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Full Length Research Paper

Benthic biodiversity in the Pichavaram mangroves, Southeast Coast of India

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An attempt was made to study the benthic biodiversity in Pichavaram mangrove ecosystem, Southeast coast of India. Monthly (duplicate) sampling was done in 3 stations, (Station I - fresh water zone, Station II - core mangrove zone and Station III - marine zone) for a period of one year from January 2008 to December 2008. As many as 22 species of benthic macro fauna were recorded in the study area (16 species of polychaetes, 4 species of crustaceans and 2 species of molluscs). The population density varied between 394 and 23,888 number/m^2. The species diversity was ranged from 1.52 to 3.87; species richness was from 1.24 to 4.09 and species evenness from 0.71 to 0.96. The maximum diversity was recorded in Station II and minimum in I. As observed in the conventional indices, the values of taxonomic and phylogenetic diversity were also more in Station II compared to Stations I and III. K-Dominance curve drawn paralleled the trend of diversity indices. Cluster and MDS showed the similarity in faunal composition stations within the zones.

Key words: Mangroves, benthos, biodiversity, polychaetes.

INTRODUCTION

Mangrove forests have declined significantly in South Asian countries over the past four decades. The main reasons for mangrove loss and degradation have been population pressure, wood extraction, conversion to agriculture and salt production, tin mining, coastal industrialization, and conversion coastal agriculture (Ong, 1995; Macintosh, 1996). Mangrove is the habitat of very rich faunal, which is comparable to tropical evergreen forest and coral reef ecosystems. Mangroves are extremely important to humans for a variety of reasons including aquaculture, agriculture, forestry, as a source of fire wood and other local use (Kathiresan and Bingham, 2001).

The benthic invertebrates have a profound effect on sediment structure and their biochemical processes by enhancing the porosity and water flow through the sediments. Besides this, their feeding on the sediment surface and plant matter promotes nutrients recycling (Kathiresan, 2000). The distribution, abundance and importance of fauna in mangrove environment were recently realized (Parulekar, 1994). The muddy or sandy sediment of mangrove forest act as a home for a variety of epifaunal and infaunal invertebrates (Kumar, 1995).

Mangroves are inhabited by a variety of benthic invertebrates, such as polychaetes, brachyuran crabs, gastropods, bivalves and sipunculids. Composition of these communities and their importance varies enormously from one habitat to another depending upon the sediment characteristics of the mangroves ecosystem. The saline conditions tolerated by various mangrove species range from brackish water, through pure seawater (30 to 40 ppt), to water concentrated by evaporation to over twice the salinity of ocean seawater (up to 90 ppt).

Similarly, it is understood that faunal assemblages influence the functioning of mangrove ecosystem in various ways. Invertebrates often show marked zonation patterns, and colonize a variety of specific micro-environments. Benthic invertebrates also act as a very good source of food for many bottom feeding fin and shell fishes which enter into the mangroves during high tide for breeding (Sheaves and Molony, 2000).

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In spite of rich faunal diversity in mangroves, it has always been given least importance by the scientific community world over. Realizing the importance, a large number of works pertaining to ecology of mangrove fauna of mangroves of east and west coasts of India has been carried out (Patra et al., 1990; Devi and Venugopal, 1989; Chakraborthy and Chowdhury, 1992; Balasubramanyan, 1994; Santhakumaran and Sawant, 1994; Kumar and Anthony, 1994; Kondalrao and Ramanamurthy, 1998; Kumar, 1995, 1997, 2001 and Saravanakumar et al., 2007). The limited number of benthic biodiversity studies was carried out so far in the Pichavaram mangroves. Having the above facts in mind, the objectives of this study was to compare the benthic biodiversity in three zones (FWZ-Fresh water zone; CMZ-Core mangrove zone; MZ-Marine zone) of Pichavaram mangroves. This information will be valuable for monitoring the ecological development of mangroves sites in South Asia.

MATERIALS AND METHODS

Study area and sampling design

Monthly sediment sampling was made from January 2008 to December 2008. Two replicate sediment samples were collected from each of the selected stations, namely fresh water zone (I), core mangrove zone (II) and marine zone (III), (Latitude 11° 27'N, longitude 79° 47'E) - (Figure 1). Peterson grab (0.0251 m^2) was used for collection of sediment samples. Two grab hauls were made at each station, a little quantity of sub-sample (~50 g) was collected for analysis of soil texture and the rest was washed at the sampling site using 0.5 mm sieve. Sediment was then shade dried and the total organic carbon was analysed (El-Wakeel and Riley, 1956).

The percentage composition of sand, silt and clay was calculated, and the sedimentary class was found based on the suggested nomenclature (Shepard, 1962) and soil texture was done by pipette analysis (Kurumbein and Pettijohn, 1938). Grab hauls (sediment samples) were collected according to standard protocol (Mackie, 1994). The environmental parameters such as temperature, salinity, pH and dissolved oxygen (DO) were analyzed by following the standard methods (Strickland and Parsons, 1972).

