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Studies on the Mangrove Macro Faunal Diversity and Assessment among Different Sites in Port Blair Bay, South Andaman Islands

Vishwas Rao M[1]*, Ajith Kumar TT[2] and Swagat Ghosh[3]

[1]*Centre of Advanced Study in Marine Biology, Faculty of Marine Sciences, Annamalai University, Parangipettai 608 502, Tamil Nadu, India*
[2]*Senior Scientist, National Bureau of Fish Genetic Resources (Indian Council of Agricultural Research), Canal Ring Road, Dilkusha Pos, Lucknow - 226 002 U.P., India*
[3]*Centre for Marine Living Resources and Ecology (CMLRE) Ministry of Earth Sciences (MoES), Kerala, India*

Abstract

The mangrove intertidal zone is characterised by plenty floral and faunal diversity. The mangroves provide important habitat for a wide range of species like diverse communities of benthic organisms and function as nursery habitats for different types of crab, prawn and fish species and support offshore fish populations and fisheries. To assess the occurrence, spatial distribution and species composition of macro fauna in a mangrove area, core samples were taken along with transect in Portblair bay, South Andaman Islands. Three sites were taken; each study area was divided into three zones viz. Proximal, middle and distal zones, which were analyzed according to the floral composition. The highest value was observed at Barmanallah (2061 no.m^{-2}), followed by Carbyn's Cove (1710 no.m^{-2}) and the lowest value was noticed at Manjery (882 no.m^{-2}). *Terebralia palustris, Cerithidea sp., Periopthalmus sp., Uca sp., Balanus sp.* and *Polychaetes* were dominated in order. Some locations were found to support a high diversity of organisms across habitats, while other locations had high densities of a few species only.

Keywords: Chlorophyll-a; *Rhizophora mucornata*; mangroves

Introduction

Mangroves are one among the most productive coastal ecosystem. The development and luxuriance of mangrove communities depends on various individual factors and their interactions such as substratum, its depth and consistency, interaction of frequency of flooding, soil, water salinity and extent of sheltered areas [1]. The flora includes 26 true mangrove and 15 allied species [2]. It shows a diverse variety of photosynthetic bacteria, plankton, benthic diatoms, floating epiphytic and benthic algae and halophytic marshy vegetation. The common mangrove species are *Rhizophora mucornata, R. apiculata, Avicennia mariana, A. alba, A. officinalis, Bruguriea gymnorrihiza, Sonneratia alba, S. apetala, Aegilatis rotundiflora, Ageiceras corniculatum* and the common mangrove plam *Nipa fruticans* [3].

The residential organisms present in the mangrove regions include vertebrates like kingfishers, mudskippers, snakes and mangrove monitor lizard. Terrestrial invertebrates comprise spider, ants, termites, moths and mosquitoes. Aquatic invertebrates includes molluscs, crustaceans and polychaetes [4,5].

A substantial proportion of the mangrove fauna comprises species derived from the neighbouring terrestrial habitats. Most of the major groups of terrestrial animals are significantly represented in mangroves. The fauna generally represents aquatic, semi-aquatic and terrestrial communities adapted at stress condition. There are 8 species of mammals, 53 species of birds, 7 species of reptiles, 3 species of amphibians, 253 species of fish, 13 species of polychaetes, 410 species of arthropods and 53 species of meiofauna are reported from the mangroves of Andaman and nicobar Islands [6].

The mangrove ecosystem is primarily divided into three distinct zones such as proximal zone, the middle zone and the distal zone [7]. The current study was made to delineate the relative variation in the macro faunal diversity at the three zones of the mangrove region. Thus, the present study aims to contribute to the knowledge of the diversity of macro fauna and its assessment in the mangrove regions of the Port Blair bay.

Materials and Methods

Study area

The study was conducted in the mangrove habitats of Carbyn's Cove creek (11°38'N, 92°44'E), Barmanallah (11°33'N, 92°43'E) and Manjery (11°34'N,92°44'E) in South Andaman. All the three stations were highly diversified with mixed mangrove ecosystem. Manjery has a fresh water stream, which follows from the eastern side of the mangroves. In Barmanallah, a fresh water stream flows into the bay; the mouth of the creek receives inflow of sea water from the sea into the stream. The creek in Carbyn's Cove has a high fresh water load which is dominated by the domestic and sewage wastes.

Each study area was divided into three zones namely proximal, middle and the distal zones and the macro fauna was analyzed adopting the method proposed by Garge et al., and dagar et al. [8,9].

