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Diversity of zooplankton in Parangipettai coastal waters, southeast coast of India

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Abstract

Results of an investigation carried out on the spatio-temporal variation of zooplankton in the Bay of Bengal (Station 1) and Vellar Estuary (Station 2) from September 1997 to August 1998 are presented. Hydrological parameters such as water temperature, salinity, *p*H and dissolved oxygen were noticed in the ranges of 26.5-32.0°C; 3-34‰; 7.05-8.63 and 3.6-8.6 ml/l respectively. The inorganic nutrients like nitrate, nitrite, phosphate and silicate concentrations varied between 4.2 and 49.6μM; 0.9 and 7.9μM; 0.6 and 2.1μM and 7.9 and 139.9μM respectively. Totally 50 species of zooplankton and 17 varieties of larval forms were identified from 2 stations. Of these, the copepods were the dominant group. The population density varied from 560 to 87,780 No./m^3 at station 1 and 184 to 1,56,164 No./m^3 at station 2. Species diversity was higher (1.89-4.01 bits/individual) at station 2 than at station 1 (1.83-3.96 bits/individual). Higher values of plankton density and diversity were found during summer and post monsoon seasons and they were positively correlated with salinity and surface water temperature.

Introduction

The Vellar Estuary is situated at Parangipettai (11° 29′ N; 79° 46′ E), east coast of India. It has a year round connection with the Bay of Bengal and is subjected to semidiurnal tides with a maximum tidal amplitude of about 1 meter. The Vellar Estuary is connected with the Coleroon Estuary through Killai Backwater and Pichavaram mangrove channel. Much information is available on the physico-chemical properties of the Vellar Estuary and the adjacent waters (Krishnamurthy, 1967; Ramamoorthi, 1971; Krishnamurthy and Sundararaj, 1973; Vijayalakshmi and Venugopalan, 1973; Sivakumar, 1982; Chandran and Ramamoorthi, 1984a and b; Chandran, 1987). Reasonable extent of information on the seasonal distribution of zooplankton from Parangipettai coastal waters are also available (Subbaraju, 1970 Krishnamurthy and Santhanam, 1975; Santhanam *et. al.*, 1975 and Kumar, 1993). Recently many shrimp farms have been established on the banks of the Vellar Estuary, hence an investigation on the diversity of zooplankton of the Parangipettai coastal environs was undertaken in relation to the hydrobiology

of the area during September 1997 to August '98.

The authors are thankful to the Director of CAS in Marine Biology and the authorities of Annamalai University.

Material and methods

For samplings, two sites representing the sea (Bay of Bengal-station1) and the estuary (Vellar-station 2) were chosen. Station-1 is located 3 km away from the mouth of the Vellar Estuary and station-2 situated just opposite to the Marine Biological Station (Fig.1). Rainfall data were obtained from the local meteorological station at Parangipettai. Temperature was measured using a standard centigrade thermometer. Salinity was estimated by refractometer and *p*H was measured using ELICO Grip *p*H meter. Dissolved oxygen was estimated by the modified Winkler's method (Strickland and Parsons, 1972). Nutrients were analysed by adopting the standard procedures described by Strickland and Parsons (1972). Surface samplings of zooplankton were made at monthly intervals by horizontal towing of plankton net (0.35 m mouth diameter) made up of bolting silk (cloth No 10; mesh size 158μm) for twenty minutes. The collected samples were preserved in 5% neutralized formalin and used for qualitative analysis. A known quantity of water (1000 litres) was filtered through a bag net of the same mesh size and the numerical plankton analysis was carried out using a binocular microscope. Zooplankton diversity was calculated using Shannon-Weaver's index (Pielou, 1975), species richness was calculated by Simpson's index. Species evenness was calculated using the formula of Pielou (1966).

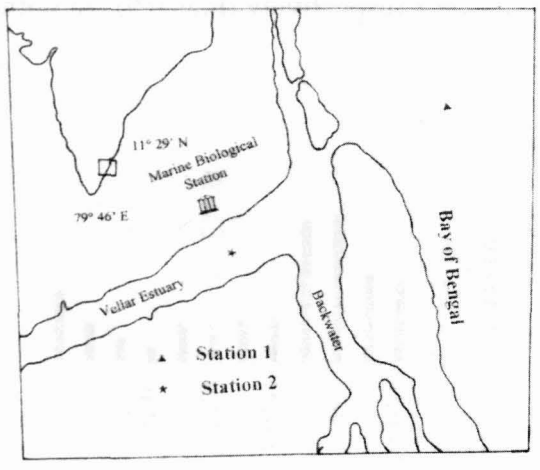

Fig. 1. *Map showing station positions*

Results

Physico-chemical parameters

Monthly rainfall ranged from minimum value (55.2 mm) recorded during the premonsoon season to the maximum value (895.5 mm) recorded during the monsoon season. No rainfall was recorded during January to April and in June.