Benthic fauna

After sieving, all the organisms were carefully fixed in 5 - 7% (neutralized) formalin. Subsequently, the organisms were stained with Rose Bengal solution. Polychaetes (Day, 1967), crustaceans (Barnes, 1980), amphipods (Lyla et al., 1999), gastropods (Rajagopal et al., 1998) and bivalves (Shanmugam et al., 1997) were first segregated into group level and then identified to species level with the help of standard taxonomic references. The organisms were identified and counted under a stereoscopic microscope (Olympus SZ 40X magnification) and density of organisms was expressed as individuals per square meter.

Data analysis

The data were analyzed by various statistical methods namely univariate, graphical/distributional and multivariate methods. Two computer programmes namely SPSS (ver. 11.5.) and PRIMER (ver. 6.) (Clarke and Gorley, 2006) were used.

Univariate methods such as Shannon–Wiener index (H') (Species diversity), Margalef index (d) (Species richness) and Pielou's evenness index (J'). Warwick and Clarke (1995) proposed two new diversity indices, capturing the structure not only of the distribution of abundances amongst species but also the taxonomic relatedness of the species in each sample. The first index is taxonomic diversity (Δ) and the second one is total phylogenetic diversity were worked out. *k*-dominance curve were plotted and the results are graphically represented. Multivariate methods such as Bray–Curtis similarity and multi-dimensional scaling (MDS) ordination were carried out and are represented graphically.

BIO-ENV procedure

To ascertain the relationship between biological and environmental variables, the BIO-ENV procedure (Clarke and Ainsworth, 1993) was employed. The basic principle behind this is to measure the agreement between the rank correlations of the biological (Bray-Curtis similarity) and environmental (Euclidean distance) matrices. A weighted Spearman rank correlation coefficient ($\rho\omega$) was used to determine the harmonic rank correlation between the biological matrix and all possible combinations of the environmental variables.

$$\rho\omega = \frac{6}{N\,(N-1)} \sum_{i=1}^{N} \frac{(ri - si)^2}{ri + sj}$$

The environmental variables such as sand (%), silt (%), clay (%), total organic carbon (mgc/g), temperature (°C), salinity (ppt), dissolved oxygen (mg/L) and pH were used.

RESULTS

Environmental entities

The environmental parameters recorded in three stations are given in Table 1a-c. The water temperature varied from 27 to 31.5°C, with minimum during monsoon and maximum in summer season; salinity ranged between 0 and 34.2 psu with seasonal pattern same as that of temperature with maximum during summer and minimum in monsoon season; pH ranged between 7.2 and 8.4 in Stations I and III with minimum was recorded in monsoon and maximum in summer season. The DO was varied from 3.1 to 5.8 mg/L with minimum value during summer and maximum in monsoon season. Total organic carbon varied from 9.7 to 21.7 mgc/g. As observed in salinity and temperature, the higher value was recorded in summer and minimum in monsoon season. Coming to soil texture, the sand content was found to vary from 20.3 to 72.1%; silt content fluctuated from 0.6 to 7.9% and the clay content ranged from 20.5 to 80.0%.

Among the stations, the maximum sand was recorded in Station III (post monsoon) and minimum was in Station II (pre monsoon), the maximum clay content was in Station II (summer) and minimum was in Station III monsoon) and silt was maximum in Station III (monsoon) and minimum was in Station I (summer). The soils are

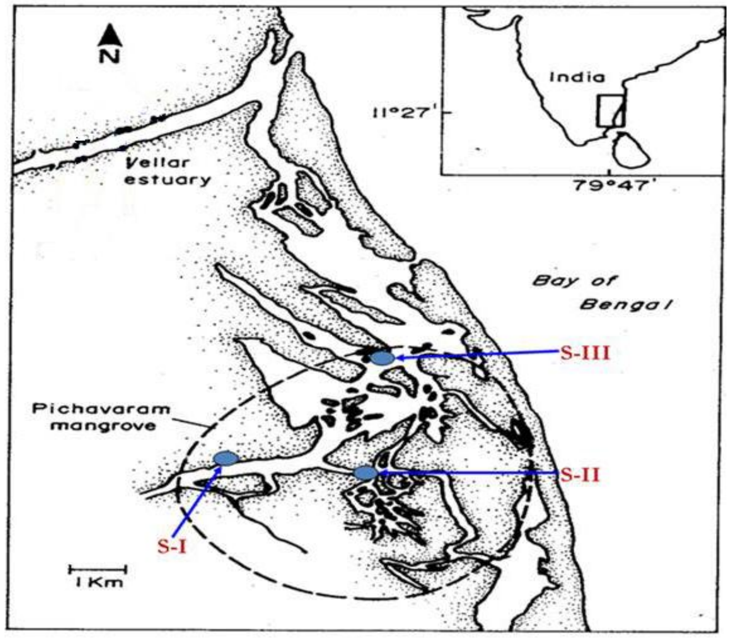


Figure 1. Sampling stations sampled in Pichavaram mangroves (I-III).