Sampling

The fauna was determined by transect quadrate method as suggested in the manual on the tropical marine resources [10]. The quantitative sampling was carried out in January 2011 to May 2011 at three locations. In each station, macrofauna samples were taken, when the sediment was exposed during low tide. The quadrate measuring 1 m × 1 m was further divided into small squares measuring 30 cm laid down and randomly the samples were taken.

***Corresponding author:** Vishwas Rao, Centre of Advanced Study in Marine Biology, Faculty of Marine Sciences, Annamalai University, Parangipettai 608 502, Tamil Nadu, India, Tel: +919994720116; E-mail: vishwasrao.au@gmail.com

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Physico-chemical parameters

In addition to identifying the macro fauna, environmental parameters such as salinity, temperature, dissolved oxygen, BOD, Chorophyll-a and pH were estimated. Salinity was measured by using an optical refractometer (ATAGI, Japan), pH was measured by using gel plast electrode (Hamilton, Switzerland), temperature of the surface water was recorded by using a mercury thermometer, dissolved oxygen and BOD was estimated by using the Winkler's method. The chlorophyll – a estimation was carried out by adopting the method proposed by Strickland and Parsons [11]. All the parameters recorded from different locations were analysed using the Surfer 8.

Statistical analysis

Multivariate analysis were constructed for different stations (using 999 randomisations in PRIMER 6 software), to examine the effectiveness of sampling and to compare the rate of species accumulation between different stations. Initially, variability in species composition (S), abundance of species (N), Margalef diversity (D) were analyzed. Dominance was calculated as the percentage of the total abundance of a given species relative to the total number of species. The diversity was calculated by the Shannon-Wiener diversity index (H') on log 2 base [12]. The equitability (J') was expressed as Pielou's evenness index [13]. Permutations were worked out based on a Bray – Curtis similarity matrix generated from square -root transformed data.

Results

Environmental parameters

The physical parameters were similar in all the locations throughout the experimental period, indicating the well-mixed nature of the estuary from different locations (Table 1). Water temperature was ranged from 28 to 31°C. Salinity at 29 to 32%, dissolved oxygen (DO) 3.2 to 3.5 mg/l, pH is ranged from 6.42 to 7.2, BOD at 2.1 to 2.4 and chlorophyll –was ranged from 2.68 to 3.03 µmol/l. The range in these parameters reflects the strong influence of freshwater and saltwater inputs in the different locations and all these parameters were analysed using Surfer 8 (Figure 1).

Spatial variation

Numerical abundance: Among the three locations, the highest value was observed at Barmanallah (2061 no.m^{-2}), followed by Carbyn's Cove (1710 no.m^{-2}) and the lowest value was noticed at Manjery (882 no.m^{-2}) (Table 2).

Carbyn's Cove: Out of five samplings done at the proximal zone, the highest value was noticed in the first sampling with 166 no.m^{-2} and the lowest value was noticed in the third sampling with 145 no.m^{-2}. In the middle zone, the highest value was noticed in the first sampling with 168 no.m^{-2} and the lowest value was noticed in the third sampling with 116 no.m^{-2}. The highest value in the distal zone was noticed in the third sampling with 47 and the lowest value was noticed in the fourth sampling with 26 no.m^{-2}. The dominant macro fauna found in all the zones were *Terebralia palustris, Cerithidea cingulata, Periopthalmus sp* and *Uca sp.* Fish juveniles and polychaetes were also found in all the zones [14,15].

Month	Temperature	Salinity	pH	DO	BOD	Chl-a
January	29	29	6.7	3.3	2.4	2.68
Febraury	31	29	7.2	3.55	2.25	3.03
March	31	32	7.1	3.51	2.16	2.91
April	29	31	6.7	3.4	2.25	2.73
May	28	30	6.4	3.2	2.23	2.83

Table 1: Environmental Parameters from all the locations (Mean values).

