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Assessment of soft bottom polychaete diversity in Thondi, Palk bay, India

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Abstract

Polychaete assemblages are relatively poorly known in comparison to other components from Indian waters. In the present study, the spatial and seasonal distributions of polychaetes were investigated in the Thondi coastal area. Polychaete assemblage structure seems to be influenced by environmental parameters, such as temperature, salinity, pH, dissolved oxygen and total organic carbon. A total of 34 polychaete species were found, of which 26 species were in station I while 22 species in station II. There was a pronounced variation in diversity of polychaetes between the studied sites. Among the families maximum percentage of species constituted by Glyceridae (12%) and minimum Owenidae (4%) at station I and in station II, the Eunicidae (14%) was maximum and Pisinidae as (4 %) minimum. The population density varied from 1456 to 2456 no m^{-2} in station I; 2120 to 4424 in station II and diversity index varied from 1.96 to 2.48 in station I; 2.01 to 2.53 in station II. Species richness varied from 1.21 to 1.65 in station I; 1.36 to 1.69 in station II and evenness index varied from 0.9 to 0.97 in station I; 0.91 to 0.98 in station II. BIO-ENV analysis showed that salinity, TOC and temperature as the key variables in influencing the faunal distribution.

Key words

Palk bay, Polychaete, Diversity indices, Environmental parameters

Introduction

Polychaetes have traditionally been considered either as the dominant group, in terms of abundance or biomass or as an important contributor to the structure and functioning of the macrobenthic communities (Lee, 2009; Mutlu *et al.,* 2010). In the recent past, it evoked considerable scientific attention to explore its potentiality for monitoring environmental quality in various habitats (Grall and Glemarec, 1997; Hutchings, 1998; Solis-Weiss *et al*., 2004; Arvanitidis *et al*., 2005) as well as in zoogeographical studies (Musco and Giangrande, 2005; Dogan *et al.,* 2005). Among the benthic groups, polychaetes are one of the best indicators of environmental changes for its sensitivity and tolerancy in a gradient from pristine to heavily polluted habitats (Pocklington and Wells, 1992; Dernie *et al*., 2003; Ravichandran and Rameshkumar, 2008). Polychaetes are worldwidely used in environmental impact assessment studies (Clarke, 1993; Eaton, 2001; Dauvin *et al.,* 2004; Harkantra and Rodriguez, 2004; Kress *et al.,* 2004; Samuelson, 2001). Since, they exhibit variety of body shapes, feeding styles, reproductive modes and form a link in the marine food web. Polychaetes consume decomposed organic matter (bacteria, planktonic and benthic organisms, detritus *etc.*) and in turn act as food for many bottom feeding fishes, birds and other marine invertebrates. Hence, the studies have become inevitable to know the potentiality and also for better management of an aquatic ecosystem. Several studies pertaining to polychaetes were carried out earlier in the estuaries of east and west coasts of India. Species composition and seasonal variation of benthic animals in Coleroon estuary were studied by Jagadeesan and Ayyakkannu (1992). Venkatesh Prabhu *et al.* (1993) observed the colony of benthos in relation to environmental parameters in Gangolli. The community structure of polychaetes of intertidal region of Sagar island, Hoogly estuary, Sunderbans was described by Chakraborty and Choudhury (1994). The macro invertebrates dwelling in the soft sediments in Marmagoa harbour, Goa was studied by Ansari *et al.* (1994). Water quality and benthic fauna were studied in Kayankulam backwaters and Arattupuzha coast along the south east coast of

India (Prabha Devi *et al*., 1996). An attempt has therefore, been made to study the spatial assemblage patterns of polychaetes in relation to environmental variables in Thondi coastal waters, southeast coast of India.