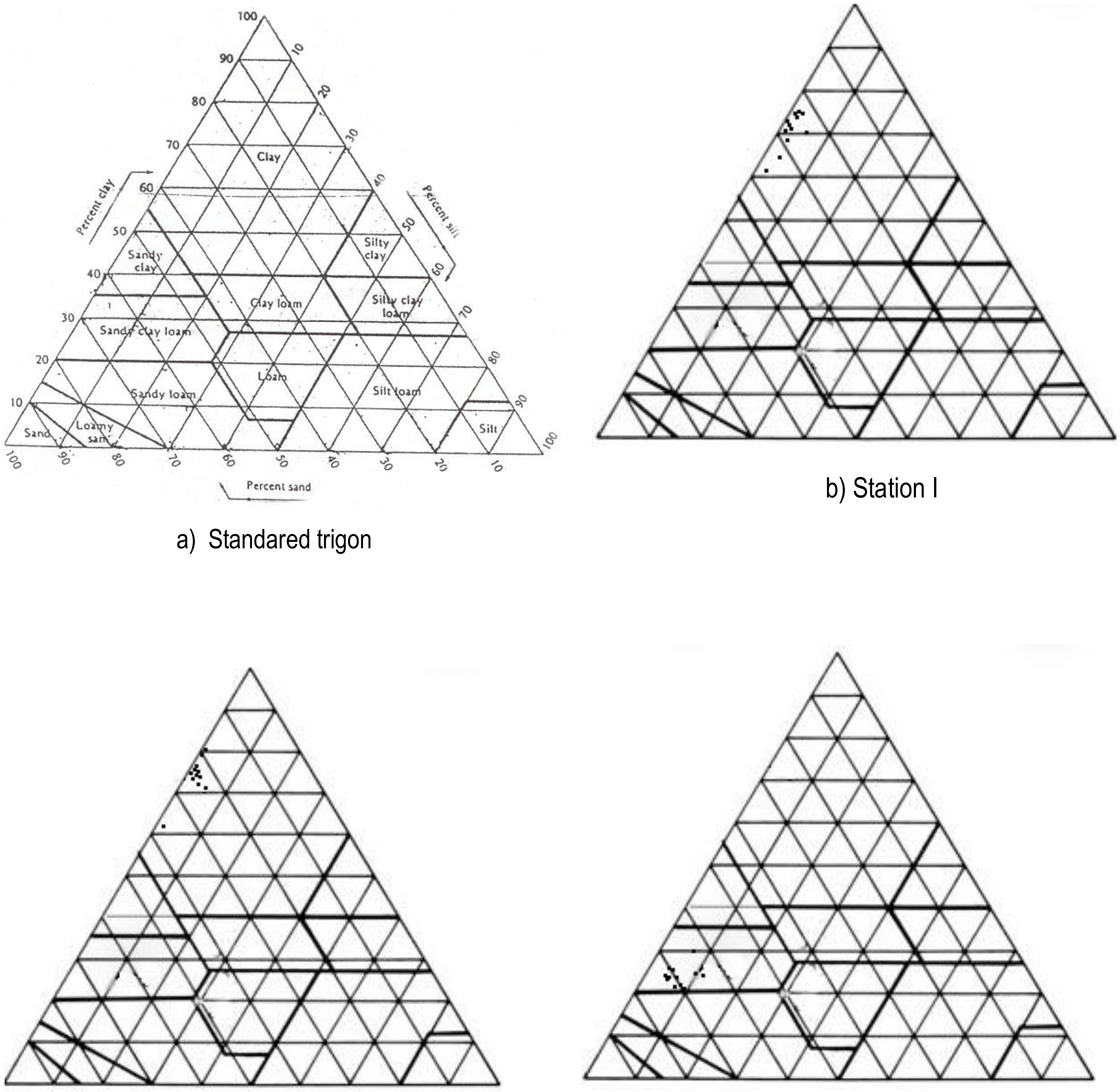
Table 1a-c. Seasonal and station wise changes in environmental parameters at Station I, II and III.

S/N	Parameter	Post monsoon	Summer	Pre-monsoon	Monsoon
		(a) Station I			
1	Temperature	28.59±0.52	29.06±0.01	28.33±0.45	28.48±0.51
2	Salinity	11.75±4.49	22.38±4.55	17.98±1.61	6.60±9.01
3	pH	7.70±0.09	8.05±0.08	8.13±0.01	7.82±0.10
4	Dissolved oxygen	3.50±0.15	3.23±0.15	4.23±0.32	5.26±0.15
5	Total organic carbon	11.4±1.44	14.06±0.80	12.36±1.35	12.33±1.76
		(b) Station II			
1	Temperature	29.28±1.14	29.47±0.52	28.61±0.51	28.57±0.485
2	Salinity	17.07±7.50	28.36±4.63	24.3±3.191	8.76±12.39
3	pH	7.90±0.12	8.01±0.109	7.99±0.030	7.79±0.284
4	Dissolved oxygen	3.8±0.2	3.46±0.05	4.66±0.32	5.5±0.1
5	Total organic carbon	15.86±0.51	17.1±0.8	17.1±0.85	19.23±2.45
		(c) Station III			
1	Temperature	29.48±1.59	31.32±1.47	30.08±0.76	28.52±0.50
2	Salinity	22.84±6.67	32.03±2.00	26.34±1.50	23.95±10.59
3	pH	7.9±0.26	8.3±0.1	8.15±0.06	7.97±0.12
4	Dissolved oxygen	4.1±0.36	3.5±0.2	4.46±0.30	5.53±0.251
5	Total organic carbon	15.16±1.68	15.33±0.33	14.5±0.72	15.23±1.05

classified into various soil classes based on the point at which the values meet using the standard diagram (Figure 2a). After calculating the percentage composition, the data were further plotted on soil trigons (Figure 2b-d).

