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Vertical distribution of polychaetes in brackishwater pond of Nethravathi estuary, India

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Abstract: *Vertical distribution of polychaetes in a semi-enclosed brackishwater pond of Nethravathi estuary was studied for one year from February 2004 to January 2005. The semienclosed brackishwater pond is a shallow water body with an average depth of 1-1.5 m with an area of 12 ha having direct connection with the estuary, which opens into the Arabian sea. A total of nine species of polychaetes were identified. Among these, Dendronereis aestuarina and D. arborifera were most common and accounted for 65.62 % of total abundance. The fauna were more abundant at 5 - 10 cm depth than at 0-5 cm depth and decreased beyond 10 cm depth. Species composition and the abundance of polychaetes were generally high during postmonsoon followed by premonsoon and monsoon season. Polychaete abundance showed positive significant correlation with organic carbon content at all depth layers of sediments in all the stations.*

Key words: *Vertical distribution, Polychaete, Brackishwater, Estuary, Sediment*
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Introduction

Polychaetes are one of the most important groups of soft bottom communities in terms of species, individuals and biomass (Knox, 1977). These organisms are important in the form of diet for many fishes and invertebrates (Amaraal and Migotto, 1980). Recent studies showed that the distribution of these organisms and their niche depend largely on sediment type (Kumar and Anthony, 1994; Kumar, 1997; Marakala *et al.,* 2005; Pinto *et al*., 2006; Ansari *et al.,* 2007; Nanajkar and Ingole, 2007; McIntyre, 2008; Prabhu *et al.,* 2008). Many investigations were carried out on the abundance and distribution of polychaetes (Ramachandra *et al.,* 1984; Prabhu *et al*., 1993; Ferraris *et al*., 1994; Manjappa *et al.,* 2003). In contrast, studies on vertical distribution of polychaetes are ignorant. Hence, in the present study, an attempt has been made to investigate the vertical distribution and abundance of polychaetes from the brackishwater impoundment along Nethravathi estuary, south-west coast of India.

Materials and Methods

The brackishwater impoundment located along the Nethravathi estuary (12° 50′ N, 74° 50′ E) was selected for the present investigation. It is a shallow water body with an average depth of 1-1.5 m. and an area of 12 ha having direct connection with the estuary which opens into the Arabian sea. The area under study is an important nursery ground for most of the fin fish and shellfish and also serves as a centre for fish seed collection. Dense mangrove vegetation is present at the northern side of the pond. Four sampling stations were selected (Fig. 1), of which, Station 1 and 2 are nearer to the mangrove area, while Station 3 is at the centre of the pond where there is no mangrove vegetation and Station 4 is located where large number of woods are logged for seasoning by Karnataka Woods and Plywood Company.

A core type sampler (8.8 cm internal diameter) was used for the collection of polychaetes. The sampling design was based on previous work by Hewitt *et al*. (1997). The core was pierced into the sediment upto 20 cm depth, and then the sediment core obtained was cut into three portions, *viz.*, 0-5, 5-10 and 10-15 cm, immediately after collection to avoid errors due to the migration of polychaetes. The samples obtained were sieved (mesh 0.5 mm), sorted and preserved in 5% formalin and 0.1% rose bengol in brackishwater separately. Polychaetes were identified to the lowest possible taxonomic level, counted and abundance was expressed as No. m^{-2}. (Fauvel, 1953). Sediment samples from each strata was subjected for textural analysis (Buchanan and Kain, 1971) and organic carbon content (El-Wakeel and Riley, 1957). Water and sediment sample was collected in triplicate from the selected stations for the analysis of physico-chemical parameters like temperature of water and sediment, salinity, dissolved oxygen and pH (Strickland and Parsons, 1977). Diversity indices in terms of species richness were calculated (Margalef, 1967). Simple correlation coefficient matrix between polychaetes and selected environmental parameters was calculated using MINITAB package version 8.3.