Surface water temperature ranged from 26.5 ° C to 31.0 ° C at station 1 and from 28°C to 32°C at station 2 (Fig.2). Salinity showed wide variations and fluctuated from 6 to 35 ‰ at station 1 and 3 to 34 ‰ at station 2 (Fig.3). The *p*H ranged between 7.1 and 8.6 at station 1 and 7.0 and 8.6 at station 2 (Fig.4) where in low values were recorded during the premonsoon season and higher values during the postmonsoon season. Dissolved oxygen concentration (ml/l) varied from

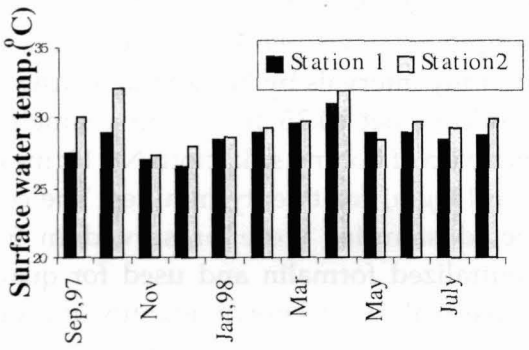

Fig. 2. *Variations in surface water temperature*

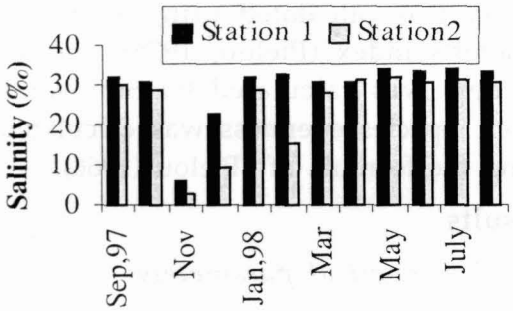

Fig. 3. *Variations in salinity*

3.6 to 7.8 at station 1 and 3.8 to 8.6 at station 2 (Fig.5) with the maximum dur-

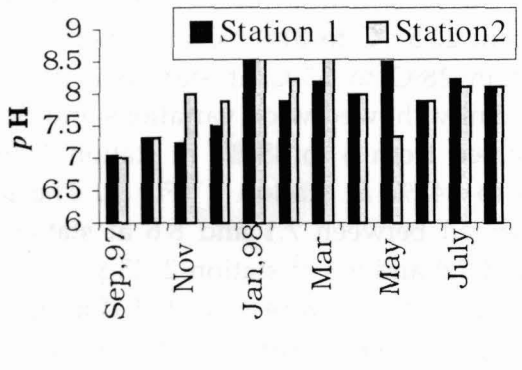

Fig. 4. *Variations in pH*

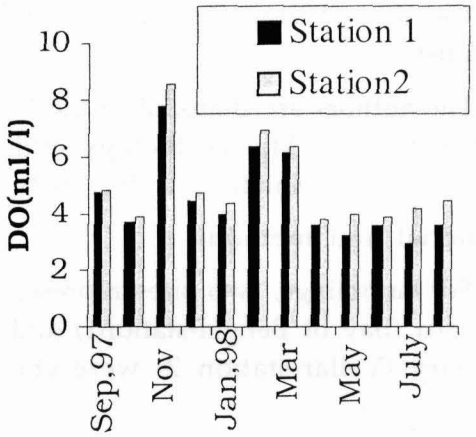

Fig. 5. Variations in dissolved oxygen

ing the monsoon season and the minimum concentration during the summer season at both the stations.