Biological entities

Among 22 species of macrofauna recorded from three stations, polychaetes were found to be the dominant group with 16 species; crustaceans emerged as next dominant group with 4 species and bivalves and gastropods came next in the order with 1 species each. In Station I, a total of 7 species of macrofauna were recorded. Among these, there were 2 species of polychaetes, 3 species of crustaceans, 1 species each of bivalves and gastropods. With respect to Station II, a total of



a) Standared trigon

b) Station I

c) Station II

d) Station III

Figure 2a-d. Variations in soil texture in the study area.

18 species were recorded. Among these, 12 species belonged to polychaetes, 3 species to crustaceans, 1 each to bivalves and gastropods. At Station III, 12 species of macrofauna were found. Among these, 7 species of polychaetes, 4 species of crustaceans and 1 species of gastropod were recorded.

Among the polychaetes, *Polydora hoplura hoplura*, *P. capensis*, *Exogone clavator, Pygospio elegans, Euclymene* sp. were found to be common in all the stations during the study period. Concerning the crustaceans, *Apseudus* sp., *Grandidierella* sp. and *Eriopisa chilkensis* were found to occur throughout the study period. In case of bivalves, *Meretrix casta* and gastropod *Cerithidea cingulata* showed consistency in their occurrence in three stations. With respect to population density, in Station I, the density of benthic organisms varied between 394 and 12, 938 NOS/m^2 with maximum during summer and minimum during monsoon season. At Station II, the population density varied from 790 to 23, 888 NOS/m^2. With respect to Station III, the density of organisms varied from 715 to 20, 859 NOS/m^2 (Figure 3). Among the stations, maximum during summer in Station 2 and minimum during monsoon season in Station 1.

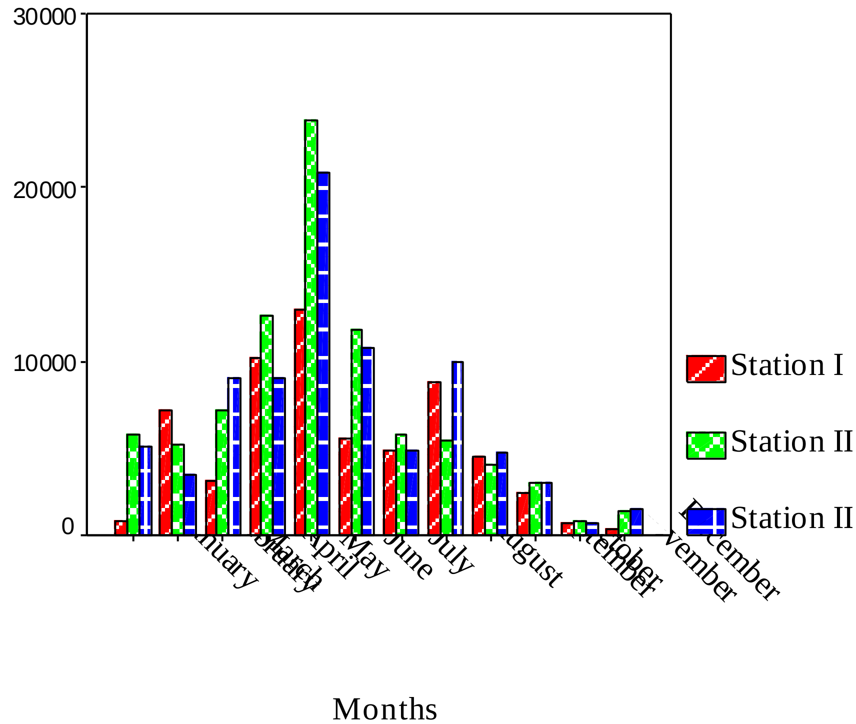


Figure 3. Monthly variations in population density of macrobenthos recorded in Stations I-III during the study.

Regarding the percentage composition of macrofauna, in Station I, polychaetes were found to be the dominant group by constituting 47.2% of the total benthic organisms recorded. Crustaceans formed next dominant group with 42.0%. Gastropods and bivalves came next in the order with a percentage contribution of 6.1 and 4.6% respectively (Figure 4a). As in Station I and II, polychaetes topped the list with 50.6%. Crustaceans ranked second with contribution of 44.6%. Gastropods and bivalves contributed 3.4 and 1.3%, respectively to the total benthic organisms (Figure 4b). With respect to Station III, polychaetes continued to be the dominant group with 47.5%. Crustaceans formed next dominant with a contribution of 41.7%. Gastropods and bivalves contributed 7.3 and 3.5%, respectively to the total benthic organisms collected (Figure 4c).