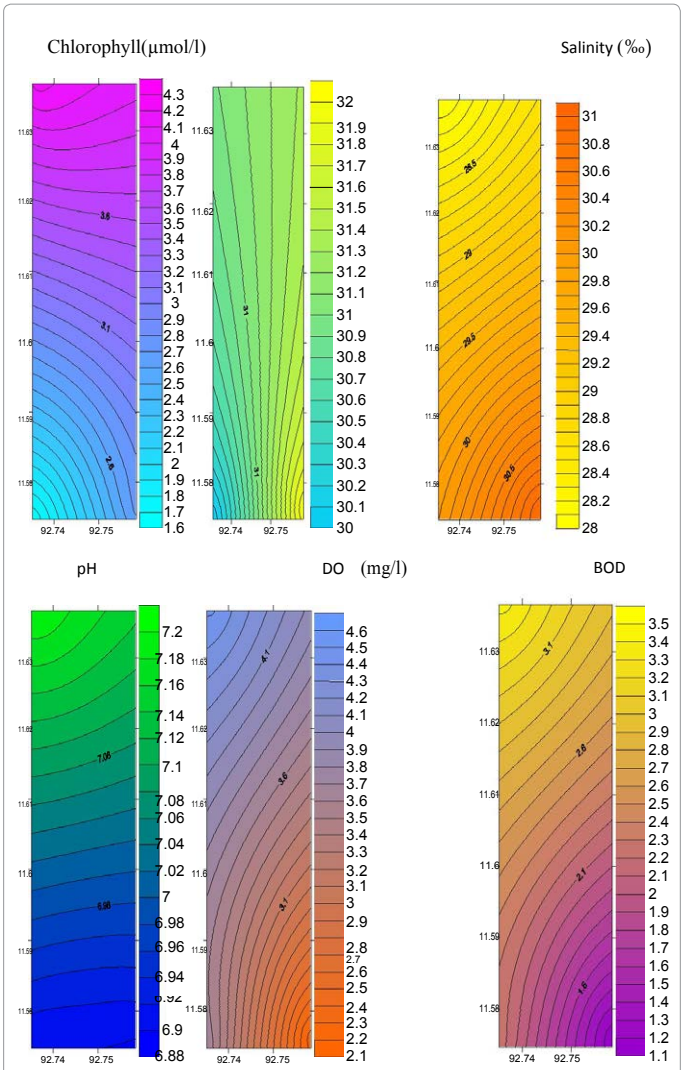

Figure 1: Spatial variation in physico-chemical properties recorded during January 2010 to May 2010.

Manjery: In proximal zone, the highest value was noticed at the first sampling with 48 no.m^{-2} and the lowest value was noticed in fifth sampling with 34 no.m^{-2}. In the middle zone, the highest value was noticed in the fourth sampling with 113 no.m^{-2} and the lowest value was noticed in the second sampling with 88 no.m^{-2}. The highest value in the distal zone was noticed in the first sampling with 40 no.m^{-2} and the lowest value was noticed in the third and fourth samplings with 31 no.m^{-2}. The dominant macro fauna found in all the zones were *Terebralia palustris, Littorina scabra scabra, Uca sp, Periopthalmus sp.* and *Polychaetes* [16].

Barmanallah: In this location, the highest value was noticed in the proximal zone at fifth sampling with 147 no.m^{-2} and the lowest value was noticed in the first sampling with 85 no.m^{-2}. In the middle zone, the highest value was noticed in the second sampling with 229 no.m^{-2} and the lowest value was noticed in the third sampling with 182 no.m^{-2}. In the distal zone, the highest value was noticed in the first sampling

Month	Carbyn's Cove			Manjery			Barmanallah			
	Proximal	Middle	Distal	Proximal	Middle	Distal	Proximal	Middle	Distal	Total
January	166	168	36	48	100	40	85	214	102	959
February	161	154	42	46	88	38	128	229	91	977
March	145	116	47	35	98	31	135	182	70	859
April	165	130	26	36	113	31	133	220	67	921
May	159	148	38	34	112	32	147	203	55	928
Sub total	796	716	189	199	511	172	628	1048	385	4644
Total	1710			882			2061			4644

Table 2: Numerical abundance from all the locations (Mean value).

Sample	S	N	d	J'	H'(loge)
Carbyn's cove	10	28	2.914	0.9148	2.154
Manjery	11	24	2.89	0.9308	2.127
Barmanallah	11	27	3.036	0.9261	2.186

Table 3: Species Diversity from all the locations.