Results and Discussion

Environmental parameters: Mean values of water quality parameters such as water temperature, salinity, pH and dissolved oxygen during the different season are given in Table1. Temperature was high during the premonsoon period and low

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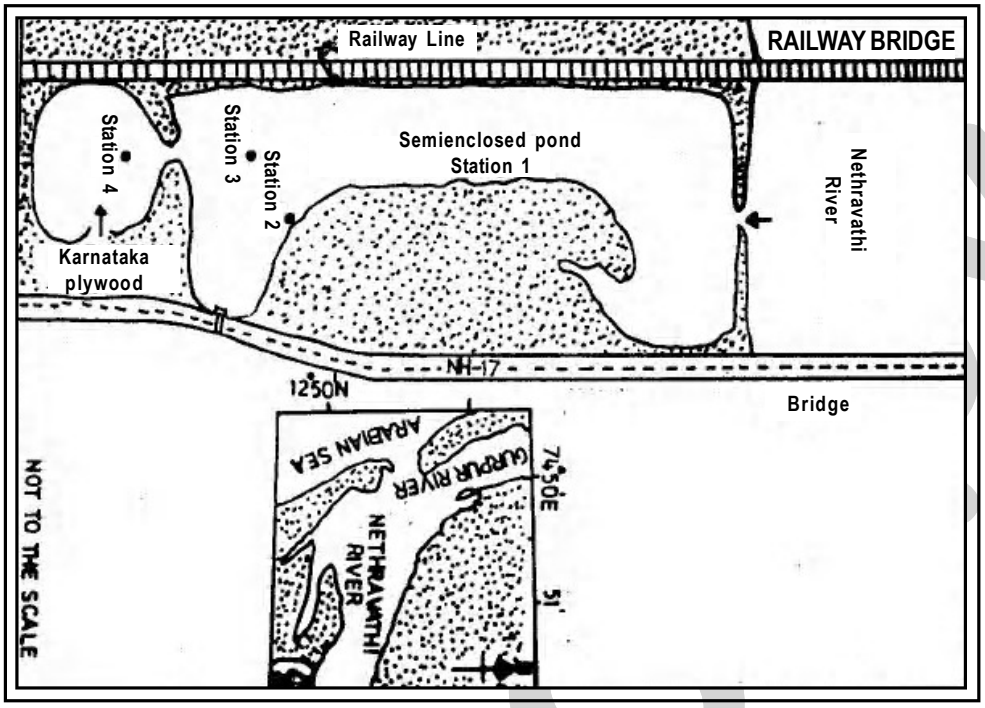

Fig. 1: Map showing the location of stations along Nethravathi estuary

Table - 1: Season-wise hydrographic parameters at different stations (Values are means ± SD of 3 replications and 12 months)

Stations	Seasons	Water temperature (°C)	Salinity (ppt)	pH	Dissolved oxygen (ml l^{-1})
1	Pre-monsoon	34.75 ± 0.66	20.47 ± 3.31	6.88 ± 0.40	4.11 ± 0.49
	Monsoon	31.5 ± 2.43	4.87 ± 5.13	7.09 ± 0.34	5.68 ± 0.54
	Post-monsoon	30.0 ± 1.16	9.81 ± 6.06	7.15 ± 0.14	5.10 ± 0.47
2	Pre-monsoon	35.13 ± 1.02	20.50 ± 3.44	7.05 ± 0.44	3.86 ± 0.60
	Monsoon	31.4 ± 2.19	4.58 ± 4.93	7.20 ± 0.25	5.00 ± 0.57
	Post-monsoon	29.88 ± 1.14	9.92 ± 6.19	7.03 ± 0.19	4.62 ± 0.67
3	Pre-monsoon	36.05 ± 0.98	21.1 ± 4.23	7.04 ± 3.45	4.78 ± 0.93
	Monsoon	31.03 ± 1.72	4.33 ± 5.20	7.24 ± 0.20	7.75 ± 0.75
	Post-monsoon	30.35 ± 1.05	9.73 ± 6.70	7.18 ± 0.21	6.39 ± 0.21
4	Pre-monsoon	34.93 ± 0.56	21.37 ± 3.30	7.26 ± 0.21	4.30 ± 0.48
	Monsoon	31.40 ± 2.44	4.73 ± 5.09	7.13 ± 0.14	6.77 ± 0.89
	Post-monsoon	30.28 ± 0.71	10.33 ± 6.29	7.06 ± 0.19	6.66 ± 0.93

Table - 2: Sediment characteristics in relation to depth (0-5, 5-10 and 10-15 cm) at different stations (Values are means ± SD of 3 replications and 12 months)

