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Studies on Sediment Characteristics of Madhurantakam Lake, Tamilnadu, India

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Abstract: We report the results of quantitative and qualitative investigations of the ostracod fauna of the benthos of Madhurantakam Lake in Tamilnadu, India. Five species of ostracod were recorded from the benthic samples, *Cyclocypris* sp. *Cypris* sp. *C. lacustris, Cypriconcha* sp. and *Physocypris* sp. The highest density of benthic ostracods was 4268 ind. m^{-2}. The top layer (5 cm) showed high ostracod abundance, which indicates the richness of this layer in terms of organic matter and nutrients. The ostracod abundance and diversity were high during the post-summer months of June, July and August 2002. The ostracods dominated the macro-invertebrate fauna in all the sampling areas of the lake.

Key Words: Ostracod, Lake, Benthos

Introduction

The biotic community of lake water is related to those of the major habitats and includes the littoral macrophytes, plankton, neustons, nektons, periphytons and benthos. Aquatic sediment plays a critical role in the water quality modelling and nutrient cycling of the aquatic environment, which has recently received much attention, because of the overriding importance of microbial metabolism in direct mineralisation of organic matter, and in the inorganic biogeochemical cycling of nutrients (Wetzel, 1975). The benthos occupies an important position in the lake ecosystem, serving as a link between primary producers, decomposers and higher trophic levels and plays an important role in the detritus food chain, constituting the final major trophic group in the ecosystem (Pandit et al., 1985).

Among decomposers, benthos is mainly detritivorous, breaking down organic structures and substances, releasing the compounds and the elements back into the environment, and utilising energy, carrying it to the next trophic level (Odum, 1971). The distribution and density of the benthic community depends upon, the physico-chemical characteristics of water like salinity, pH, seasonal variation (Alcocer et al., 2001), toxicity and dissolved oxygen concentration (West et al., 1993).

The nature of sediment such as organic matter contents (Boulton and Lake, 1992), and the textural property of sediment are major factors in the density of benthos. Organic matter plays a potentially important role in the global carbon cycle. The sedimentary organic matter acts as an important source of nutrients to the overlying water. Release of nutrients to the system in sufficient quantities can promote algal bloom, and thus primary productivity is greatly enhanced. The bathymetric distribution of benthos determines communities according to the classified zones (littoral, sub-littoral and profundal) of the water column and depth of sediment (Petridis and Sinis, 1993; Wells et al., 1999).

Materials and Methods

Study Area

Lake Madhurantakam (Figure 1) is one of the largest lakes in southern India and was constructed by Lionel Place, Collector of Chennai (Madras) in 1798. It is located in the Kancheepuram district of Tamilnadu State. Its total watershed area is 1177 ha with a maximum depth of 6.39 m and a capacity of 609 m cu m. The free catchment area is 69.80 km^2 and the combined catchment area of the lake is 360 km^2. Since there has been only limited research on the benthic fauna of this lake, a benthic sampling programme was drawn up and executed.

Four stations at Madhurantakam Lake were selected for the present study: (1) Vannandhurai, (2) Chinna

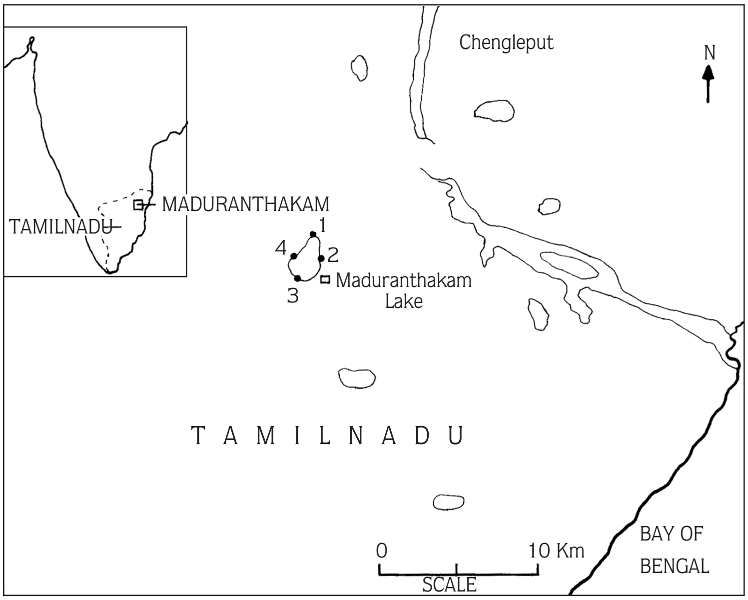

Figure 1. Study area – Madhurantakam Lake, South India.