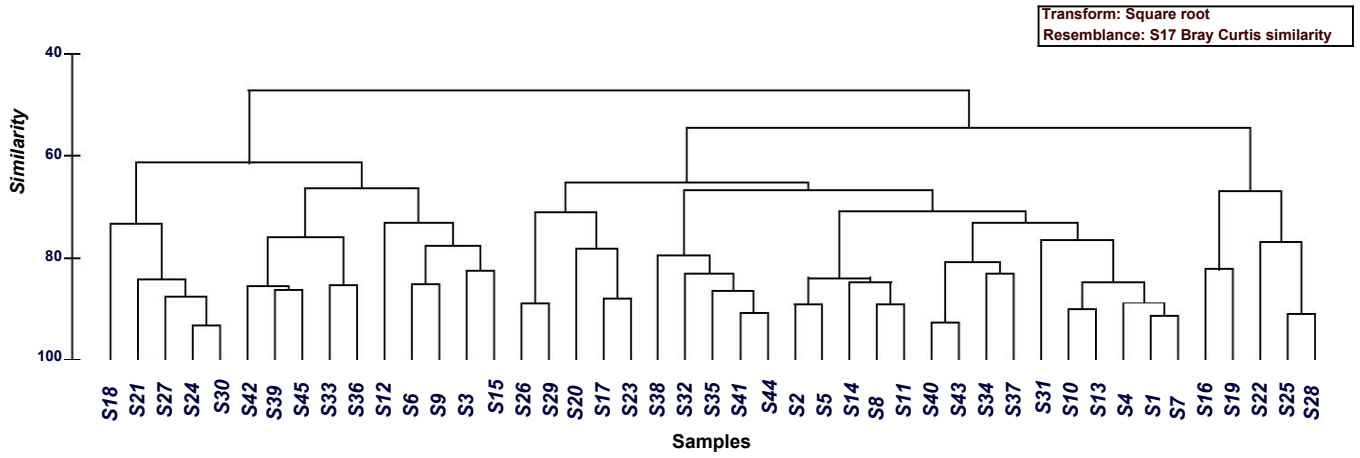

Figure 2: Hierarchical cluster analysis the macro fauna.

with 102 no.m^{-2} and the lowest value was noticed in the fifth sampling with 55 no.m^{-2}. The dominant macro fauna found in this location were *Terebralia palustris, Brittle star, Anadera granosa, Saccostrea cucuulatai* and *Polychaetes* [17].

Species composition: A total of 4644 individuals belongs to 16 families were collected. Numerically, *Terebralia palustris, Cerithidea sp., Periopthalmus sp., Uca sp., Balanus sp.* and *Polychaetes* were dominated in order. The other individuals were less common, with approximately one quarter of the total number of the individuals encountered in the three locations. *Terebralia palustris* was the most dominated species present at all three sites sampled, followed by *Uca sp, Cerithidea sp, Polychaetes* and *Balanus sp*. [18].

Species diversity: Diversity indices were calculated for each spatial level with pooled data (Table 3). Significantly higher values in the Barmanallah stations were recorded for taxonomic distinctness. Species richness (S) in different locations was generally greater, higher levels were noticed in Manjery and Barmanallah with 11 indv.m^{-2}. The lowest value was noticed in the carbyn's Cove with 10 indv.m^{-2}. The highest value of macro faunal abundance (N) was noticed in the Carbyn's Cove with 28 indv.m^{-2} and the lowest value was noticed in Manjery with 24 indv.m^{-2}. Margalef diversity (D) was also noticed and the highest value was observed at Barmanallah with 3.036 and the lowest value was recorded at Manjery with 2.89. Shannon-Wiener diversity index (H') was noticed in all the three locations, the highest value was found at barmanallah with 2.186 H'(loge) and the lowest value was noticed in Manjery with 2.127 H'(loge). Pielou's index (J') shows that the Manjery which has given highest value 0.930 J' and the lowest value was noticed in Carbyn's Cove with a value of 0.914 J'.

Clustering and nonmetric multidimensional scaling (NMMDS) of macro faunal community: The macro faunal communities of 45 plots of the transect from all the three locations were similar up to 50% and thus were divided into 9 major groups by hierarchical cluster analysis. The group consists of S18, S21, S24, S27, S30; group S33, S36, S39, S42, S45; group S3, S6, S9, S12, S15; group S17, S20, S23 S26, S29; group S32, S35, S38, S41, S44; group S2, S5, S8, S11, S14; group S34, S37, S40, S43; group S1, S4, S7, S10, S13, S31; group S16, S19, S22, S25, S28. The NMMDS was also supports the result of the hierarchical cluster analysis and provides more tangible indication of the distance between macro faunal communities of various plots and their similarity status (Figures 2, 3a and 3b).