Stations	Depth (cm)	Organic carbon (%)	Sand (%)	Silt (%)	Clay (%)
1	0-5	1.87 ± 0.85	78.07 ± 2.97	18.18 ± 3.59	3.75 ± 1.34
	5-10	1.93 ± 0.8	79.18 ± 4.28	16.47 ± 4.83	4.35 ± 2.21
	10-15	1.37 ± 0.7	74.48 ± 11.28	21.47 ± 8.23	4.05 ± 4.12
2	0-5	1.52 ± 0.78	76.12 ± 14.79	15.77 ± 6.76	4.36 ± 3.05
	5-10	1.75 ± 0.72	75.55 ± 15.08	21.01 ± 13.98	3.49 ± 1.98
	10-15	1.17 ± 0.62	74.96 ± 11.86	20.32 ± 12.2	4.63 ± 2.81
3	0-5	1.23 ± 0.7	65.99 ± 11.55	29.07 ± 11.76	4.97 ± 3.23
	5-10	1.81 ± 0.79	71.22 ± 13.71	24.77 ± 13.49	4.0 ± 2.74
	10-15	1.55 ± 0.8	65.77 ± 15.86	28.8 ± 15.01	5.61 ± 3.04
4	0-5	1.83 ± 0.84	70.26 ± 11.6	25.53 ± 12.09	4.21 ± 2.0
	5-10	2.27 ± 0.86	70.66 ± 15.24	23.59 ± 13.16	5.74 ± 5.00
	10-15	1.97 ± 0.62	70.21 ± 12.79	24.95 ± 12.39	4.83 ± 3.11

Table - 3: Abundance (No. m^{-2}) of polychaetes at different depths, stations and seasons

Species	Seasons											
	Pre-monsoon (Feb. - May)	Monsoon (June - Sept.)	Post-monsoon (Oct. - Jan.)	Pre-monsoon (Feb. - May)	Monsoon (June - Sept.)	Post-monsoon (Oct. - Jan.)	Pre-monsoon (Feb. - May)	Monsoon (June - Sept.)	Post-monsoon (Oct. - Jan.)	Pre-monsoon (Feb. - May)	Monsoon (June - Sept.)	Post-monsoon (Oct. - Jan.)
	Station 1			Station 2			Station 3			Station 4		
						Depth (0 – 5 cm)						
Dendronereis aestuarina	3443	2624	2460	2296	2296	3115	2459	1640	7376	4098	2459	15738
Dendronereis arborifera	1640	984	656	328	1148	1148	164	820	1804	1312	1312	7558
Lumbriconereis polydesma	984	-	328	164	164	-	-	-	1148	-	328	492
Lumbriconereis notocirrata	656	328	492	984	656	2296	1312	164	656	492	492	3771
Lycastis indica	-	164	1148	-	-	164	328	492	1312	328	-	1640
Nereis glandicincta	492	-	328	164	164	328	164	-	164	-	-	820
Nereis chilkaensis	164	164	656	164	-	328	-	-	492	-	164	164
Nephthys polybranchia	-	328	492	328	-	656	492	-	164	-	-	820
Nephthys oligobranchia	492	164	492	656	492	656	492	328	820	328	492	1640
Total	**7871**	**4756**	**7052**	**5084**	**4920**	**8691**	**5411**	**3444**	**13936**	**6558**	**5247**	**32643**
						Depth (5 – 10 cm)						
Dendronereis aestuarina	3280	6066	4426	2624	6558	3272	3116	2952	4591	4099	1804	13771
Dendronereis arborifera	1148	1968	164	984	2460	1968	1640	1968	3337	2788	492	4099
Lumbriconereis polydesma	-	-	328	-	656	-	-	164	656	-	-	-
Lumbriconereis notocirrata	656	492	328	820	1476	1312	328	820	820	328	-	2296
Lycastis indica	984	492	164	656	656	-	328	-	492	492	-	984
Nereis glandicincta	-	164	328	-	328	-	492	-	-	-	-	328
Nereis chilkaensis	820	2132	-	164	328	328	-	328	328	-	-	164
Nephthys polybranchia	-	-	164	-	-	328	492	-	-	328	-	-
Nephthys oligobranchia	656	164	164	984	1864	1312	492	656	820	984	656	3280
Total	**7544**	**11478**	**6066**	**6232**	**14266**	**7520**	**6888**	**6888**	**6453**	**9019**	**2952**	**24922**
						Depth (10 - 15 cm)						
Dendronereis aestuarina	1312	1968	656	656	2295	164	492	164	492	2132	1476	2460
Dendronereis arborifera	328	656	164	164	984	-	164	-	164	328	-	492
Lumbriconereis polydesma	-	-	-	-	-	-	-	-	-	-	-	-
Lumbriconereis notocirrata	-	164	328	164	328	-	328	164	164	656	164	1148
Lycastis indica	-	-	-	-	328	-	-	-	-	-	-	-
Nereis glandicincta	164	-	-	-	-	-	-	-	-	-	-	-
Nereis chilkaensis	-	-	-	-	164	-	-	-	-	328	-	-
Nephthys polybranchia	-	-	-	164	-	-	164	-	-	-	-	-
Nephthys oligobranchia	164	164	164	164	820	-	164	-	164	164	492	1312
Total	**1968**	**3116**	**1312**	**1312**	**4919**	**164**	**1312**	**328**	**984**	**3608**	**2132**	**5412**

