Spatial and temporal distribution of macrobenthos in Point Calimere of Southeast coast of India

V. Sasikala*, A.Saravanakumar & T. Balasubramanian
Centre of Advanced Study in Marine Biology, Faculty of Marine Sciences,
Annamalai University, Parangipettai-608502, Tamil Nadu, India
*E-mail: sasiselvam2009@gmail.com
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This paper deals with the spatial distribution and diversity of macrobenthos and their relationships with physico-chemical parameters in Point Calimere (Kodiakkarai). Sampling was done during 2006 to 2007. The diversity value was found above 3. A total of 75 species of benthic fauna were recorded in Point Calimere. Among these polychaetes were represented by 39 species, 14 species each by bivalves and gastropods and 7 species by crustaceans and other group such as Siphunculid. Surface water temperature ranged from 26.18°C to 31.92°C. Salinity varied from 26.15 to 34.86 ppt, while water pH fluctuated from 7.9 to 8.2. Dissolved oxygen concentration ranged from 4.18 to 5.42 mg/l. However, there were obvious differences in the population density of macro fauna in the inshore and offshore stations.

[Keywords: Macrobenthos, Diversity, Distribution, Water quality]

Introduction
Macro fauna forms the dominant biomass in marine sediment and play an important role in ecosystem processes such as secondary production, nutrient recycling and pollutant metabolisms. Macro benthic community analysis is part of international standards for the assessment of marine habitat quality, such as the European Union water Frame work Directive. Disturbances caused by mobile fishing gears temporarily alter the redox state of the system and thus the rate of remineralization is increased. Changes in benthic community structure are widely used in pollution assessment studies. The benthic taxa are routinely studied in numerous environmental impact assessment programmes as bio indicators of ecological disturbances. Among the benthic fauna, polychaetes have been used in many studies as markers of environmental health by virtue of their numerical abundance and diversity, widespread presence, diversified of feeding modes, wide tolerance to environmental imbalances and limited motility. Besides the multiple anthropogenic stressors that impact the coastal ecology of burgeoning cities the world over, natural events (rain, floods, sea level rise) also significantly impact the macrobenthic species assemblages. Thus the estimation of benthic production is useful to assess the Coastal fishery production of a particular area. Its distribution highly depends on physical nature of the substratum, nutritive content, degree of stability, oxygen content and level of hydrogen sulphide. The small changes in the environment will have considerable response on the benthic community and it avails to measure the degree of pollution. An assessment on health of a particular ecosystem can be achieved only through a careful analysis of benthic fauna. As there is no study on macro benthos in point calimere coastal water hence the present study has been undertaken to understand the macro benthic community structure, density, and diversity of point calimere.

Materials and Methods
The samples were collected from Point Calimere which is located in Nagapatnam District along the southeast coast of India (10°18’N;79°59’E), Tamil Nadu. It is one of the most important bird and black buck sanctuaries of India. Large numbers of salt pans and small scale marine chemical industries are located in this area. Dense mangrove vegetation is one of the prominent features of this area. Four stations were selected for the study (Fig.1). Stations 1 (Lat.10°16’21.53” N; Long.79°49’37.83” E,) and...
were located at 10 and 15 m depths respectively.

Station 3 is located in Lat. 10°15′19.04″ N; Long. 79°50′6.49″ E, Station 4 is located in Lat. 10°16′37.77″ N; Long. 79°53′20.41″ E. Station 3 and 4 were located in offshore, the depth of the stations are 30, 35 m respectively.

Sampling was made for a period of one year from October 2006 to September 2007. Water quality parameters were measured using standard methods. The temperature was recorded by using a standard precision Celsius thermometer with accuracy of ± 0.5 °C and the value expressed in degree Celsius. Salinity was estimated with the help of refractometer (ATAGO, Japan) and the values were expressed in ppt. Dissolved oxygen was estimated using the Winkler’s method and the values were expressed in mg/l. The water and sediment pH were measured using digital pH meter.

Triplicate sampling was carried out using a long armed Van-veen grab for macrofauna (0.0251 m²). Soon after retrieval, samples were gently sieved through a 0.5-mm sieve. The organisms retained by the sieve were preserved in 5% formalin and brought to the laboratory for further identification. The sorted organisms were first segregated into different groups and then identified to specific, genetic, or other higher levels to the greatest extent possible with the help of standard taxonomic references.