Diversity indices

The diversity indices calculated for three stations are given in Table 2. In Station I, the species diversity (Shannon-Weiner index) ranged from 1.52 to 3.36; species richness fluctuated between 1.24 and 3.49; species evenness (Pielou's evenness) from 0.74 to 0.93; taxonomic diversity from 32 to 76.93 and the total phylogenetic diversity fluctuated from 180 to 1000. At Station II, the species diversity ranged from 2.24 to 3.87; species richness fluctuated between 1.73 and 4.09; Pielou's evenness varied from 0.71 to 0.96; taxonomic diversity from 55.43 to 76.88 and the total phylogenetic diversity values ranged from 340 to 1120. With respect to Station III, the species diversity (Shannon-Wiener index) varied from 2.70 to 3.61; species richness from 2.04 to 3.59; species evenness from 0.77 to 0.98; taxonomic diversity values were from 65.57 to 79.48 and total phylogenetic diversity varied from 460 to 980. Among three stations, the minimum diversity and richness values were recorded in Station I (fresh water zone) and maximum in Station II (core mangrove zone). As regards species evenness, the minimum value was recorded in Station II and maximum in Station III (marine zone). The taxonomic diversity also showed minimum in Station I and maximum in Station III. Similarly, the total phylogenetic diversity was minimum in Station I while maximum in Station II. When the values were viewed seasonally, summer and post monsoon seasons registered the maximum values and monsoon and premonsoon seasons the minimum values.

The *k*- dominance plot drawn clearly demonstrated the diversity pattern in three stations. When the data of all the stations were plotted together, the curves for Stations II and III (core mangrove zone, marine zone) were found to lie below the curve of I and rose slowly due to the presence of more number of species giving 'ʃ' shape, indicating maximum diversity, whereas the curve for

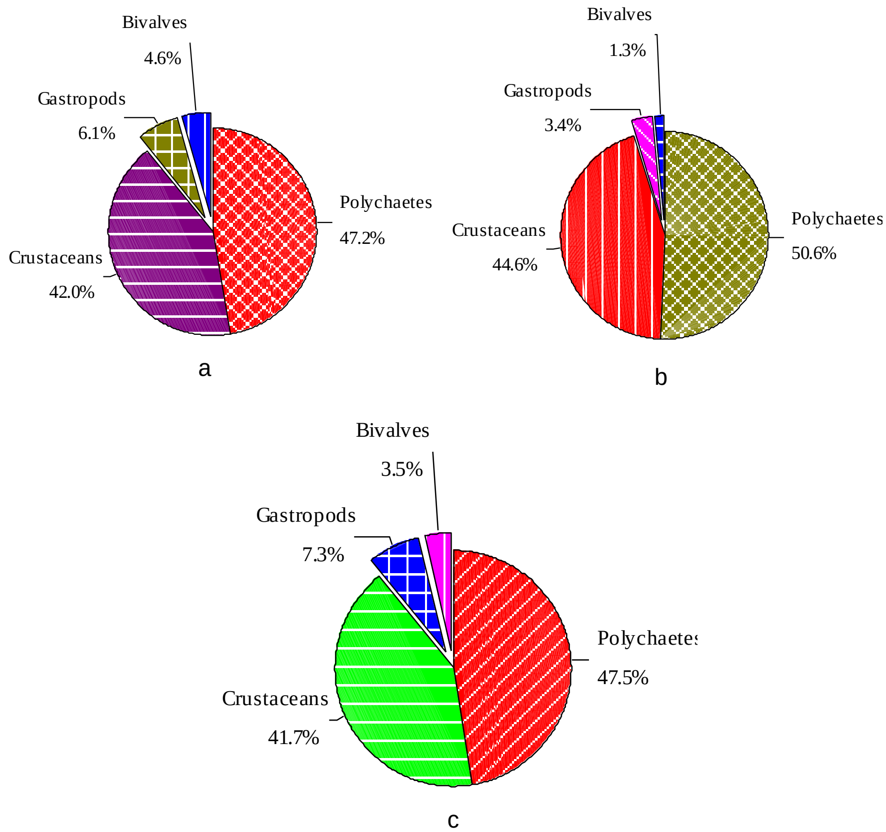


Figure 4. Percentage composition of macrobenthos recorded in (a) Station I, (b) Station II and (c) Station III .

Table 2. Diversity indices in various stations of Pichavaram (I – III) mangroves.

Station	*H'* (log2)	d	J'	Delta	sPhi+
I	1.52-3.36	1.24-3.49	0.74-0.93	32-76.93	180-1000
II	2.24-3.87	1.73-4.09	0.71-0.96	55.43-76.88	340-1120
III	2.70-3.61	2.04-3.59	0.77-0.98	65.57-79.48	460-980

Station I (Fresh water zone) was lying above, showing minimum diversity. This plot also ably proved the rich diversity nature of Stations II and III compared to Station I (Figure 5).

Figures 6 and 7 display results of hierarchical clustering and MDS ordination, respectively. From the resulting dendrogram (Figure 6), among the stations, samples of marine zone got grouped at the highest level of similarity (94%) followed by fresh water zone (93%) and core mangrove zone (90%). Further, cluster of core mangrove and marine zones were formed in a single cluster at the next level of similarity (86%) and cluster of fresh water zone grouped successively to this at the next level (79%).