- = Absent

during monsoon season. Salinity showed wide fluctuations (0.9 to 26.43 ppt) showing higher values during premonsoon period. This period was characterized by absence of river influx and more incursion of sea water during high tide from the sea. Decline in salinity during July-September was due to monsoon freshwater inflow from the river. Dissolved oxygen concentration varied from 3.39 to 7.74 ml l^{-1}. Waters were fairly well oxygenated during monsoon period and poorly oxygenated in premonsoon season. pH values ranged from 6.43 to 7.6.

Sediment characteristics: Percentage of sand, silt and clay fraction of sediment are given in Table 2. Generally, sand fraction was found to be more in the sediment and it decreased from upper to lower strata. At Station 4, a higher fraction of sand was recorded during premonsoon and postmonsoon season, while during monsoon and postmonsoon silt fraction was higher. But in other stations, sand fraction was higher during postmonsoon and premonsoon period, however, silt fraction prevailed during

Table - 4: Simple correlation coefficient matrix between polychaetes and selected environmental parameters

Parameters	Depth (cm)											
	Station 1			Station 2			Station 3			Station 4		
	0-5	5-10	10-15	0-5	5-10	10-15	0-5	5-10	10-15	0-5	5-10	10-15
Water temperature	0.291	0.217	-0.142	-0.273	-0.049	-0.157	-0.367	0.098	0.516	-0.529	-0.315	0.067
pH	0.221	0.406	0.098	0.314	0.311	0.170	-0.275	0.054	-0.177	-0.387	-0.283	0.121
DO	0.028	0.258	0.023	0.441	0.206	-0.059	0.032	0.143	-0.180	0.178	0.146	0.307
Salinity	0.579*	0.077	-0.287	0.160	-0.429	-0.465	0.055	0.208	0.629*	0.003	0.163	0.413
Organic carbon	0.954*	0.885*	0.847*	0.819*	0.867*	0.736*	0.880*	0.912*	0.946*	0.959*	0.909*	0.732*
Sand	-0.274	0.070	0.124	0.394	0.157	0.180	0.038	0.232	0.058	0.009	0.018	0.415
Silt	0.410	-0.107	-0.124	-0.267	-0.175	-0.002	-0.318	-0.162	-0.154	-0.192	-0.065	-0.391
Clay	-0.494	0.098	-0.093	-0.595*	0.043	0.466	-0.637*	-0.361	0.453	-0.249	0.106	-0.151

* Significant at $p \leq 0.01$, DO = Dissolved oxygen

premonsoon and monsoon period at all layers. Between the layers, sand and silt fraction was more at upper and middle layer compared to lower layer at all the stations. But in Station 2, 3 clay fraction was higher at middle and lower layers. Middle layer (5-10 cm) contained high organic content followed by top and lower layer of the sediment at Station 1,3, whereas high organic carbon followed by lower and top layer at Station 4 (Table 2).