Species accumulation curves were also constructed for all the three location to examine the effectiveness of sampling and to compare the rate of species accumulation between each location (Figure 4). The species accumulation curve based on all plots showed a typical initial steep increase and a subsequent asymptotic approach to the

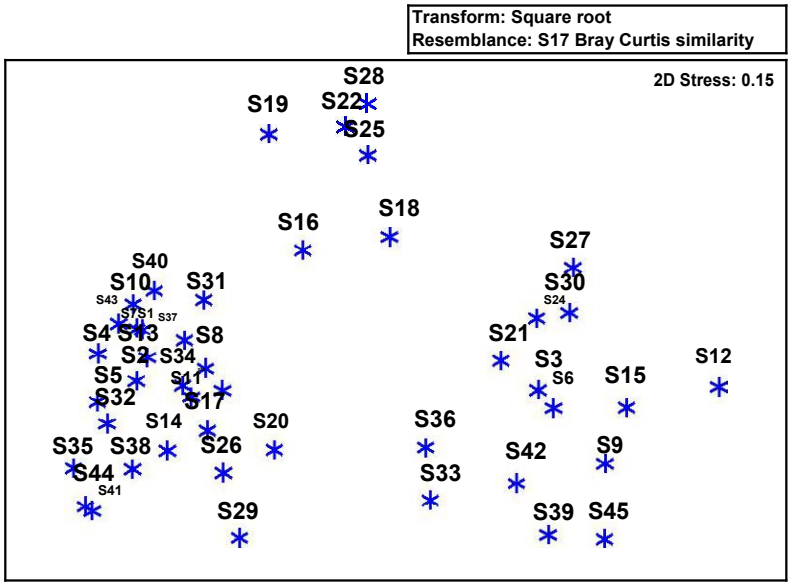

Figure 3a: Non-metric Multi-Dimensional Scaling the macro fauna.

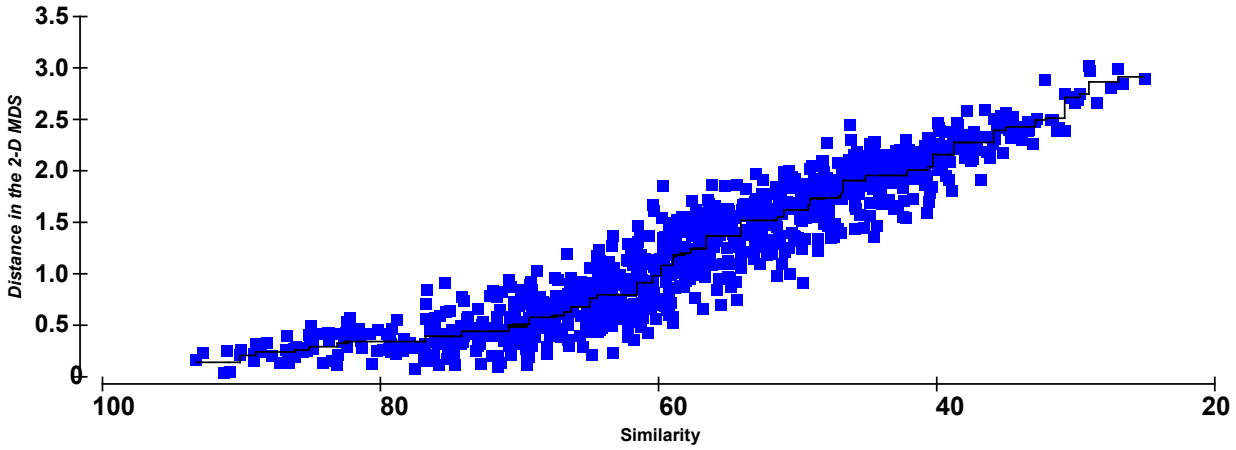

Figure 3b: Non-metric multi-dimensional Scaling the macro fauna.