The non-metric multi dimensional scaling (MDS) plot also revealed the same groupings as recognized in the cluster. The stress value, which overlie on the top right corner of the plot, was also found to be very minimum (0.01) signaling the good ordination pattern of species in stations of various zones (Figure 7).

In the BIO – ENV method, eight variables such as temperature, salinity, pH, dissolved oxygen, total organic carbon, sand, silt and clay were allowed to match the biota. The results showed that, salinity, clay, total organic carbon and temperature were featured as the key variables explaining the best match (0.71) with faunal distributions. Following this, silt, pH and sand were also manifested as important variables influencing the faunal distribution (Table 3).

DISCUSSION

The distribution of mangrove fauna in relation to water quality has been described quantitatively by Deekae and

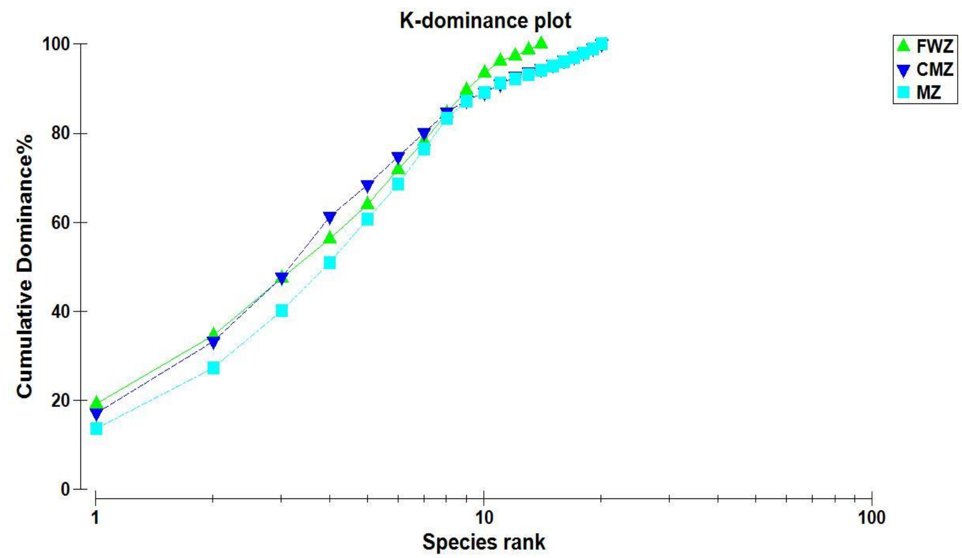


Figure 5. K- dominance curves for the Stations I-III (FWZ; Fresh Water Zone; CMZ; Core Magrove Zone and MZ; Marine Zone).

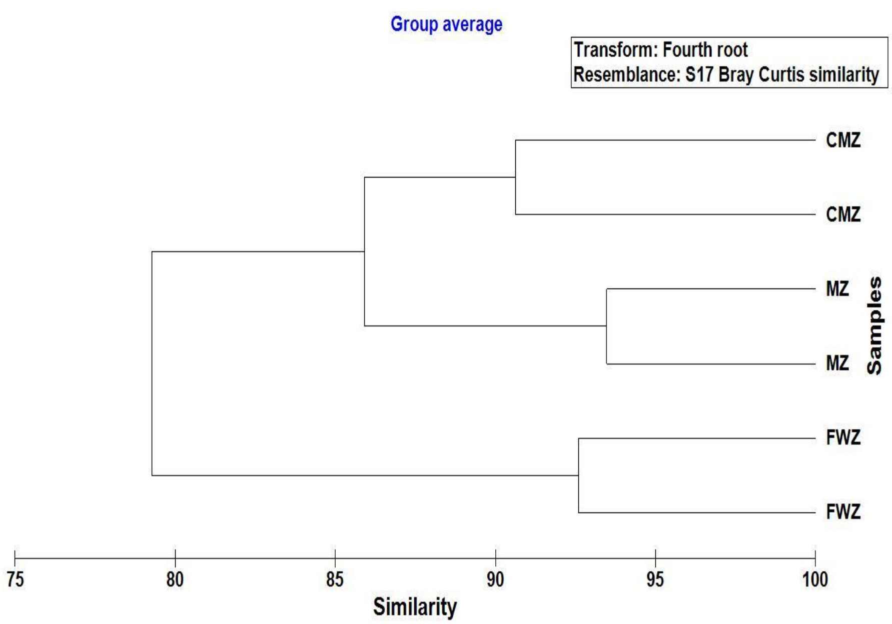


Figure 6. Dendrogram showing grouping of Stations I-III (FWZ; Fresh Water Zone; CMZ; Core Magrove Zone and MZ; Marine Zone) sampled during the study period.

Henrion (1993) and Guerreiro et al. (1996). In the present study, the temperature level varied from 27 to 31°C. All the stations showed a similar trend in seasonal variations with minimum in monsoon and maximum during summer as reported earlier by Kathiresan (2000) and Saravanakumar et al. (2007).