Mean and Standard deviation (graph) were employed for the better understanding of relationship between the physicochemical parameters by using MS - excel work sheet. Their settlement was analyzed using several indices: univariate measures such as Margalef’s species richness (d), Shannon– Wiener diversity (H’ log) and Pielou’s evenness were used for treating the data and were calculated using computer software of PRIMER (Plymouth Routines In Multivariate Ecological Research ver. 5.2).

Results
The physical parameters of water and sediment were similar in all the stations throughout the experimental period, indicating well-mixed nature of the ecosystem. The water temperature varied from 26.18 °C to 31.92 °C (Fig. 2); the salinity ranged from 26.15 to 34.86 ppt (Fig. 3). Dissolved oxygen varied between 4.18 and 5.42 mg/l (Fig. 4). The pH values were from 7.9 to 8.2 (Fig 5).
In sediments, macronutrients such as total nitrogen (TN), total phosphorus (TP) were recorded, and these are varied from 0.18 to 6.63 mg/g and 0.14 to 6.15 mg/g, respectively the total organic carbon values fluctuated from 1.02 to 15.73 mgC/g (Figs. 6, 7, 8).
Sediment texture in terms of sand, clay, and silt (%) were 37.41–91.42, 4.73–32.14, and 3.85–30.46 in all the stations (Fig. 9).

A total of 75 macro benthic faunal species at all stations were represented by four group viz., Polychaetes, Bivalves, Gastropods, Crustaceans and other group. In station 1 (in shore), bivalves were found to be the dominant group by constituting 38.05%; Polychaetes ranked next dominant group with a percentage of 31.10%. Gastropods contributed 27.76%; Crustaceans with 0.82% and other group with 2.27%; 33% of bivalves, 32.86% of polychaetes, 26.69% of gastropods, 3.31% of Crustacean and other group 4.14% were found at station 2 (in shore). In the Off shore station 3, the Polychaetes emerged as a dominant group with 64.91% followed by gastropods with 19.72%; bivalves with 5.68%; Crustaceans with 4.23% and other group with 5.46%, and station 4, Polychaetes with a percentage of 39.74%; bivalves contributed with 34.64% followed by gastropod with 21.35%; Crustaceans with 1.60% and other group with 2.67% (Fig. 10, 11, 12 & 13).

The benthic macro faunal density (ind/m²) was calculated and ranged from 1206 to 8084 nos/m² from 1206 to 2983 nos/m², from 1787 to 3702 nos/m² from 2473 to 6449 nos/m² and from 4922 to 8084 nos/m²(Fig. 14) in station 1, 2, 3 and 4 respectively. The highest benthic macro faunal density was recorded in the post monsoon season at station 4.

The Shannon-Wiener index varied from 3.86 to 5.08 in inshore stations. While the offshore it was ranged between the 3.64 and 4.75. The species
richness (Margalef index) varied from 3.44 to 7.67 in the inshore stations and 3.44 to 5.83 in the off shore stations. The species evenness (Pielou’s index) fluctuated from 0.71 to 0.91 in the inshore stations while 0.72 to 0.88 in the off shore stations (Fig.15, 16 & 17).

The BIO-ENV procedure is a method to measure the agreement between the rank correlations of biological and environmental matrices. The results showed that, salinity, temperature, sand, silt and sediment pH were found to be the key variables explaining the best match (0.78) with faunal distributions. Following this, silt, clay and TOC were manifested as important variables showing next best match (0.73) with benthic fauna. Water pH and total nitrogen also formed best match with fauna at the successive levels (Table.1)

<table>
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Discussion

One of the main goals of benthic ecology has been to understand the mechanisms regulating relationships between physico-chemical parameter and organisms. The present study shows that the macro faunal communities of four (inshore & off shore) stations exhibit distinct variations. Benthic macrofaunal community is characterized by temporal and spatial changes in its population. Macro faunal distribution pattern seems to be fully governed by the physico-chemical and hydro biological characteristics of the environment. This study has shown that there is difference in macro benthic fauna at different sediment types like sand and mud nature of the stations. Generally the species richness was found more in station 1 during all the seasons and less richness was observed during pre-monsoon and monsoon seasons in station 3 & 4 respectively. The maximum value was found during post monsoon season. The present observation is in concord with the earlier works done by Samithurai et al.