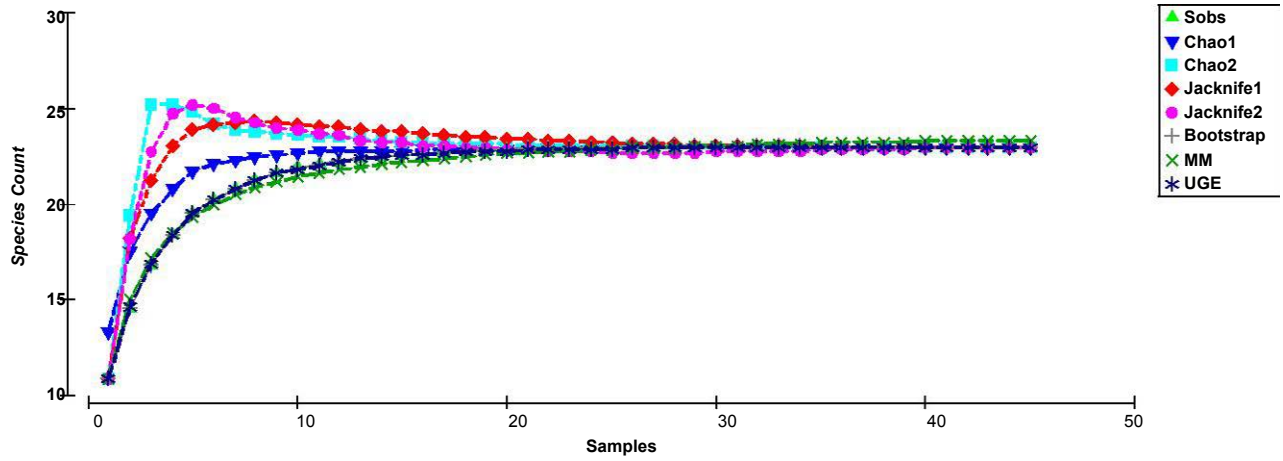

Figure 4: Species Accumulation Plot the macro fauna.

total number of 16 recorded families of which 22 species occurred exclusively in all the three locations.

Dominance structure regarding abundance was equal in the Carbyn's Cove and Barmanallah regions than Manjery (Figure 5). ABC-curve slopes showed a great variation in the Manjery. At Barmanallah and Carbyn's Cove, the communities were more balanced than at Manjery, where *Terebralia palustris, Cerithidea cingulata, Periopthalmus sp.* and *Uca sp.* were dominated in terms of abundance.

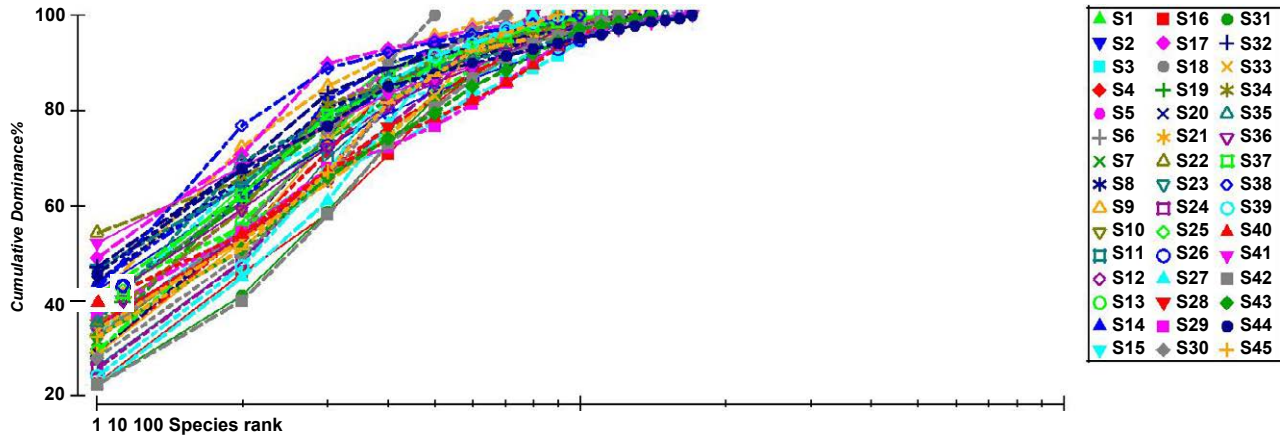

Figure 5: Dominance plot the macro fauna.