In the case of nutrients, the ranges (μM) of nitrate and nitrite were: 4.2 - 40.5 at station 1 and 5.6 - 49.6 at station 2; 0.9 - 6.8 at station 1 and 1.5 - 7.9 at station 2 respectively. The ranges (μM) of phosphate and silicate concentration were 0.6 - 1.8 in station 1 and 0.7 - 2.1 in station 2; 7.9 - 109.0 in station 1 and 11.9 - 139.9 in station 2 respectively (Figs.6-9). At both

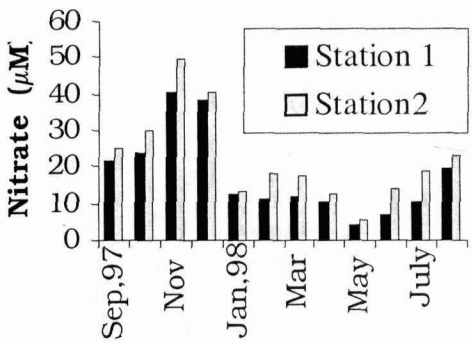

Fig. 6. *Variations in nitrate concentration*

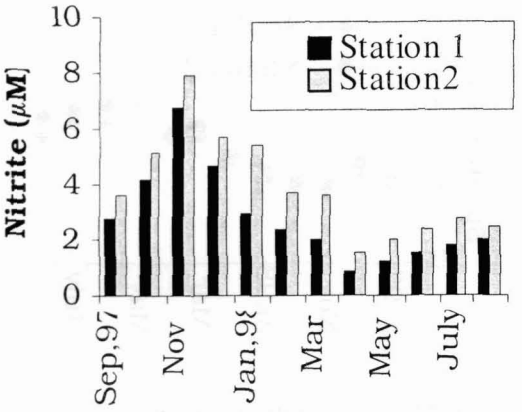

Fig.7. *Variation in nitrite concentration*

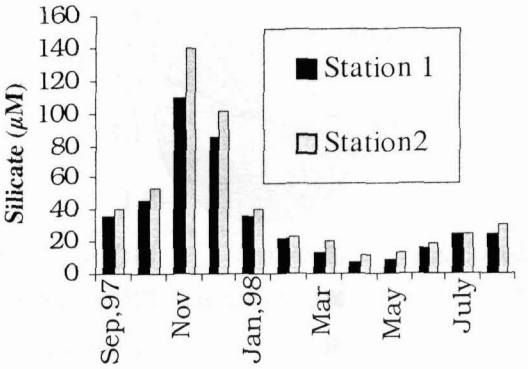

Fig. 9. *Variations in silicate concentration*

stations all the nutrients were low during the summer season and high during the monsoon season.

Zooplankton distribution

A total of 67 zooplankters belonging to the following groups were encountered. Ciliata: *Tintinnopsis tocantinensis, T.tubulosa, T.cylindrica, T.minuta, Favelle philippinensis* and *F.brevis;* Colenterata: *Bougainvilla* sp.; Ctenophora: *Pleurobrachia* sp.; Rotifera: *Brachionus angularis, B.plicatilis* and *Monostyla bulla;* Foraminifera: *Globigerina rubescens;* Copepoda: *Calanus* sp., *Nannocalanus minor, Rhincalanus cornutus, Eucalanus attenuatus, E.elongatus, Paracalanus parvus, Acrocalanus gracilis, Centropages furcatus, C.gracilis, C.orsinii, Pseudodiaptomus annandalei, P.aurivilli, Temora turbinata, T.discaudata, Labidocera acuta, L.pectinata, Acartia erythraea A.spinicauda, A.danae, A.southwelli, A.clausi, Microstella rosea, Macrostella gracilis, , Euterpina acutifrons, Oithona rigida, O.similis, O.nana,*