Madhagu, (3) Periya Madhagu and (4) Bangala/Overflow (Figure 1). All 4 locations were selected in such a way as to cover and study the benthic faunal groups established in different localities with varying anthropogenic influences. Station 1 is highly influenced by human activities, while the whole lake is influenced by the activities of domesticated animals.

Sampling Program

A bimonthly sampling programme was adopted for the present study, initiated from 15 April, 2002, onwards. The sampling was carried out until August, 2002. Both water and sediment samples were collected.

Water Sample: Surface water samples were collected in clean polypropylene containers and were brought to the laboratory for further analysis. For the estimation of dissolved oxygen, water was fixed in BOD bottles at the sampling site itself.

Sediment Sample: Core samples were collected using a polyvinylchloride (PVC) corer 5 cm in diameter and 30 cm in length. The sharpened bottom end was forced into the sediment to a 15 cm depth to collect bottom sediment samples. Each 5 cm of the core sediment was separated and classified as a top (0-5 cm), middle (5-10 cm) or bottom (10-15 cm) layer. A portion of sample was preserved in 5% neutralised formalin for further biological analysis.

Physico-chemical analysis of water: The surface water samples were subjected to physico-chemical analyses, which were carried out as per the standard methods prescribed for the examination of water and wasteswater (APHA, 1992). Temperature, pH, salinity, dissolved oxygen and total suspended solids were determined.

Sedimentology: Sediment pH, organic matter (chromic acid method), calcium carbonate (rapid titration method) and phosphate (strong acid digestion method) were estimated (Ramesh and Anbu, 1996).

Benthic Community

Non-planktonic fauna: The samples were stained with Rose Bengal and washed repeatedly through a set of 2 sieves with mesh sizes of 1000 mm and 300 mm. Taxa retained by the larger meshes were hand sorted under 12x magnification, whereas organisms retained by the 300 mm mesh were separated from the accompanying detritus using the kerosene-ethanol phase separation technique described by Burmuta (1984). The taxa were identified and counted with the help of standard keys (Edmondson, 1959; Boulton and Lake, 1992).

Ostracod fauna: The samples were washed on a 300 mm mesh sieve to remove fine particles. The residues were kept for about 1 h in a tray containing an aqueous solution of Rose Bengal stain. The residues on the sieve were then washed to remove the excess stain and were observed under a low-power dissection microscope. Individuals were counted and identified with the help of the standard keys mentioned above.

Results and Discussion

Figures 2 to 5 show bimonthly and stratiographic variations of ostracod abundance in Mathurantakam Lake between April and August, 2002. The top layer of the sediment showed the highest abundance compared to the middle and bottom layers. The highest abundance was noted at station 4. *Cypris* sp. was the most common species, occurring at almost all the sampling occasions and at all the stations, *Cyclocypris* sp. was the next dominant species.

The lowest pH (7.95) was recorded at station 4 during late July, and the highest (9.22) during early June at the same station. Alkaline pH was noted overall, with the mean varying from 8.5 and 8.97 among the stations. Sediment pH is one of the most important properties involved in the distribution and abundance of the benthic community and the relationship between ion exchange capacity and nutrient availability (Foth, 1990).

The organic matter concentration varied between 0.255% and 9.38%. A high mean concentration (4.967%) was recorded in the top layer of station 2 and the lowest mean organic matter concentration (1.023%) in the bottom layer of station 1 (Table 1). $CaCO_3$ concentrations varied between 0.25% and 3.60%, and the total phosphorus level ranged between 0.06 and 1.75 mg/g (Table 1).

The top layer of the core contained major ostracod fauna assemblages in all stations during the study period. Abundance and density of benthic ostracod fauna was highest, at 4268 ind. m^{-2}, at station 4 in the top layer and lowest (194 ind. m^{-2}) in the bottom layer at stations 1, 2 and 3. The ostracods dominated the macrobenthic fauna,

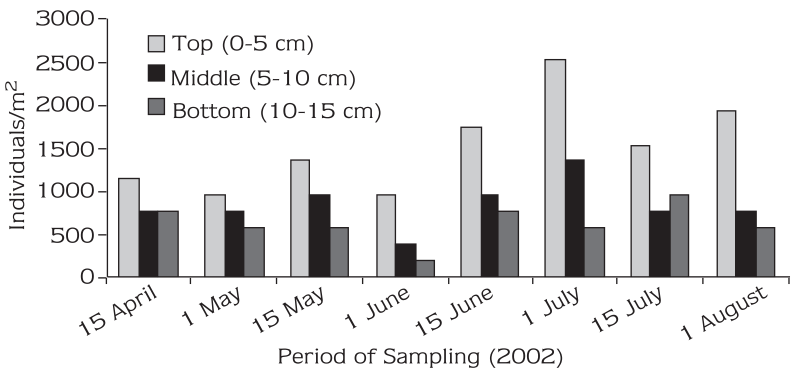

Figure 2. Stratiographic and bimonthly variation of ostracod fauna at station 1.