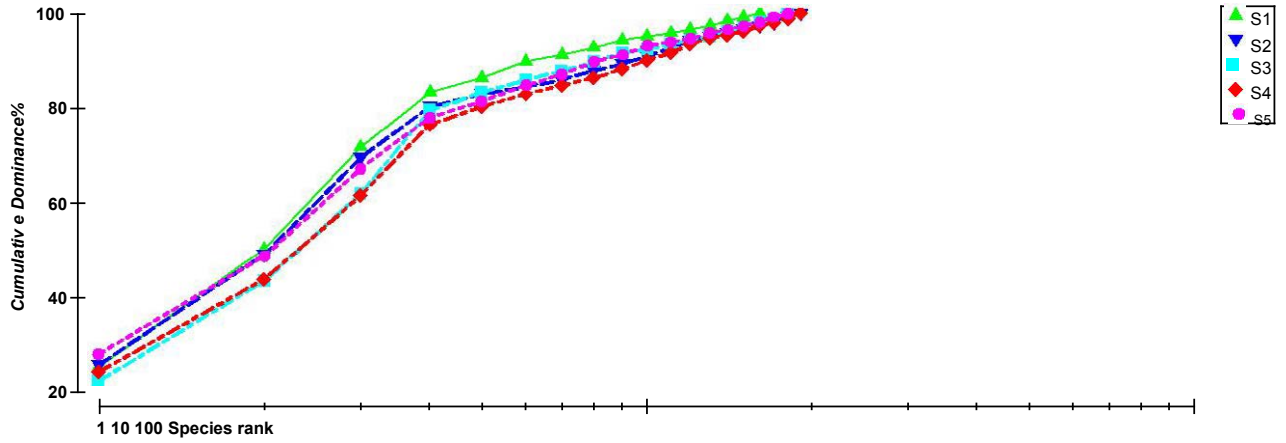

Figure 5a: Dominance plot for the macro fauna from Carbyn's Cove.

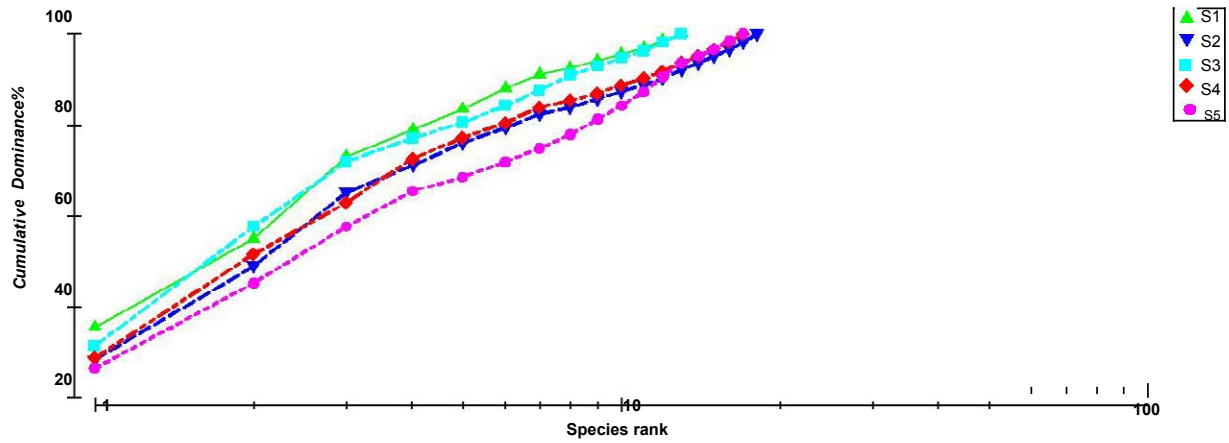

Figure 5b: Dominance plot for the macro fauna from Manjery.

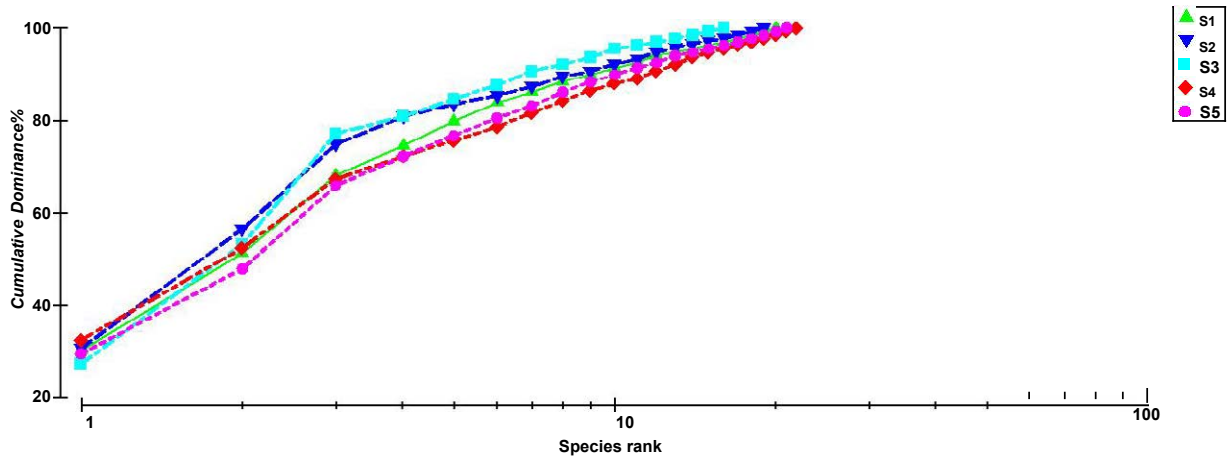

Figure 5c: Dominance plot for the macro fauna from Barmanallah.