The salinity acts as a limiting factor in the distribution of living organisms, and its variation was due to dilution and evaporation. In the present investigation, dissolved oxygen showed high during monsoon at all stations which might be due to the cumulative effect of higher wind velocity and, it varied from 3.2 to 5.5 mg/L. Similar observation with high value during monsoon and low during summer was reported earlier by Fernando (1987) and Tripathy et al. (2005). The seasonal variations in dissolved oxygen mainly due to the freshwater influx and

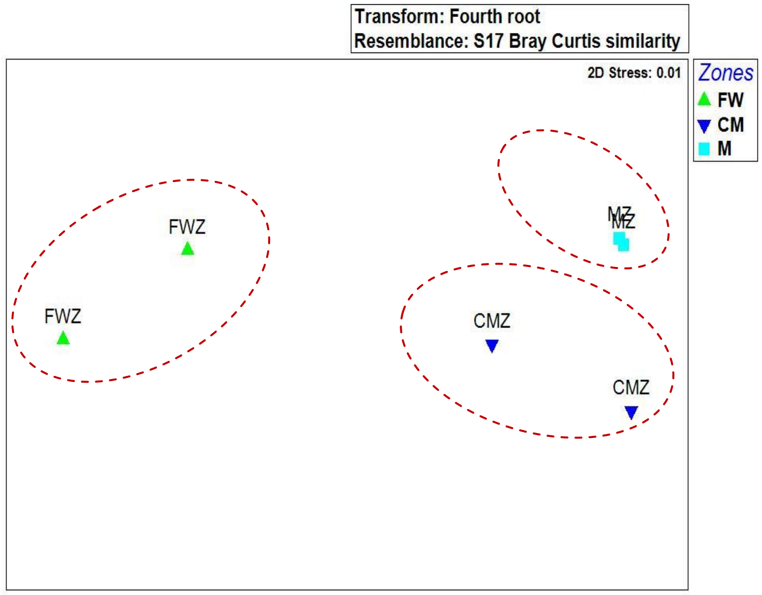


Figure 7. MDS plot for macroenthos in three Stations I-III (FWZ; Fresh Water Zone; CMZ; Core Magrove Zone and MZ; Marine Zone).

Table 3. Harmonic rank correlations (ρω) between faunal and environmental similarity matrices in various stations of mangroves.

No. of variables	Best variable combinations	Correlation (ρω)
4	Salinity-clay-total rganic carbon-temperature	0.71
3	Temperature-Salinity-Silt	0.68
3	Clay-total organic carbon-pH	0.67
2	Sand-salinity	0.65

ferruginous impact of sediments. It is well known that the temperature and salinity affect the dissolution of oxygen (Vijayakumar et al., 2000). The surface water pH remained alkaline at all the stations throughout the study period, with maximum value during summer and minimum during monsoon.

Generally, fluctuations in pH values during seasons of the year are attributed to factors like removal of CO_2 by photosynthesis through bicarbonate degradation, dilution of seawater by freshwater influx, reduction of salinity and temperature, and decomposition of organic matter. The total organic carbon varied from 9.7 to 21.7 mgc/g with maximum value at Station II (summer) and minimum in Station I. The maximum during summer might be due to the thick presence of *Rhizophora* spp. where litter fall was more, which in turn increased the total organic carbon content as reported earlier by Dehairs et al. (2000); Kristensen et al. (2008) and Hasrizal et al. (2009). The muddy or sandy sediments of mangrove forests act as a home of a variety of infaunal and epifaunal invertebrates and their role vary from one habitat to another depending upon the water and sediment characteristics of the mangroves (Kumar, 1995). In the present study, the sediment composition showed striking variations in percentage of sand, silt and clay fractions. The sand, silt and clay composition varied between seasons and stations.

Among the stations, the percentage of sand was high in station III and low in Stations II and I. Similarly the clay and silt were more in Stations I and II and low in station III. The high clay content in Station II might be probable reason for more number of organisms compared to Stations I and III since the most of the benthic organisms are detrital feeders. Ramanathan (1997) reported that in Pichavaram mangroves, the percentages of clay and silt was more, which constituted together 70 - 90% of mangrove sediments followed by sand. Similarly, Reddy and Hariharan (1986) observed that the benthic communities are largely influenced by the texture of the sediment.

Generally, in a benthic sample, polychaetes constitute more than the other faunal groups. The dominance of polychaetes in terms of diversity and species composition in diverse ecological niches is due to their high adaptability to wide range of fluctuation in environmental factors. Their dominance can also be attributed to the high organic carbon content in the sediments.

The present study recorded 16 species of polychaetes out of 22 macro fauna in Pichavaram. In confirmation of this, several benthic researchers studied elsewhere reported that the polychaetes as dominant group followed by other groups. The present observation showed numerical dominance in the order of polychaetes, molluscs (bivalves and gastropods), crustaceans and others has been observed earlier by Ansari et al. (1986); Mohammed (1995); Kumar (2001); Murugesan et al. (2007). The dominance of polychaetes in all the stations might also be due to the conducive environment provided by aerial roots and dense canopy of the mangroves which offered protection against desiccation and this enabled polychaetes to be abundant. In the present study, the macro-benthic faunal density ranged from 394 to 23,888 nos/m^2 in Stations I and II with highest abundance (23, 888 nos/m^2) was recorded at Station II during summer season. This could be due to higher total organic carbon coupled with a stable environment recorded during this season while low population density (394 nos/m^2) recorded during monsoon at station I might be due to the influx of freshwater as it is said to be freshwater zone.