Materials and Methods

Regular monthly samplings were made for six months from September 2005 to February 2006 in Thondi (79° 44' 10" N latitude; 79° 10' 45" E longitude), coastal belt of Palk bay. Two stations were fixed; station I is located at the river mouth and station II 1 km away from the shore (Fig. 1). Stations were fixed with the view to find out the influence of fresh water influx on polychaetes diversity. As station I is situated quite close to river mouth, there was no water flow during summer. Therefore, the study period was restricted to only six months. Water temperature was measured in the field itself by using mercury filled centigrade thermometer; salinity estimated with the aid of hand refracto meter (model E-2) and pH with a pH pen (Elico model L1-120). For the estimation of dissolved oxygen Winkler's titration method was followed (Strickland and Parsons, 1972). The total organic carbon (TOC) in sediment was estimated following the method of El-Wakeel and Riley (1956). Three replicate sediment samples were taken from each station using Peterson grab (0.08 m^2) and gently sieved through 0.5mm mesh. The organisms retained by the sieve were preserved in 5% neutralized formalin with addition of few drops of rose bengal for enhanced visibility during identification. The preserved organisms were identified up to species level with the available literature (Fauvel, 1953; Day, 1967) and counted using binocular microscope. The species diversity of polychaetes was calculated by using Shannon-Wiener index (H') (Shannon and Wiener, 1949), species richness (SR) was calculated using Margalef index (D') and species evenness index (J') (equitability) were calculated using the formula of Pielou (1966). The BIO-ENV method was used to find out the influence of environmental variables (similarity calculated with the Euclidean distance coefficient) on the biological variables (presence-absence data, using Bray–Curtis similarity measure) (Clarke and Warwick, 2001). The above indices were calculated by using PRIMER ver. 6, statistical software.

Results and Discussion

In station I, the surface water temperature varied from 27 to 29°C (28) with minimum (27°C) during monsoon (December, 2005) and maximum (29°C) during postmonsoon (February, 2006). In station II, it fluctuated from 26.5 to 29.5°C (28) with lowest value (26.5°C) during monsoon (December, 2005) and highest value (29.5°C) during postmonsoon (February, 2006). Temperature is an important ecological factor which has profound influence on activities and distribution of polychaetes. As the study area has been subjected to wide range of fluctuation in water quality, the water temperature showed monsoonal minimum and post monsoonal maximum as observed by earlier workers (Albayrak *et al.,* 2007; Iken *et al.,* 2010). Salinity at station I varied from 25.5 to 29‰ (28.25) with minimum (25.5‰) during

Fig. 1: Map of Thondi, Palk bay, southeast coast of India showing the study stations I and II

monsoon (December, 2005) and the maximum (29‰) during postmonsoon (February, 2006); in station II, it ranged from 26 to 29.5‰ (27.33). The minimum value (26‰) was recorded during monsoon (November, 2005) and maximum value (29.5‰) during postmonsoon (February, 2006). Higher values during postmonsoon could be ascribed to the higher degree of evaporation in the study area and less tidal action with decreased freshwater inflow. The findings of low values due to monsoonal downpour and inflow of freshwater from land drainage conform with Anvar Batcha (1997).

Water pH at station I varied from 8.0 to 8.4 (8.18) with lowest value (8.0) during monsoon (November, 2005) and highest value (8.4) during postmonsoon (February, 2006); at station II, the pH values were from 8.1 to 8.5 (8.26) with minimum (8.1) during monsoon (November, 2005) and maximum (8.5) during postmonsoon (February, 2006). As observed in other water quality parameters, pH also plays its own role in benthic environment. The variations in pH values between stations were less pronounced.

Dissolved oxygen concentration at station I was found to vary from 3.9 to 4.8 mg l^{-1} (4.43) with minimum (3.9 mg l^{-1}) during premonsoon (September, 2005) and maximum (4.8 mg l^{-1}) during postmonsoon (February, 2006). In station II, it fluctuated from 3.7 to 4.9 mg l^{-1} (4.36). The lowest value (3.7 mg l^{-1}) was recorded during premonsoon (September, 2005) and the highest value (4.9 mg l^{-1}) was during postmonsoon season (January, 2006). The dissolved oxygen is an index to study the productivity of an environment. It mainly depends on the nature and abundance of the planktonic organisms, monsoonal downpour, salinity etc. The level of dissolved oxygen, which plays a key role in the benthic system, showed low value during premonsoon and high in postmonsoon in both the stations corroborating the observations of Cinar and Altun (2007) and Ergen *et al*. (2006). The low dissolved oxygen observed during premonsoon could be ascribed to the higher salinity of water,