In Manjery, *Saccostrea cucuulata*, *Assiminea sp, Nerita sp.* was higher than that of every other species (Figures 5a-5c)

Discussion

Prabhu et al., [19] studied the macro benthic fauna in near shore sediment of Gangoli and observed that *Polychaetes* constituted the dominated fauna followed by echiurids, echinoderms, molluscs and crustaceans. To support this, the present result also shows that in all the locations the polychaetes were dominated followed by molluscs and crustaceans.

Terebralia palustris, Littorina scabra scabra were most abundant in the mangrove regions of India, Palaziat, Tarun [11,12] had studied the mangrove macro fauna of Carbyn's Cove and reported the domination of gastropods. For macro faunal communities of the transect near Barmanallah, it was obvious that there was zonation phenomenon from the high tide part to the low tide part, which was consistent with the reports of Garge et al., [10]. It is shown that the hierarchical clustering and non-metric multi-dimensional scaling, the zonation of macro faunal communities is consistent with the distribution of the vegetation types of mangroves. Although the macro faunal communities in all the locations were similar, reaching a level of 50%, so that these macro faunal communities can be clustered into a group. Similarly, the macro faunal communities which were found in the group of S33, S36, S39, S42; group S3, S6, S9, S12, S15 and S17, S20, S23, S26, S29 and these three plots can be clustered into a group in a similarity to a level of 70%. Also, for all plots established, there was no obviously different diversity of the macro fauna but significant difference exists among the vegetation types of mangrove, which indicates that types of mangrove communities influence the zonation of macro fauna owing to the growing environment provided by different mangrove communities.

The community characteristics of mangroves may also affect the distribution of macro fauna. It is well known that the heterogeneity of growing environment is very important for the distribution and diversity of macro fauna. This is a cause resulting in the difference if macro fauna community structure in different mangrove communities. Besides, difference of basic coverage in different mangrove communities affects the light intensity in forest. This will also affect the diversity of macro fauna [13]. The research on Andaman and nicobar natural mangroves done by Thottathri [12] shows that the existence of mangrove vegetation has significant impacts on the types and distribution of crabs, which is caused mainly by the difference of shade condition of mangrove. Vannini et al., [12] studies also shows that, the light intensity in the forest of natural mangrove has important influence on the distribution of macro fauna. It is obvious that the difference in properties of different types of mangrove communities would affect the distribution of macro fauna.

The spatial zonation phenomenon of macro fauna in the mangrove area is the result of long term ecological adaptation. The ecological series of mangrove communities with the macro fauna in all the stations were more obvious, hence causing a clear zonation. Together with decapod crustaceans and molluscs which are the most well represented taxon of marine origin in mangrove forests. The high mangrove mollusc diversity is probably determined by the availability of diverse range of macro habitats. In mangroves, molluscs occupy all the levels of the food web, as predators, herbivores, detritivores and filter feeders. They are zoned both horizontally and vertically and include both mobile and sessile species. The abundance of macro fauna in the mangrove communities in all the stations in the present study is dominated by the molluscs which are consistent with the findings of Plaziat et al., Kathiresan and Bingham [11].

Conclusion

The present study revealed that the mangroves in South Andaman were great abundances of Gastropods, followed by crustaceans, bivalves and finfish. In Carbyn's Cove the faunal diversity is greater than Manjery and Barmanallah. The faunal composition in Manjery is entirely different from Burmanallah and Carbyn's Cove in the proximal zone. *Terebrelia sp, Uca sp, Cerithidea sp.* and *periopthalmus sp.* showed even distribution and greater abundance in proximal and middle zones. While the *Cassidula sp.* was found abundantly and exclusively in the distal zone of Burmanallah. Most of the dominating major faunal composition in Manjery region showed a decrease in number for the months of February and March in the proximal zone. *Calibanarius sp* is exclusively found in the proximal zone of Manjery. It could be understood from the results of the present study that there is a definite zonation of mangrove flora and fauna in the three study areas.

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