Added to this, Kurian (1984) reports that productivity is also comparatively high in mangroves as the nutrients rich bottom sediments facilitate the luxuriant growth of algae, consequently the abundance of benthic fauna. Similarly, Saravanakumar et al. (2007) and Tolhurst and Chapman (2007) reported the similar range of population density. As regards percentage composition of macrofauna, polychaetes were found to be the dominant group in all the stations followed by crustaceans, gastropods and bivalves. Zhou (2001) and Huang et al. (2002) have reported that the polychaetes, crustaceans and molluscs are the three major groups contributing substantially to the total benthic organisms in mangrove environment.

Species diversity is a simple and useful measure of a biological system. Redding and Cory (1975) 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) proposed that the use of diversity indices is advantageous for the description of fauna at different stages in the succession. Sanders (1968) also postulated that the species diversity is mainly controlled by the fluctuations in the environment that lead to low diversity. There are reports stating that when the diversity value is more than 3, the system is considered to be pristine and diverse in nature. Species diversity in the present study registered a wide fluctuation between 1.52 in Station I and 3.87 in Station III. Maximum diversity so also the species richness was recorded in Station II during summer and minimum in I during monsoon and higher values recorded in summer in the study area is in conformity with the earlier observations made elsewhere (Chandran, 1987; Murugesan, 2002; Ajmal et al., 2005; Devi, 1994). In the present study, richness values were more during post monsoon season (4.09) in Station II, which is comparable to the studies made by Kumar (1995) and Sunilkumar (1996). The low richness recorded in this study (1.24) in Station I might be due to fresh water inflow that might have induced low saline conditions, which in turn affected the distribution of benthos, particularly the polychaetes.

The above said conventional indices are unduly influenced by the sampling effort and evenness property and these indices can be used only with the quantitative data, unlike taxonomic diversity and phylogenetic diversity which can very well be used with presence / absence data. Not only that, the conventional indices also lack the statistical frame work for comparison of one sample with another. Therefore, the diversity indices based on the taxonomic relatedness of species have been introduced such as taxonomic diversity, and total phylogenetic diversity index by Clark and Warwick (2001). These two indices were used presently with a view to finding out the statistical significance of the difference in diversity between three stations. When the results were viewed, the taxonomic diversity was more in Station III (65.57 - 79.48) than in stations I (32 - 76.93) and II (55.43 - 76.88). But total phylogenetic diversity was more in Station II (340 - 1120) than in Stations I (180 - 1000) and III (460 - 960) indicating the taxonomic breadth of the biota (Clarke and Green, 1988). In addition to the above, k-dominance plot clearly demonstrated the trend as observed in diversity indices. The curves for Stations II and III rose slowly due to the presence of a large number of species. The percentage contribution of each species was added, the curve extended horizontally (species number is evident in the x - axis), before reaching the cumulative 100%.

In the present study, cluster analysis and MDS was used to find out the degree of similarity among the stations of Pichavaram mangroves. Cluster analysis (or classification) is helpful to find out natural groupings of samples, such that samples within a group are more similar to each other than the samples in different groups. In the present study, data of two replicate samples were allowed as input for cluster and MDS analysis. The dendrogram revealed that samples of various zones got grouped individually indicating variation in species composition in particular zone. However, as cluster analysis has inherent disadvantage of linking ultimately with the dissimilar groups, ordination of the samples was also done using MDS. The aim of this method is to represent the samples collected as points in a map (usually low - dimensional space). Samples lying closer have more similarity in species composition and abundance while samples lying far apart have more dissimilarity in species composition and abundance. The

MDS plot also revealed that the stations of respective zones formed groups separately again demonstrating the variation in species composition and abundance in three stations. The stress value, overlying on the right top corner of this map, was also very minimum indicating the good ordination of the samples. Ajmal et al. (2005) also report similar clustering and MDS pattern.

The Pichavaram mangrove forest has been in existence since 1500 years (K. Kathiresan per. com). The distribution of benthos exhibited not only higher density during the post monsoon and summer seasons but also consisted of more diverse fauna at Station II. The productivity and nutrient load was more in Station II and this might be due to the fact that an ample amount of mangrove litter fall occurs which in turn increases the productivity thereby enriching the bottom fauna. Not only that, the age and sprawling area might also be the plausible reason for the higher diversity in Station II than Stations I and III where canopy is less.

The decrease in benthic abundance during monsoon may be attributed to the low temperature and salinity. A medium amount of organic matter and salinity also supports more benthic production. Therefore, it can be deduced from the study that ecological factor like temperature, salinity and total organic carbon have profound influence on the abundance and distribution of benthic organisms in the Pichavaram mangroves. Continue monitoring of benthic diversity may provide the base line data for future monitoring.

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