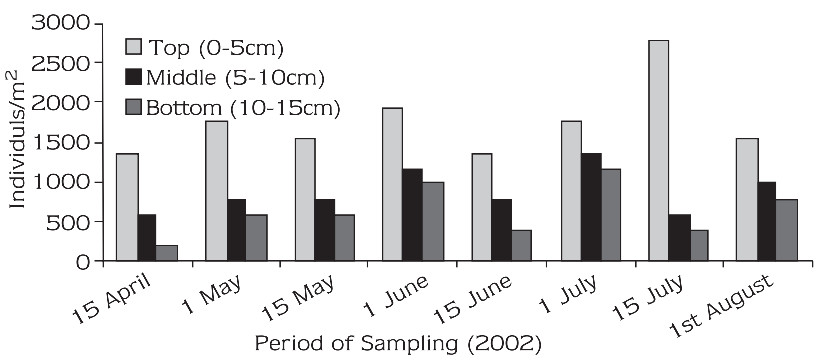

Figure 3. Stratiographic and bimonthly variation of ostracod fauna at station 2.

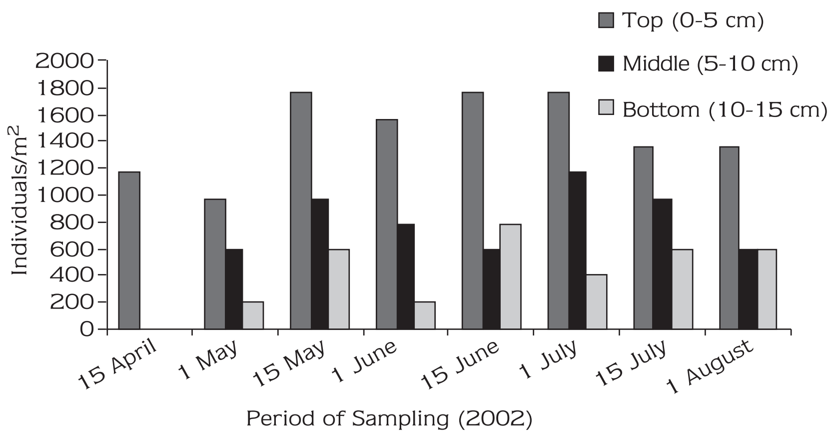

Figure 4. Stratiographic and bimonthly variation of ostracod fauna at station 3.

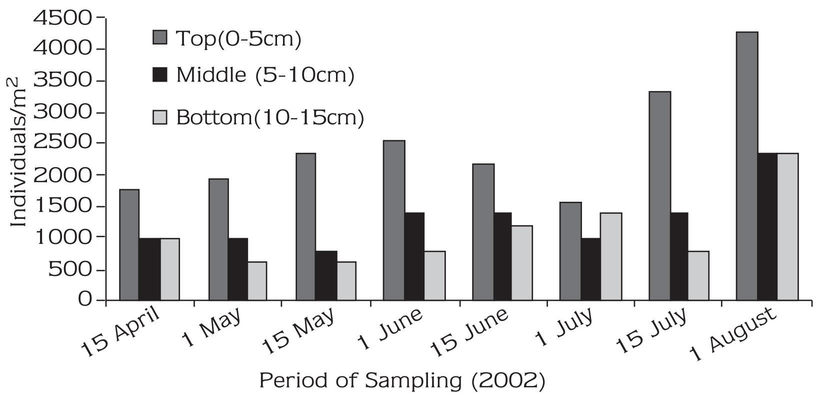

Figure 5. Stratiographic and bimonthly variation of ostracod fauna at station 4.

contributing 65%, 59%, 58% and 58% to the total abundance at stations 1, 2, 3, and 4, respectively. This was followed by molluscs (16%, 10%, 24% and 24%) and nematode worms (7%, 29%, 18% and 18%), and oligochaets were fewer in number.