Faunal composition and population density: A total of 9 species of polychaetes belonging to 3 families were recorded. They are *Dendronereis aestuarina, D. arborifera, Lumbriconeries polydesma, L. notocirrata, Lycastis indica, Nereis glandicincta, N. chilkaensis, Nephthys polybranchia* and *N. oligobranchia*. Of these, *Dendronereis aestuarina* and *D. arborifera* were abundant throughout the year and occurred in all stations at all depth layers. The percentage composition of these two species accounted for 65.62% of total polychaete density. Where as, *Lumbriconeries notocirrata* and *Nephthys oligobranchia* species were recorded at all the layers, with irregular distribution. Polychaetes were recorded at three depth levels (0-5, 5-10 and 10-15 cm) in an estuarine mangrove biotope of Cochin, where in Nereis glandicincta and Dendronereis heterpoda occurred in the deeper 10-15 cm layer (Kumar, 1997).

The seasonal variations in density of polychaetes at different layers of sediments are given in Table 3. The population density was high at middle layer followed by upper and lower layer at Station 1 and 3, while, at Station 4 they were highly abundant at upper layer followed by middle and lower layers. A decrease in population density was observed with sediment depth in the in an estuarine mangrove biotope of Cochin (Kumar, 1997) and in the intertidal zone of Aberdeen (McIntyre, 2008). The main controlling factor on some sediment seems to be reduced oxygen due to poor drainage and on others the close packing of the particles leading to reduced interstitial space.

The total population density of polychaetes was almost similar at Station 1 and 3 but slightly higher at Station 4 (Table 3). The high population density at Station 4 was coincided with high organic carbon content compared to other stations. The polychaete abundance was more regular at Station 4, even at lower depth levels (5-10 and 10-15 cm) compared to other stations (Table 3). This could be due to the abundance of organic carbon at wood logging area (Station 4) which might have encouraged good growth and abundance.

Species composition of polychaetes varied between stations, depths of sediment and season. Species composition was generally high during postmonsoon followed by premonsoon and monsoon season. Similar type of polychaete abundance, the maximum being in premonsoon and the minimum in southwest monsoon season was observed in the Zuari estuary of Goa (Ansari and Parulekar, 1998). The response of the fauna depends on the salinity oscillations coupled with the heterogeneity of the sediment (Fonseca and Netto, 2006). Population density was recorded to be higher at middle layer (5-10 cm) at all the stations. Even though, the meiofauna occurred down to the 30-35-cm sediment layer, the bulk of meiofauna (80%) occurred in the top 20 cm sediment layer (Ingole *et al.,* 2005).

Higher population density coincided with higher fraction of silt and clay. The higher organic carbon concentration supported the high population density at all the stations. Similar observation was made in the mangroves of Cochin backwater (Kumar and Anthony, 1994; Kumar, 1997). The dominant polychaete species *Dendronereis aestuarina* was recorded throughout the study period in upper and middle layers but irregularly recorded in lower layer at all the stations. However, *Dendronereis arborifera* was recorded at all the stations, but irregularly distributed. In general, the lower densities of polychaetes were recorded during monsoon season as supported by earlier works (Chandran *et al*., 1982; Prabhadevi, 1994). The probable reason could be during monsoon the intensity of rainfall and freshwater inflow could alter the substratum and hence the settlement of fauna and their preference to the substratum, resulting irregular pattern of distribution of the benthic fauna (Prabhadevi, 1994).

In the present study, the admixture of silt and clay fraction influenced the abundance of polychaete population as sand fraction was more or less uniform at all the stations and at all depth layers of the sediment (Table 4). Polychaetes found to prefer fine to medium type of sandy bottom with moderate amount of admixture of silt and clay (Prabhadevi, 1994). Intertidal distribution of meiofauna is determined by temperature and salinity and also by the grain size of the deposit which affects the interstitial space, water content, and availability of food and oxygen (McIntyre, 2008). Positive significant correlation exists between polychaete population and organic carbon content (Table 4). High organic carbon supported higher population of polychaete in the study area. The level of organic carbon in the sediment associated with well oxygenated water is conducive for the healthy growth of benthic fauna (Harkantra and Parulekar, 1987). The amount of organic carbon present in the sediment is very important as survival, reproduction and distribution of macrobenthos mainly depends on the nutritional status of the bottom deposit in the habitat especially for deposit feeders (Fenchel, 1970; Bhat and Neelakantan, 1988).

The polychaetes in the Nethravathi estuary comprised of 9 species that correlated with the sediment texture and organic carbon. The species *Dendronereis aestuarina* and *D. arborifera* with great abundances (more than 65% of the total abundance), possibly play a key role in the Nethravathi estuary and serve as an important food source for the higher trophic levels. In future, this work may be used as a baseline information for further studies.

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