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A study on benthic community structure in a backwater canal (T.S. Canal, Thottapally), Kerala, India

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Abstract

Benthos give indications to the environmental status of any aquatic system and are excellent bio indicators of ecosystem changes especially the sediment. The bottom fauna is represented by a wide spectrum of animal groups and exhibits wide diversity. The benthic community in T.S canal in particular the benthic groups and their relative abundance was studied. The benthos in the T.S. Canal was represented by 12 groups, nematodes were the most abundant groups, followed by polychaetes and oligochaetes. Seasonally, the highest density of benthos in T.S. Canal was during pre-monsoon season and the lowest during the monsoon season. The density of benthos was positively correlated with bottom water and sediment temperatures. The high density of total benthos at stations close to the sea indicates that the majority of benthic groups present in the canal prefer saline condition

Keywords: Benthos, T.S. Canal, Thottapally, backwater.

Introduction

The backwater tracts in Kerala have been, and continue to be, extremely productive providing the habitat for a variety of flora and fauna represented by plankton, macrophytes, benthos and nekton. The substrates or sediments of aquatic habitats are repositories of accumulated nutrients and toxins that are some of the principal causes of environmental deterioration. Benthos, organisms living in the sediments of aquatic habitats, can give indications to the environmental status of any aquatic system and are excellent bio indicators of ecosystem changes for reasons like the length of their life cycle and their intimate contact with the sediment. The benthos with wide species range and distribution has importance in stress effect evaluation based on their community behavior, density, distribution and environmental sensitivity. The bottom fauna is represented by a wide spectrum of animal groups and exhibits wide diversity. The study of benthos in relation to hydrographical features is inevitable to understand the potential of aquatic environments[1]. Aquatic environments are subjected to various physicochemical stresses, either of short or prolonged duration, due to anthropogenic activities.

The Thottapally Spill way canal in The Alleppey district of Kerala is a backwater canal or channel constructed in 1953 to check flood and salinity intrusion and divert flood waters of 3 major rivers (Pamba, Manimala and Achankoil) to the Arabian Sea by leading channels. Benthic ecology of several estuaries/backwaters of Kerala has been subjected to detailed studies in Cochin backwaters[2-4]. The recent studies in Cochin backwaters and Vembanad backwaters by is worth mentioning[5-7]. No such serious attempts have been made to study the benthic community in nearby backwater bodies or T.S. canal in particular could be found and hence this study was conducted with main objective to study the benthic groups and their relative abundance.

Materials and methods

The study area, Thottapally Spillway canal or T.S. Canal, a man made backwater canal lying at 9°17"30'N lat. and 76 25"30'E long, is located in the Alleppey district of Kerala, Figure-1. The region is a bar-built estuarine zone. The backwater has no permanent connection with the sea, but it gets connected seasonally to the sea through the opening of the sand-bar, especially during monsoon season, allowing seawater to penetrate into the canal. The leading channel of T.S. Canal, lying perpendicular to the Arabian Sea, is 365 m wide with both the sides protected with cement wall. Lying connected to the canal are, Puthen Ar, a tributary of Pamba River, and the Kollam-Kottappuram national waterway. There is a bridge across the leading channel, connecting the national highway (NH 47). Below the bridge, i.e., between the pillars; forty spillway iron shutters are fitted. The shutters are used to regulate the flow of water into and out of the bay. The shutters are manually opened and closed as and when the need arises.

For the present study five stations (Figure-1) were selected along the T.S. Canal, at an approximate distance of 50m from each other.

Station 1 is a true freshwater zone of the canal where the Pamba river joins the canal as the tributary Puthen Ar. There is high flow rate during monsoon season with turbid water. The banks of this site are characterized by human settlements.

Station 2 Station 2 is the site of confluence of three water channels, i.e., Puthen Ar, national waterway and leading channel of T.S. Canal, characterized by the flow of water in two directions i.e., to the south to Kayamkulam Lake and to the west to Arabian Sea. There is heavy vegetation of aquatic plants, and trees along the bank of this part of the canal.

Station 3 Station 3 is located on the eastern side of the spillway bridge which is an area of active sand mining and a timber mill are situated close to this station. During flood times, when the shutters of the spillway are open, there is high flow rate and floating weeds are brought in large quantity by the inflowing water. During monsoon times local people use this place for bathing and washing.

Station 4 Station 4 is on the western side of the spillway bridge and is a site of sewage disposal from the nearby hotels. At this place during monsoon season the flow rate high anf fishing is very active along this stretch of the canal, mainly cast net fishing and gill net fishing.