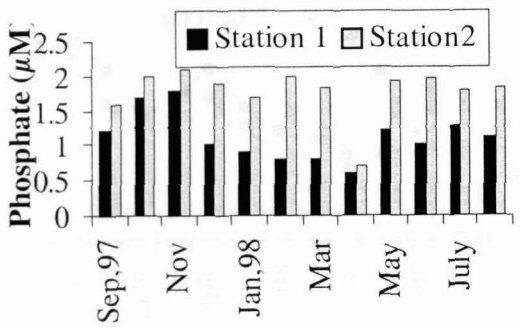

Fig. 8. *Variations in phosphate concentration*

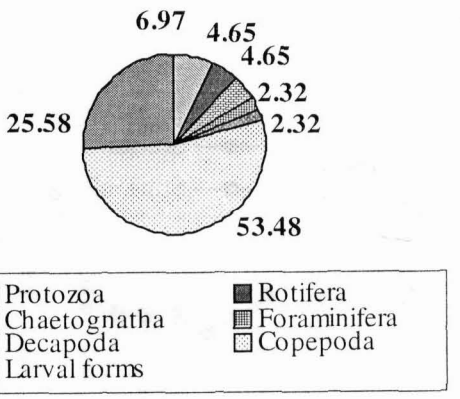

Fig. 10. *Percentage composition of zooplankton - station 1*

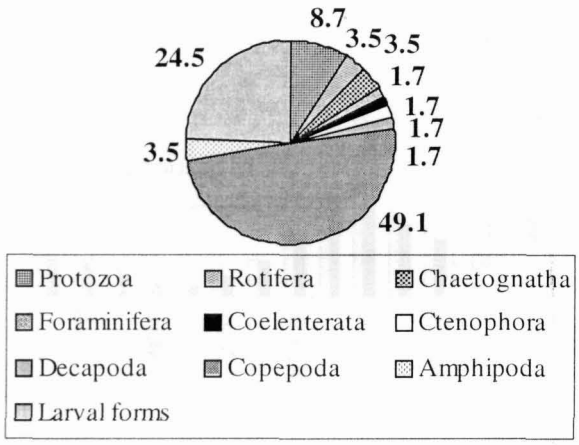

Fig. 11 *Percentage composition of zooplankton - station 2*

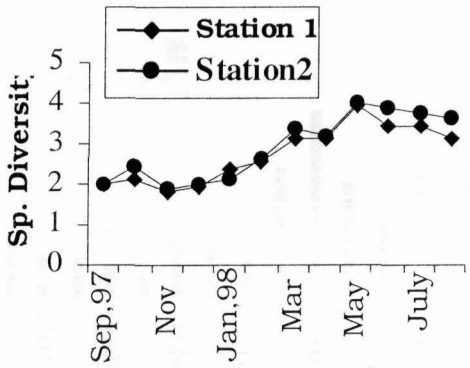

Fig. 13. *Monthly variations in species diversity*

O.spinirostris, O.brevicornis, O.plumifera, Oncaea venusta and *Corycaeus vitrea;* Amphipoda: *Urothoe spinidactyla* and *Ericthonius brasiliensis;* Chaetognatha: *Sagitta enflata* and *S.bifunctata;* Larval forms: copepod nauplii, cirripid nauplii, crustacean nauplii, gastropod veliger, Tornaria larva, Metatrochophore larva, Echinispira larva, polychaete larva, shrimp zoea, euphausid zoea, shrimp protozoea, brachyuran zoea, shrimp mysis and crab megalopa ; and fish eggs.

At station 1, forty-four groups of zooplankters were present, the highest formed by Copepoda (23 spp.), followed by 12 types of larval forms and 3 species of protozoa, 2 species each of rotifera and chaetognatha and 1 species each of foraminifera and decapoda. Almost a similar numerical pattern with a total of 59 groups were recorded in station 2 represented by copepoda (28), larval forms (16), proto-

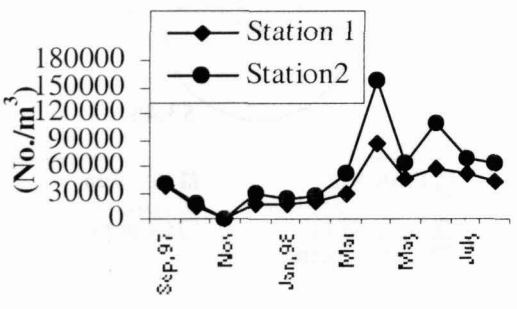

Fig. 12. *Monthly variations in population density*

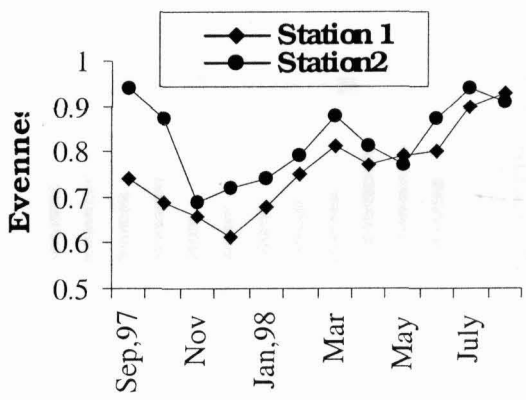

Fig. 14. *Monthly variations in species evenness*

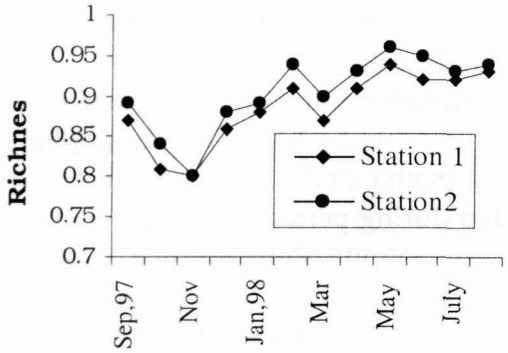

Fig.15. *Monthly variations in species richness*

zoa (5), rotifera (2), amphipoda (2), chaetognatha (2), coelenterates (1), ctenophora (1), foraminifera (1) and decapoda (1). Figures 10 and 11 give the percentage composition of zooplankton at station 1 and 2 respectively.