Table - 1: Polychaete species and their percentage composition recorded at two stations of Thondi, Palk bay, southeast coast of India during September 2005 to February 2006

Family	% Composition		Species	Station I	Station II
	Station I	Station II			
Pisionidae	6	4	*Pisionidens indica*	*	*
Pilargidae	6	5	*Ancistrosyllis* sp.	*	*
			Thalasapia annandalai	*	-
Syllidae	11	6	*Syllides longocirrata*	*	*
			Irmula spissipes	*	*
			Autolytus prolifer	*	-
			Syllis cornuta	*	-
Nereidae	11	12	*Platynereis dumerilii*	*	*
			Tylonereis fauveli	*	-
			Leonnates decipiens	*	-
			Dendronereis aestuarina	-	*
Glyceridae	12	13	*Glycera alba*	-	*
			Glycera prashahi	-	*
			Glycera tesselata	-	*
Eunicidae	9	14	*Lumbrineris laterlli*	*	*
			Lumbrineris heteropoda	*	*
			Lumbrineris polydesma	*	*
			Eunice tubifex	*	*
			Dorvillea mandapamae	*	-
Spionidae	8	4	*Polydora kempi*	*	*
			Malacoceros indica	*	-
			Leonates sp.	*	-
Cossuridae	6	7	*Cossura coasta*	*	*
			Cossura delta	*	-
Oweniidae	4	6	*Owenia fusiformis*	*	*
Ophelidae	6	6	*Polyophthalmus pictus*	*	*
			Ophelina acuminata	*	*
Maldanidae	6	8	*Maldane sarsi*	-	*
			Euclymene annandalei	-	-
Cirratulidae	6	7	*Raphidrilus nemasoma*	*	*
			Cirratulus cirratus	*	*
Capitellidae	9	8	*Capitella capitata*	-	*
			Pulliella armata	*	-

* = Present, - = Absent

higher temperature and less inflow of freshwater. Similar postmonsoonal maximum and premonsoonal minimal were reported by Murugesan *et al.* (2009).

In station I, the organic carbon content in the sediment ranged from 0.71 mg g^{-1} (November, 2005) to 3.28 mg g^{-1} (January, 2006) with a mean value of 2.21 and 0.42 mg g^{-1} (October, 2005) to 2.89 mg g^{-1} (February, 2006) at station II with a mean value of 1.69. Polychaetes utilize organic carbon for their metabolic process (Jørgensen *et al.*, 2008). It plays an important role in accumulation and release of different micropollutants and also reflects more accurate levels of organic pollution. Hence, the measurement of organic carbon content of the sediment is a yardstick to study the productivity of an aquatic ecosystem. In the present study, the minimum values were found during monsoon and maximum during postmonsoon season. The higher values recorded in postmonsoon season could be ascribed to the increased water salinity resulting in rapid flocculation and precipitation of major fraction of terrigenous organic matter as demonstrated by Amaral *et al.* (1998) and Cinar and Altun (2007).

In the present study, 33 species of polychaetes belonging to 13 families were recorded. Of which, 26 species in station I, 1 species each belonged to Pisionidae, Oweniidae, Capitellidae; 2, Pilargidae, Cossuridae, Ophelidae, Cirratulidae; 3, Nereidae, Spionidae; 4, Syllidae; 5 to Eunicidae. At station II, 22 species were recorded. Of which, 1 species belonged to Pisionidae, Pilargidae, Cossuridae, Oweniidae, Capitellidae, Maldanidae, Spionidae; 2, Syllidae, Nereidae, Ophelidae, Cirratulidae; 3, Glyceridae; 4, Eunicidae. Comparing stations, 16 species were found to occur in both the stations. The checklist of polychaetes recorded in two stations is given in Table 1. With respect to species composition, the members of Eunicidae and of Nereidae showed dominance in station I and station II. The reason of dominance of two families might be due to their tolerance against fluctuations. In the present study it could be seen that there were noticeable seasonal variations in the polychaete

Table - 2: Population density and diversity indices recorded in stations I and II of Thondi, Palk bay, southeast coast of India during 2005 and 2006