Station 5 The fifth station selected was near the sand bar. The T.S. Canal gets temporarily connected to the sea by manual opening of the pozhi during flood times in monsoon, allowing the flood waters to drain out into the sea. After the flood the sand bar is formed naturally and thus connection with sea is closed.

Figure-1: showing map of study site and stations selected.

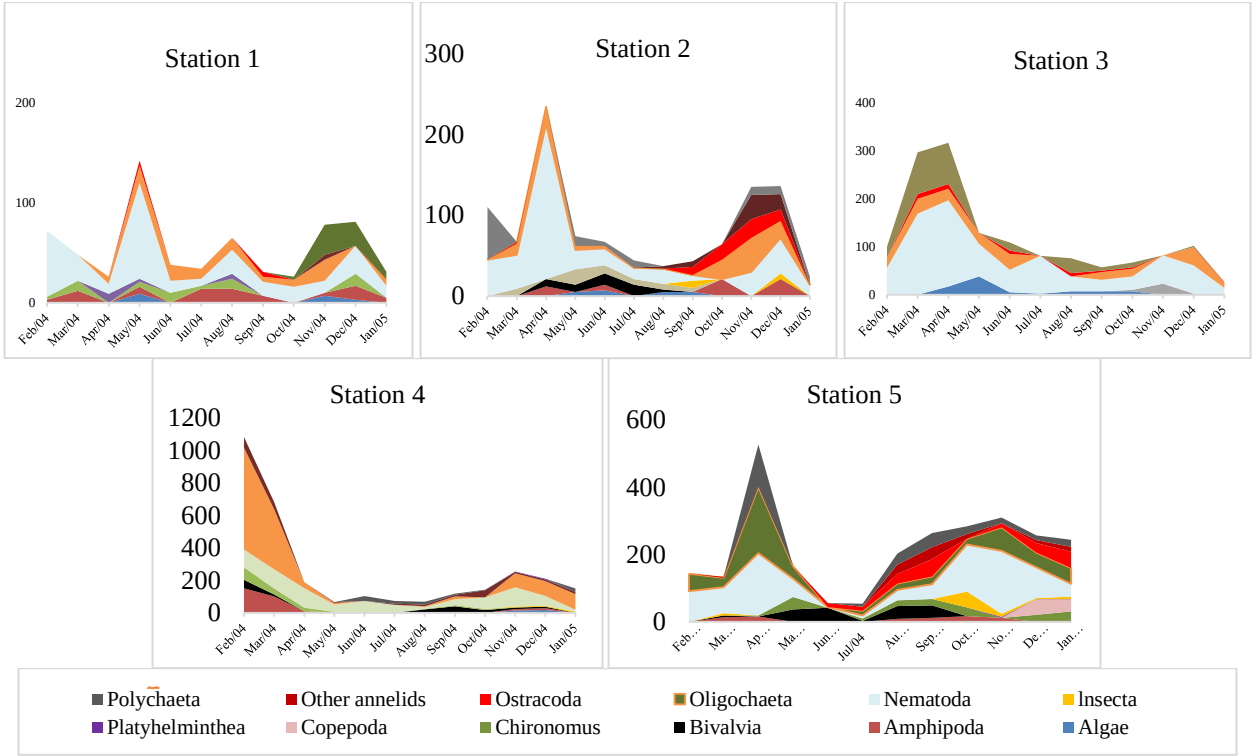

Figure-2: Showing monthly distribution of benthos at stations 1-5 in the study site.