The macro benthic density ranged between 1206 nos/ m² and 8085 nos/ m². The highest density was recorded in summer season at station 3. Comparatively the stations 1 & 2 (inshore) showed minimum density and stations 3 & 4 (Off shore) exhibited maximum, the variation due to the availability of silty soil in station 3 & 4 to sustain the macrofaunal density high while sand dominance will reduce the macrofaunal population density. Clayey silt substrate is always known to support the macro faunal density. Monsoon registered low density followed by gradual increase during post monsoon and peak follows summer season. The variations in density might be due to the anthropogenic activity and environmental disturbance, and sediment...
characteristics particularly the organic enrichment and environmental disturbance are also responsible for the variation.31-36 Among the faunal groups, bivalves showed the dominant group followed by polychaetes, gastropods, and crustaceans & others at stations 1 & 2, dominance of bivalves in terms of density and its diverse ecological niches is due to their high degree of adaptability to a wide range of environmental factors. Bivalves were highly diversified in sandy substratum rather than the clayey substratum. In the present observation bivalves were higher in stations 1 & 2 (sandy sediment) than the stations 3 & 4 (silty clay sediment). This is in conformity with the earlier studies.37-38 In station 3, polychaetes were found to be the dominant group followed by gastropods, crustaceans, bivalves and other groups, whereas bivalves replace the second dominant group in station 4. The dominance of polychaetes could be deduced to the mode of feeding and life style and relatively high proportion of silt – clay fractions in the sediments and organic carbon content of the sediments. Similar preponderance of polychaetes has been observed in earlier reports39-42.

Environmental factors such as temperature, sediment composition, and inundation are the main factors influencing the distribution of macro faunal communities. The temperature can exert its influence on the chemical characteristics of interstitial water which in turn determine the density and distribution of benthic organisms. The study area was subjected to the temperature fluctuation which might be seasons due to monsoonal changes in environmental variables43-45. Salinity is one of the important key factors which determine the composition of biological component in the marine environment. The fluctuations in salinity affect the biological characteristics of the environment. The present study did not show characteristic relationship between salinity and macro faunal distribution. Generally the higher salinity is due to evaporation and the lower due to the dilution brought by rain fall and land runoff46-49. Dissolved oxygen was high during the monsoon season at all sites, which might be due to the cumulative effect of higher wind velocity coupled with heavy rainfall and the resultant freshwater mixing. Relatively lower values were observed during summer; this may be due to the increased surface water temperature which reduces the dissolution of O₂ in the coastal waters. It is well known that temperature and salinity affect the dissolution of oxygen50. pH in surface waters remained alkaline at all sites throughout the study period with the maximum value during summer seasons and the minimum during the monsoon. However, the present study found characteristic relationship between the physic-chemical variables and macro benthic fauna.

Sediment texture plays an important role in the ecology of benthic invertebrates51-52. The pelagic larvae of macro benthic organisms before finally settling down at the bottom have to cross many barriers, and each type of bottom deposit will attract a very limited and selected set of species53. A common concept in benthic animal–sediment relation is that the feeding type of the in fauna is in one way correlated to the sediments54. Deposit or detritus feeders constitute an important and often dominating part of macro benthic invertebrates55. Sediment character has been identified as one of the driving forces in determining the macro faunal communities. In this study, the sediment composition revealed that a remarkable differences in sand, silt, and clay fractions. The percentage composition of sediment texture in the stations 1 & 2 were principally constituted by sand and the silt& clay were found to be dominant in stations 3 & 4.

Sediment nutrients such as total Nitrogen (TN), total Phosphorous (TP) and total Organic Carbon (TOC) were showed pronouncedly. Food supply seldom acts as a limiting factor in the seasonal abundance of macro benthos56. Organic nutrients enhance the growth of different types of algae that provide food resources for benthos57. In the present study, the higher density macro benthos is observed during pre-monsoon and summer seasons. Among the stations, the total organic carbon maximum found in station 3 and lower in station 2. Sandy sediments had low organic carbon content whereas, silty sediments showed relatively higher organic carbon. High organic carbon induced abundance of macrofauna in Coleroon estuary58. This confirmed that the abundance of benthic fauna is highly related to organic carbon in this study. Maximum level of total nitrogen coincides with higher values of organic carbon content. This is in good agreement with the previous workers59-60. Total phosphorous content was higher in sub tidal sediment than the intertidal sediments due to more silty clay (mud) in sub tidal sediments. The mud acts as the reservoir of phosphorous and it was most important in the coastal region.
Conclusion
This study concluded that sediment texture are the major factors responsible for fluctuation in benthic macro faunal assemblages in the study area since the sediment around the off shore of Point Calimere region had higher percentage of silt fraction which contain high organic carbon content, which could resulted the high macro faunal density in the offshore stations than the inshore stations.

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