salinity and negative correlation with dissolved oxygen at both the stations (Table 1). Species diversity of zooplankton varied from 1.83 to 3.96 at station 1 and 1.89 to 4.01 at station 2 (Fig.13). Species evenness ranged between 0.59 and 0.93; 0.77 and 0.94 at stations 1 and 2 respectively (Fig.14). Minimum was recorded in the monsoon season and the maximum during summer season. Species richness varied from 0.80 to 0.94 and 0.80 to 0.96 at stations 1 and 2 respectively (Fig.15). At both the stations minimum and maximum richness values were recorded during the monsoon and the summer seasons respectively.

Table 1. Population density in relation to various parameters

Parameter	Station		Station 2		
	Population density		Parameter	Population density	
	r value	P		r value	P
Temp.	0.73	0.01	Temp.	0.49	-
Salinity	0.52	-	Salinity	0.55	0.05
DO	-0.57	0.05	DO	-0.37	-
*p*H	-0.25	-	*p*H	-0.16	-
Nitrate	-0.68	0.01	Nitrate	-0.60	0.05
Nitrite	-0.82	0.001	Nitrite	-0.71	0.01
Phosphate	-0.64	0.01	Phosphate	-0.70	0.01
Silicate	-0.74	0.01	Silicate	-0.61	0.05

The population density of zooplanktonic organisms varied from 560 to 87,780 No./m^3 at station 1 and 184 to 1,56,164 No./m^3 at station 2 (Fig.12). The maximum population was observed during the summer season and the minimum during the monsoon season. The zooplankton population density showed a positive correlation with water temperature and

Discussion

The physico-chemical parameters such as temperature, salinity, dissolved oxygen, *p*H and nutrients showed seasonal variations. The bulk of rainfall was obtained during the northeast monsoon at both the stations and the pattern of rainfall influenced the physico-chemical and biological characters of the study area.

The high temperature during summer at both the stations can be attributed to high solar radiation. The low temperature during monsoon could be due to strong land sea breeze, rainfall and cloudy sky. The high salinity values noticed during the summer months could be due to the high solar radiation and neritic water dominance (Thangaraj, 1984). The *p*H was low during monsoon season due to the influence of freshwater, reduction of salinity and decomposition of organic matter. During summer season *p*H was high because of the uptake of CO_2 by phytoplankton. Similar observations were made earlier by Santhanam, 1976; Santha Joseph, 1975, 1982 and Sivakumar, 1982. The high dissolved oxygen concentration was due to the phytoplankton photosynthesis.

The inorganic nutrient concentration was always higher during monsoon season due to heavy rainfall, land drainage and input of fertilizers from the catchment areas and low during other months due to utilization by phytoplankton (Krishnamurthy, 1961 and Santhakumari, 1971).

The copepods were the dominant group throughout the study period in the sea and estuary, which may be due to the plentiful food availability as well as due to their continuous breeding and high reproductive capacity (Kumar, 1993). Maximum numerical counts of the copepod population have been reported when the temperature and salinity were high in the environment (Rajasegar, 1998).

Rotifers were observed during the monsoon and the post-monsoon seasons as they are least tolerant to higher salinity (Govindasamy and Kannan, 1991). The tintinnids were absent during the monsoon season because of high freshwater input while the hydromedusa, ctenophora, chaetognatha and *Lucifer* spp. were recorded during period with high temperature and salinity showing their wide tolerance to these hydrological parameters. Fish eggs and larvae were abundant during the post as well as pre-monsoon seasons indicating their seasonal distribution .

The high zooplankton population density during the summer season could be related to the stable hydrographical condition while low density during the monsoon season is attributed to heavy flood and freshwater inflow (Santhanam *et. al.*, 1975; Shanmugam *et al.*, 1986; Kumar, 1993 and Rajasegar, 1998). The density of the zooplankton was comparatively high at station 2 in the estuary than at station 1 in the sea. The estuary gets more organic matter from catchment areas (Subbaraju, 1970 and Kumar, 1993). The observed high summer biodiversity could again be related to stable hydrological parameters, which induced the denser production of many species. But during the monsoon season the freshwater flow played an important role in the hydrographical changes that reduced the species diversity.

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