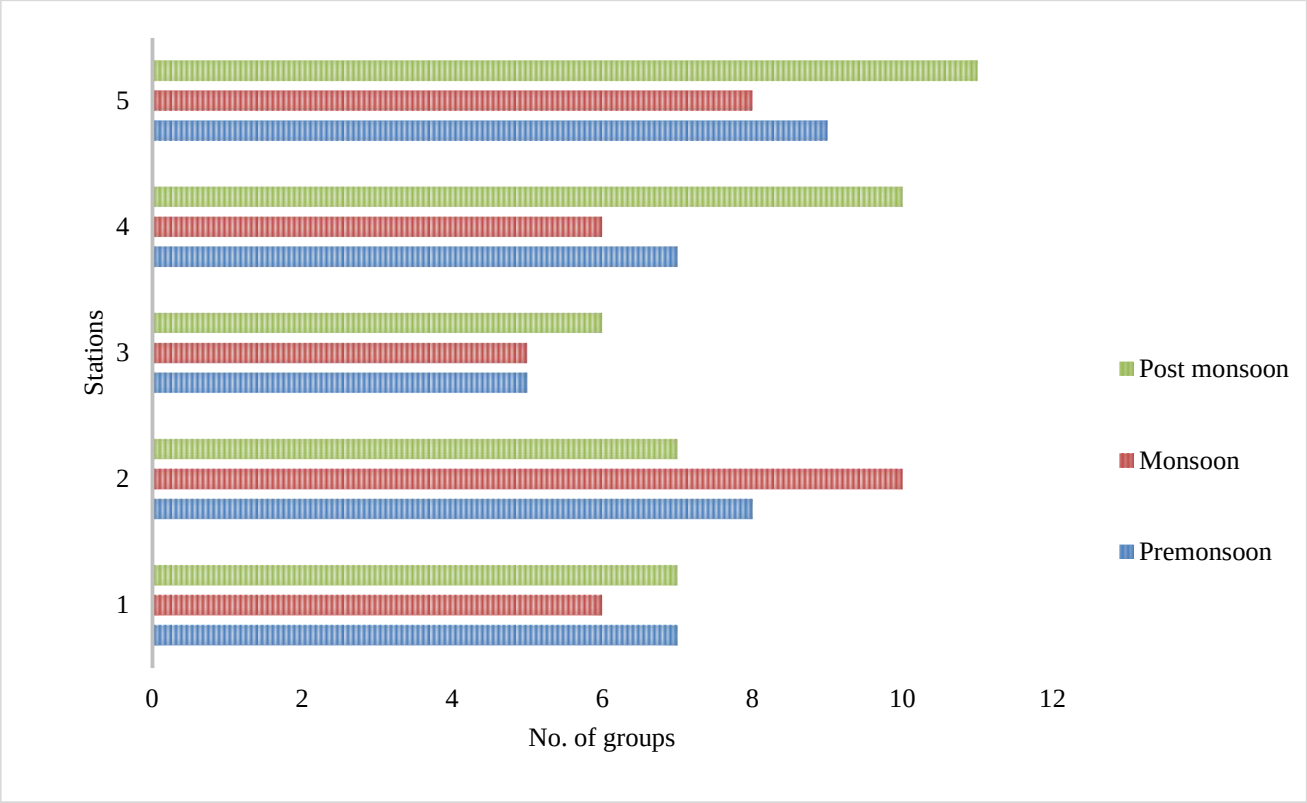

Figure-3: Seasonal abundance of benthic groups in T.S. canal, at stations 1-5 from Feb 2004 to Jan 2005.

The investigation was carried out from February 2004 to January 2005. Five stations were selected for the study along the canal and sampled twice a month every second and fourth week - between 8 a.m. and 10 a.m. Sediment samples collected using the corer was transferred into clean polythene bags and brought to the laboratory after adding 10% formalin as preservative. The sediment samples were washed and sieved with tap water in a sieve of mesh size 300µm. The organisms sieved out were transferred into clean plastic containers and preserved in 10% formalin. The samples were counted and identified with the help of standard identification keys and using research microscope (TRM, Model BX50 and Inverted Phase contrast microscope Model CK2, Olympus, Japan)[8,9]. Temperature, pH, organic carbon content and texture were determined of the sediments from the study site. The temperature of the sediment was noted using a Celsius thermometer as soon as the corer was lifted out of water. The sediment pH Organic carbon content was measured and the results were expressed in percentage[10,11]. Sediment texture was also analyzed[12]. The proportions of different textural components were expressed in percentage

Results and discussion

The benthos in the T.S. Canal was represented by 12 groups with density ranging from 24 per cm^3 to 1086 per cm^3 (Figure-3).

In T.S. Canal nematodes were the most abundant groups, followed by polychaetes and oligochaetes, the noteworthy features were that nematodes were represented in allmonths at all stations. High densities of nematodes and polychaetes occur in sandy-silt sediment[13]. This was true in T.S. Canal also where the sand was the major component in the sediment.

The influence of sediment texture on distribution of benthic population is further evident from the negative correlation between percentage of sand and abundance of benthos and from the positive correlation between percentage of clay and abundance of benthos. Mean grain size and sediment particle distribution, which is a function of hydrodynamic regime, plays a significant role in species diversity, biomass and population density of benthos[14].