Study period	Population density		Shannon-Wiener's index (H')		Margalef index (D')		Pielous evenness index (J)	
	ST. I	ST. II	ST. I	ST. II	ST. I	ST. II	ST. I	ST. II
2005								
Sep	1763	2421	2.15	2.19	1.52	1.5	0.94	0.96
Oct	1754	2635	2.11	2.22	1.45	1.46	0.93	0.94
Nov	1625	2415	2.05	2.1	1.35	1.4	0.92	0.93
Dec	1456	2,120	1.96	2.01	1.21	1.36	0.9	0.91
2006								
Jan	2036	3841	2.35	2.45	1.58	1.57	0.95	0.96
Feb	2456	4424	2.48	2.53	1.65	1.69	0.97	0.98

ST = Station

Table - 3: Harmonic rank correlation ($\rho\omega$) between faunal and environmental similarity matrices in Thondi, Palk bay, southeast coast of India

No. of variables	Best variable combination	Correlations ($\rho\omega$)
3	Salinity, TOC and temperature	0.71
2	Temperature and salinity	0.68
2	pH and salinity	0.62

communities in the study area. Similar changes were noticed earlier by Sunil Kumar (1995) in backwaters of Cochin, west coast of India.

Among the families, the maximum percentage of species Glyceridae (12%) and minimum Owenidae (4%) at station I and in station II, the Eunicidae (14%) was maximum and Pisionidae and Spionidae (4%) as minimum (Table 1). Comparison seasons, postmonsoon registered the maximum number of species and monsoon registered the minimum number of species in both the stations.

With respect to density at station I, the population density (Table. 2) varied from 1456 to 2456 no m^{-2} with minimum (1456 no m^{-2}) during monsoon (December, 2005) and maximum (2456 no m^{-2}) during postmonsoon season (February, 2006). At station II, it varied from 2120 to 4424 no m^{-2} with minimum (2120 no m^{-2}) during monsoon (December, 2005) and maximum (4424 no m^{-2}) during postmonsoon (February, 2006). Density of polychaetes showed fluctuations between stations and seasons as low in monsoon followed by gradual increase in postmonsoon. The population density was low at station I (1456 no m^2- monsoon December, 2005) and high at station II (4424 no m^2-postmonsoon February, 2006). The minimum density of polychaetes at station I might be ascribed to the fluctuation in water quality parameters which in turn, influence the distribution of benthic organisms conforming Sunil Kumar (1995) in Cochin backwaters, west coast of India.

At station I, Shannon diversity index (Table. 2) varied from 1.96 to 2.48 with minimum (1.96) value during monsoon (December, 2005) and the maximum (2.48) in postmonsoon (February, 2006). At Station II, the diversity index fluctuated from 2.01 to 2.53 with minimum (2.01) during monsoon (December, 2005) and maximum (2.53) in postmonsoon (February, 2006). The values of species richness (Table. 2) paralleled the trend of species diversity. In station I, species richness varied from 1.21 to 1.65 with minimum (1.21) in monsoon (December, 2005) and maximum (1.65) in postmonsoon (February, 2006). At station II, it was from 1.36 to 1.69 with minimum (1.36) in monsoon (December, 2005) and maximum (1.69) in postmonsoon (February, 2006). Maximum species richness (1.69) was observed at station II in postmonsoon (February, 2006) and minimum (1.21) at station I in monsoon (December, 2005).

Species evenness index (Table 2) in station I varied from 0.9 to 0.97 with minimum (0.9) during monsoon (December, 2005) and maximum (0.97) in postmonsoon (February 2006). At station II, evenness index (J') fluctuated from 0.91 to 0.98. The minimum (0.91) was observed during monsoon (December, 2005) and maximum (0.98) in postmonsoon (February, 2006). Maximum species evenness (0.98) was recorded in postmonsoon (February, 2006) at station II and minimum (0.9) in monsoon (December, 2005) at station I. The monsoonal minimum of diversity indices values might due to maximum density of faunal composition and also unfavorable environmental parameters.

In the BIO-ENV analysis (Table 3), the following five variables namely temperature, salinity, pH, dissolved oxygen and total organic carbon were used to match the biota**.** The results revealed that salinity, total organic carbon and temperature manifested as the key variables in influencing the distribution of benthic organisms and pH and temperature featured as the secondary variables influencing the faunal distribution.

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