Patterns of ostracod variability at each station may reflect influences such as sediment pollution and natural disturbance. Ostracod assemblages display substantial stratiographic variability in all stations (Wells et al., 1999). Among the 4 ostracod taxa (*Cyclocypris* sp., *Cypris* sp., *Cypriconcha* sp. and *Physocypris* sp.), *Cypris* sp. was found to be highest in density and abundance. Table 2 shows a significant positive correlation between phosphate concentration and a high negative correlation between calcium carbonate and pH. The distribution and density of the benthic community depends upon, the physico-chemical characteristics of water like salinity, pH (Alcocer et al., 1999), seasonal variation (Alcocer et al., 2001), toxicity (West et al., 1993) and dissolved oxygen concentration. The present study clearly shows that ostracods dominate the benthic macroinvertebrate fauna and are quite tolerant of moderate variations in physico-chemical factors.

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Table 1. Physico-chemical variables of sediments at the 4 different stations.

Variable		15 April	1 May	15 May	1 June	15 June	1 July	15 July	1 August	Mean	SD
Sitation 1											
	T	0.675	0.871	1.675	3.35	8.37	6.432	6.968	8.04	4.548	3.26
OM (%)	M	0.145	0.281	1.273	3.07	4.46	1.072	2.68	3.216	2.025	1.55
	B	0.113	0.227	0.558	100.39	0.27	1.072	2.412	2.144	1.023	0.89
pH		8.6	8.86	8.95	8.55	8.98	8.85	9	8.9	8.84	0.49
$CaCO_3$ (%)		3.0	3.5	2.25	1.75	2.0	2.0	3.5	3.6	2.7	0.86
P (mg/g)		0.099	0.275	0.2	0.375	0.325	1.095	1.02	1.75	0.642	0.60
Sitation 2											
	T	0.945	1.085	1.675	2.51	8.65	7.772	9.38	7.72	4.967	3.71
OM (%)	M	0.275	0.375	1.116	1.95	6.42	2.412	4.824	9.38	3.344	3.25
	B	0.234	0.268	1.016	0.55	2.23	0.804	2.68	2.68	1.308	1.05
pH		8.62	8.82	9.08	9.17	9.07	9.01	8.9	9.05	8.97	0.34
$CaCO_3$ (%)		1.0	2.0	0.5	1.5	0.5	1.5	2.0	3.0	1.5	0.85
P (mg/g)		0.065	0.475	0.175	1	1.137	0.982	0.85	0.991	0.709	0.54
Sitation 3											
	T	1.412	1.742	4.466	2.79	7.25	2.144	6.7	8.899	4.425	2.86
OM (%)	M	1.031	1.273	1.116	1.29	3.07	1.072	4.536	2.412	1.975	1.27
	B	0.245	0.134	2.233	1.11	2.23	0.536	4.536	2.68	1.713	1.50
pH		8.26	8.46	8.86	8.5	8.92	8.8	8.9	8.01	8.59	0.18
$CaCO_3$ (%)		1.5	2.75	0.75	0.75	1.5	2	2.5	2.9	1.83	0.85
P (mg/g)		0.09	0.125	0.29	1.075	0.85	0.925	1.502	1.305	0.77	0.41
Sitation 4											
	T	0.255	0.455	3.908	5.02	3.35	3.484	8.844	7.596	4.114	3.04
OM (%)	M	0.309	0.402	3.35	2.79	1.67	0.804	2.68	1.072	1.635	1.17
	B	0.141	0.281	2.791	1.11	1.67	1.34	4.02	2.68	1.754	1.33
pH		8.5	8.64	9.13	9.22	7.97	8.1	7.95	8.5	8.5	0.17
$CaCO_3$ (%)		2.5	2	0.25	0.75	0.5	1.5	2	0.5	1.25	0.78
P (mg/g)		0.06	0.08	0.13	0.55	0.375	1.035	1.305	1.6	0.642	0.58

OM= Organic matter, T= Top (0-5 cm), M= Middle (5-10 cm), B= Bottom (10-5 cm), $CaCO_3$= Calcium carbonate, P= Phosphate.

Table 2. Correlation of sediment variables.

Variables	Organic Matter (%)	pH	Calcium Carbonate (%)	Phosphate (mg/g)
Organic Matter (%)	1.00	-	-	-
pH	0.022	1.00	-	-
Calcium Carbonate (%)	-0.025	-0.722*	1.00	-
Phosphate (mg/g)	0.831*	-0.134	0.217	1.00

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