The density of benthos at station 1-3 was similar almost all times of year while that in stations 4 and 5 showed similar density. In the pre-monsoon months, the density of benthos was noticeably higher at all stations (except station 1) than in the other months and the monthly variations were much more marked but haphazard, Table-1.

The observed monthly variation of total density of benthos was statistically significant ($P < 0.01$), Further, a comparison of density of benthos at the five stations indicates that the density was generally lower at station 1 and higher at station 5.

Table-1: Comparison of density of benthos at the five stations.

Station	Group	Months											
		Feb-04	Mar-04	Apr-04	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05
1	Total	72	48	26	143	38	34	65	31	26	78	81	31
	Algae	0	0	0	9	0	0	0	0	0	7	3	0
	Oligochaeta	0	0	7	17	16	10	12	5	7	21	0	7
	Polvchaeta	0	0	0	0	0	0	0	0	3	30	24	7
	Other annelids	0	0	0	0	0	0	0	0	0	5	0	0
	Amphipoda	3	12	0	7	0	14	14	7	0	3	14	5
	Nematoda	66	26	10	96	12	7	24	14	16	12	28	12
	Ostracoda	0	0	0	5	0	0	0	5	0	0	0	0
	lnsecta	0	0	9	3	0	0	5	0	0	0	0	0
	Chironomus	3	10	0	5	10	3	10	0	0	0	12	0
2	Total	72	67	234	74	67	44	37	43	64	134	136	24
	Algae	0	0	0	5	7	0	5	5	0	0	0	0
	Oligochaeta	0	14	21	5	3	0	0	0	24	42	21	0
	Polychaeta	65	0	0	12	5	9	0	0	0	10	10	10
	Other	0	0	0	0	0	0	3	7	0	30	19	0
	Nematoda	45	42	192	24	21	14	19	7	0	30	44	14
	Ostracoda	0	2	0	0	0	0	0	10	19	23	14	0
	Amphipoda	0	0	12	0	7	0	0	0	21	0	21	0
	lnsecta	0	0	0	0	0	0	0	9	0	0	7	0
	Chironomus	0	9	0	19	10	7	7	5	0	0	0	0
	Bivalvia	0	0	9	9	14	14	3	0	0	0	0	0
3	Total	100	299	318	129	110	81	76	57	67	82	102	26
	Algae	0	0	17	38	5	2	7	7	7	0	0	0
	Oligochaeta	21	31	24	23	33	0	0	16	16	0	38	12
	Polychaeta	23	87	86	0	17	0	31	7	10	0	3	0

	Nematoda	56	169	180	68	47	79	31	24	28	59	59	14
	Ostracoda	0	10	10	0	7	0	7	3	3	0	0	0
	Chironomus	0	0	0	0	0	0	0	0	3	23	2	0
4	Total	1082	682	189	66	103	73	69	118	142	254	210	153
	Algae	0	0	0	2	0	0	0	0	0	14	17	0
	latvhelminthea	0	0	0	0	0	0	0	0	0	2	5	0
	Oligochaeta	626	370	37	10	0	0	5	17	0	86	91	96
	Polychaeta	0	0	0	0	30	17	17	7	3	0	0	21
	Other	66	44	0	5	0	7	10	10	44	9	10	14
	Nematoda	110	118	120	44	73	47	12	37	71	118	61	12
	Amphipoda	151	101	9	0	0	0	0	0	0	9	12	0
	lnsecta	0	0	0	2	0	0	0	0	0	5	5	7
	Chironomus	77	37	23	3	0	2	3	7	7	2	0	0
	Bivalvia	52	12	0	0	0	0	21	40	17	9	9	
5	Total	143	134	527	164	56	54	204	264	285	311	257	244
	Algae	0	0	2	0	0	0	0	0	0	0	0	0
	Platyhelminthea	0	0	0	0	0	0	0	0	0	3	0	0
	Oligochaeta	52	28	197	37	0	14	19	23	17	70	44	47
	Polychaeta	0	0	126	0	0	9	33	42	23	17	14	21
	Other annelids	0	3	0	0	0	0	28	35	14	0	9	14
	Nematoda	91	77	185	54	2	9	31	44	140	187	91	38
	Ostracoda	0	0	0	0	12	12	28	52	0	12	28	49
	Copepoda	0	0	0	0	0	0	0	0	0	0	47	37
	Amphipoda	0	14	14	0	0	0	9	12	17	12	0	0
	lnsecta	0	7	0	0	0	0	0	0	47	9	3	7
	Chironomus	0	0	3	37	0	7	17	19	26	0	21	28
	Bivalvia	0	5	0	37	42	3	38	37	0	0	0	3

Table-2: Sediment parameters recorded at five stations in T.S. Canal from Feb 2004-Jan 2005.

