 70-90% of mangrove sediments followed by clay. Similarly, in the present study, coarse and fine sand was observed to range from 80-98%.

Meiofauna

The total meiofauna ranged from 152-4400, 44-7275 and 109-1198 No./10cm^2 at stations, I, II and III respectively, and was represented by nematodes, copepods, kinorhynchs, foraminiferans, oligochaetes, polychaetes, ostracods, turbellarians and allogromiids. In general all the faunal groups showed maximum concentration during summer, especially nematodes, copepods and kinorhynchs.

Nematodes were the most abundant group among the meiofauna, representing 81-97%, 70-99% and 9-97% at stations I, II and III respectively. At station III alone ostracods recorded highest density of 67.61% during September. Copepods constituted 0.5-14.3, 0.6-17.9 and 0.6-13.8% at stations, I, II and III respectively. Kinorhynchs and oligochaetes were observed to represent only less than 2% at all stations. Polychaetes represented less than 5% at stations I and II while a large numbers representing upto 17.7% was observed at station III. Foraminiferens and ostracods showed only sporadic occurrence at stations I and II. While they were observed throughout the period of observation at station III showing a minimum and maximum of 15.2% (Nov.) and 67.6% (Sep.) respectively. Oligochaetes were totally absent at station III (Fig.3).

Within mangrove sediments, as in most estuarine habitats, the numerically dominant metazoans are the nematodes and copepods constituting over 90% of the hard-bodied component of meiofauna (Somerfield *et al.*, 1998). Similar to the present observations, earlier studies on meiofauna of different mangrove system of India like Pitchavaram (Sultan Ali *et al.*, 1983; Krishnamurthy *et al.*, 1984), Thane creek (Goldin *et al.*, 1996), Goa (Ansari *et al.*, 1993), Bhitarkanika (Sarma and Wilsanand, 1994), and South Andaman (Chandarasekhara Rao, 1986) have all recorded maximum abundance of nematodes throughout the year. In general, harpacticoid copepods have been observed to be the second most abundant taxa. Goldin *et al.* (1996) observed that the tube dwelling polychaetes and oligochaetes were next in abundance to nematodes, and attributed the significant absence of copepods to the high intensity of pollution. The densities of nematodes observed, were generally within the range recorded from other littoral sediments without mangroves as also observed by Platt and Warwick (1980).

On the basis of density, the mangroves are considered to occupy a position intermediate to mudflat and salt marsh meiofauna (Dye, 1983). Observations by Ingole *et al.* (1987) from Saphala salt marsh showed that the meiofaunal density is comparable to that of mudflats and higher than either seagrass bed or salt marsh. The increase of detritus, which provides

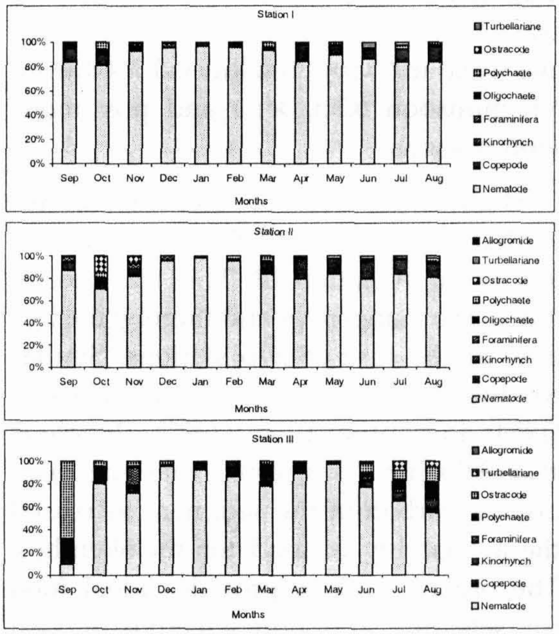

Fig. 3. *Monthly variation and percentage composition of meiofauna at stations I, II and III*

the main food for the meiofauna, is suggested to be the reason for the high meiofaunal population. Dye (1983) also suggested that the plant density is a determining factor in meiofaunal distribution. During the present study station I with plant cover and station III without plant cover harbors similar meiofaunal densities, whereas a larger meiofaunal population is observed at station II, which has plant cover. Therefore, it appears that besides plant cover, the exact type of plant cover may also play a role in determining the meiofaunal density occurring under its canopy. The area devoid of mangrove cover showed greater meiofaunal diversity than the other two stations where the density was lesser (Table I). Greater density was observed at station II (with *Avicennia* cover) compared to station I. However, Gee and Somerfield (1997) have shown that within the same tide level inundation regimes the species of trees appears to have little effect on the structure and diversity of the meiofauna community. Alongi (1987a, b) has shown that environmental factors such as temperature, sediment granulometry and tidal inundation regimes are the main factors influencing the distribution of meiofaunal communities in tropical mangrove estuaries in the same way that they do in non-tropical, non-mangrove estuaries. The variations observed in the environmental characteristics were similar to those already described in earlier studies from India, where monsoon brings about the most important changes due to fresh water inflow. The poor density of meiofauna observed during monsoon as compared to summer months has been well documented from Indian waters. This is normally attributed to the monsoon influenced changes in the environmental variables (Mclntyre, 1969; Damodaran, 1973; Sarma and Ganapati, 1975, Sultan Ali *et al.*, 1983; Fernando, 1987; Chandran, 1987; Ramanamurty and Kondala Rao, 1987, Sunitha Rao and Rama Sarma, 1990).

Table I. *Diversity indice at stations I, II and III*

Sample	S	N	d	J'	H'(log10)
St 1	8	13733	0.7347	0.272	0.2456
St 2	9	22700	0.7976	0.2936	0.2802
St 3	8	6019	0.8044	0.4871	0.4399

Particulate organic carbon in estuarine system is known to serve as food for many meiobenthic oranisms and influence their densities (Coul, 1973). Ingole *et al.* (1987) has observed that the availability of food may be the chief factor in the distribution and abundance of meiofauna in salt marsh. Studies in most mangrove meiofauna have concentrated on the fauna inhabiting sediments (Alongi, 1990, Sasekumar, 1994 and Olaffson, 1995) and is likely that the communities associated with decaying leaves have not been taken into account. However, in the present study, the organic carbon content at station I and II, both with plant cover is more or less similar and there seems to be no apparent reason for greater densities at station II compared to station I except the difference in the type of plant cover which requires further investigation.

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