Stations	Parameters		Feb.04	Mar.	Apr.	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan-05
1	Temperature (0C)		30.5	31.0	32.0	27.3	27.8	27.0	27.5	27.0	28.5	28.0	27.0	28.0
	pH		5.9	5.1	6.4	4.6	5.6	4.9	5	5.6	7.1	7.4	7.1	6.5
	Organic Carbon (%)		5.6	5.2	5.4	5.8	5.8	6.3	5.6	3.7	2.2	4.5	4.2	4.2
	Texture %	Sand	49.9	70.5	70.2	70.5	62	73.8	60	60.1	70.8	70.9	58.6	64.4
		Silt	36.7	10.2	6.4	7.9	33	23.6	38.4	37.9	4.6	9.8	36.1	30
		Clay	13.4	19.3	23.4	21.6	5	2.6	1.6	2	24.6	19.3	5.3	5.6
2	Temperature (0C)		30.5	30.8	31.5	27.3	28	27.5	27.5	27	27.8	28	27	27
	pH		5.3	5.3	6.3	5.6	5.5	5.4	5	5.8	7	7.4	6.4	6.7
	Organic Carbon (%)		6.3	5.9	5.1	3.2	3.3	3.5	3.6	3.2	5.8	3.9	4.6	4.5
	Texture %	Sand	41.6	94.3	65.5	81.5	74	52.2	72.2	72.6	73.5	64.3	73.3	82.9
		Silt	45	5.5	7.9	3.1	17	47.2	26.3	21.5	4.5	19.5	13.2	15.9
		Clay	13.4	0.2	26.6	15.4	9.6	0.6	1.5	5.5	22	16.1	13.5	1.2
3	Temperature (0C)		30	31	30.8	27	28	27	27.5	27	27.8	28	27	27.5
	pH		5.8	5.5	6	5.7	5.6	5.7	5	5.6	7	7.3	6.9	6.6
	Organic Carbon (%)		6.1	5.7	5.3	5.2	1.7	5.5	5.2	5.2	6	4.7	6	4.4
	Texture %	Sand	71.2	32.7	56.9	57.1	78	60.4	75.8	77.6	79.3	80.6	78.8	70.6
		Silt	19.6	57.4	14.7	41.2	19	38.7	22.6	20.2	18.1	10.3	17.8	27.8
		Clay	9.2	10	28.5	1.7	2.9	0.9	1.6	2.2	2.6	9.1	3.4	1.6
4	Temperature (0C)		30.3	30.3	31.8	27	28	27	27	27	28	27.5	26	27
	pH		5.6	5.6	6	6.9	5.2	5.4	5.3	5.8	7.1	7.5	6.9	6.4
	Organic Carbon (%)		5.6	6	5.2	5.8	5.7	4.7	2.3	4.3	4.7	2.3	3.4	2.2
	Texture %	Sand	66.4	86.4	41.5	41.2	32	53.3	30.8	31.4	33.4	67.2	3.3	22.3
		Silt	7	7.4	14.2	7.8	62	45.6	67.5	62.7	64.3	23.7	60.2	75.9
		Clay	26.4	6.2	44.3	51	6	1.1	1.7	5.9	2.6	9.1	6.5	1.8
5	Temperature (0C)		30	30.3	31	26.8	28	27	26.5	27	27.8	27.5	26	27
	pH		5.7	5.8	6.2	6	5.4	5.4	5.3	5.6	7.2	7.5	7.2	6.4
	Organic Carbon (%)		6	5.8	5.3	5.2	3.5	5.2	2.6	1.3	2.4	2.4	2.3	3.2
	Texture %	Sand	60.1	82.1	60.2	60.4	71	27.2	70.1	70.2	74.5	72.4	72.4	44.5
		Silt	38.3	17.6	19.3	19.9	26	71.5	28.2	26.8	20.3	22	24.5	53.7
		Clay	1.6	0.3	20.5	19.7	2.8	1.3	1.7	3	5.2	5.6	3.1	1.8

Seasonally, the highest density of benthos in T.S. Canal was during pre-monsoon season and the lowest during the monsoon season, graph. Low density of benthic population in monsoon may be due to fresh water influx and low salinity conditions[15].

The changing hydrographical conditions associated with tidal incursion, flushing of estuary and seasonal changes induced by monsoon determine the abundance and composition of benthic fauna. Similar low densities of nematode fauna in Blythestuary during monsoon, was recorded which indicated negative influence of low salinities on benthic population[17]. In Kayamkulam Lake have noted similar seasonal difference and stated that the depletion of fauna during monsoon may be due to the reduction of organic carbon, drastic change in salinity, which is true in case of T.S. canal where lowest organic carbon[18].

Multiple correlation analysis showed that the benthos was positively correlated with bottom water and sediment temperature in the sediments. Temperature of sediment is one of the important environmental factors as it influences the distribution of benthic organisms and chemical processes. In T.S. Canal changes in sediment temperature were in line with that of bottom water and significant positive correlation was noted between these two. Seasonally the highest sediment temperature was noted during pre-monsoon season and the lowest during monsoon season. The high temperature during pre-monsoon is a characteristic feature of the tropics, which is due to increased solar radiation and low rainfall. During warmer season, the water overlying the sediments gets more heated up and since there is absorption of heat it rises the temperature of the sediment. Likewise, during monsoon, the opposite phenomenon happens.

The sediment of T.S. Canal was acidic during most part of the year with a pH range of 4.6-7.5 which is the case of major backwater habitats in Kerala namely Veli Lake, Kumarakom[19,20]. Low pH generally indicates the reduction reaction in the substratum[20]. The low pH is due to the development of potential acidic sulphate soils that develop in brackish water regions. The maximum sediment pH occurs during the post monsoon season and it reaches the minimum during the monsoon season. This low value during monsoon could be due to exposure of relatively higher acidic subsurface basin soil consequent on monsoon turbulence and bottom currents. The acidic pH during monsoon is due to the influx of turbid waters into the backwater[19].

Sediment in T.S. Canal is characterized by moderate amount of organic carbon (2.2-6.3%). The moderate amount of organic carbon content in the T.S. Canal must be due to low sedimentation rate coupled with less reducing environment. Moreover, high biogenic activity might also have lowered the organic matter in the sediment. The seasonal maxima and minima of organic carbon content deposition of sand sediment in T.S. Canal is mainly attributable to the physical process of transportation and deposition of sand by the incoming river flow. The organic carbon content in T.S. canal was high during pre-monsoon season and low during post monsoon and monsoon seasons. The wide fluctuation of organic carbon in the T.S. canal may be attributed to various reasons like variation in temperature, nature of vegetation, rate of accumulation of dead and decayed foliage, topography, soil texture and depth of water. The moderate content of organic matter might also be due to coarser sediment. Higher content of organic matter is associated with finer sediments than with coarser ones[21]. Organic matter has high affinity for fine grained sediment because it adsorbs onto mineral surfaces[22]. The low organic carbon content during post monsoon could be due to large amounts of humus transported by the rivers and terrestrial land drainages during the monsoon.

The high organic matter during pre-monsoon could be because of low rainfall, reduced river discharge and closure of the mouth of the estuary during this season, which results in the development of a stagnant condition in the estuary leading to a sharp rise in the organic carbon content. Though there is heavy influx of silty sediment from river, continuous flow of water into the canal and towards the south through the national waterway, removes the fine sediment leaving behind only the coarser ones. The high percentage of sand during post monsoon may be due to the low rainfall and the consequent low transportation of silt because of the low influx of river water. Further, during this time the tidal influx flushes off fine sediment. The heavy inflow of water that deposits silt accounts for the high percentage of silt during monsoon seasons. The very low inflow of freshwater may be the reason for the high clay fraction in the sediment during the pre-monsoon.

Conclusion

The pattern of benthic assemblages found in the study area was strongly related to environmental variables, contamination level, bathymetry, quantity and composition of organic matter and sediment proprieties.

Low density of benthos at freshwater stations indicate the pollution at these places coming with river water. The high density of total benthos at stations close to the sea indicates that the majority of benthic groups present in the canal prefer saline condition. Nematodes present throughout the year at all stations and season indicate organic pollution in the T.S. canal and that the density of benthos was positively correlated with density of nematodes. The positive correlation between percentage of clay and abundance of benthos indicates the habitat preference of the benthic gropus in T.S. Canal. A detailed species level study of distribution and abundance of benthic community in the T.S. canal can provide a complete picture of the pollution status of the water body.

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