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Studies on the ecology and distribution of zooplankton biomass in kadalur coastal zone, Tamil nadu, India

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ABSTRACT

Zooplankton diversity important criteria for evaluating the suitability of water for irrigation and drinking purposes. In this study, we tried to assess the Zooplankton species richness, diversity, and evenness and to predict the state of three stations. The Zooplankton showed seasonal variations at all the stations. The order of abundance of Zooplankton at the three selected stations are Station 1 (Palar river): Rotifera > Cladocera > Ciliata > Copepoda > Others, Station 2 (Palar estuary): Ciliata > Siphanophora > Rotifera > Polychaeta > Cladocera > Copepoda > Cirripedia > Others and Station 3 (Kadalur sea coast): Copepoda > Ciliata > Hydrozoa > Rotifera > Amphipoda > Chaetognatha > Cladocera > Others.

Introduction

Zooplankton is tiny animals found in all aquatic ecosystems, particularly the pelagic and littoral zones in the ocean, also in ponds, lakes, and rivers. They are classified by size and / or by developmental stage. Size categories include: picoplankton the measure less than 2 micrometers, nanoplankton measure between 2 – 20 micrometers, microplankton measure between 20 – 200 micrometers, mesoplankton measure between 0.2 – 20 micrometers, macroplankton measure between 20 – 200 millimeters, and megaplankton, which measure over 200 millimeters (Lynn, 2007).

The zooplankton community is composed of both primary consumers (which eat phytoplankton) and secondary consumers (which feed on the other zooplankton). They provide a direct link between primary producers and higher tropic levels such as fish. Nearly all fish depend on zooplankton for food during their larval phases, and some fish continue to eat zooplankton in their entire lives (Madin *et. al.*, 2001).

According to Murugan *et. al.,* (1998) and Dadhich and Sexena (1999) the zooplankton plays an integral role and serves bio indicators and it is a well – suited tool for understanding water pollution status (Ahmad, 1996; Contreras *et. al.,* 2009).

A number of study have been carried out on ecological condition of freshwater bodies in various parts of India (Gulati and Schultz, 1980; Rana, 1991; Sinha and Islam, 2002; Singh *et. al.,* 2002; Smitha *et. al.,* 2007), but southern part of Tamilnadu, the ecological studies of freshwater body is very scanty (Haniffa and Pandian, 1980; Smitha *et. al.,* 2007).

Kim *et. al*, (2000) have reported that investigation on seasonal variation in Zooplankton composition in Pearl River estuary in China. The present work was carried out study the Kadalur is a coastal village of Tamil Nadu, that located in the neighbourhood of the estuarine region Palar river to assess the quantitative distribution of Zooplankton from the three Stations 1 (Palar river), Station 2 (Palar estuary) and Station 3 (Kadalur Sea coast)

Materials and Methods

Zooplankton samples were collected at monthly intervals from the waters of the study area by towing a plankton net (0.35 µm mouth diameter) made up of bolting silk (No. 30, mesh size 48 µm and No. 10, mesh size 158 µm, respectively for Zooplankton) for half an hour. These samples were preserved in 4% neutralized formalin and used for qualitative analysis. For the quantitative analysis of phytoplankton, the settling method described by Sukhanova (1978) was adopted. Numerical Plankton analysis was carried out by using utermohl's inverted plankton microscope.

For the sake of convenience, the Zooplankton were assigned to some major groups viz. Chaetognatha, Hydrozoa, Amphipoda, Cirripeda, Polychaeta, Siphanophora, Ciliate, Cladocera, Copepoda, Rotifera, Crustacea and others for zooplankton. Species diversity index (H'), species Richness (SR), evenness index (J') and dominant index (δ) were calculated using the formulae of Shannon and Weaver (1949), Gleason (1922), Pielou (1966) and Ignatiades and Mimicos (1977), respectively.

Shonon and Weavers formula is

$$H' = \left[-\sum_{i=1}^{s} Pi \log_2 Pi..... \right]$$

Where H' = species diversity in the bits of information per individual and Pi = Proportion of the sample belong to the species.

Species richness (SR) was calculated as described by Gleason (1922).

$$SR = \left[\frac{S-1}{\log_e N} \right]$$

Where,

S = the number of species of particular sample and

N = the natural logarithm of the total number of individuals of all the species in the sample.

Evenness index (J') (equitability) was calculated by the formula of Pielou (1966).

$$J' = \left[\frac{H'}{\log_2 S} \right]$$

Where H' = Species diversity in the bits of information per individual and

S = Number of species

Dominant index (δ) was calculated using the formula of Mc Naughton (1967) as described by Ignatiades and Minicos (1977).

$$\delta = \left[100 \frac{(n_1 + n_2)}{N} \right]$$

Where,

δ = Dominance index, equal to the percentage of total standing crop contributed by the two most important species

n_1 and n_2 = Percentage of total population of total phytoplankton standing crop in the same series of sample.

Zooplankton were identified using the classical works of Wilson (1932), Rose (1933), Dakin and Colefax (1940), Davis (1955), Ward and Wipple (1959), Kasthurirangan (1963) and Wickstead (1965).

Results and Discussion

The result on Zooplankton diversity observed during the different seasons, Station 1 (Palar river), Station 2 (Palar estuary) and Station 3 (Kadalur Sea coast) during the present study (July 2009 to June 2010) is given in Table 1, Table 2 and Table 3. The percentage composition of Zooplanktons at different stations of the present study area according to the descending order are Station 1: Rotifera > Cladocera > Protozoa > Copepoda > Others, Station 2: Copepoda > Siphanophora > Rotifera > Polychaeta > Cladocera > Ciliata > Cirripeda > Others, Station 3: Copepoda > Ciliata > Hydrozoa > Rotifera > Amphipoda > Chaetognatha > Cladocera > Others. Others includes Mysidaceae, Curmaceae, Decapoda, Eucopipoda, Salps, Dolioids and larvae of other forms. Minimum and maximum percentage composition was recorded during monsoon and summer seasons at all the Stations.

At Station 1 zooplankton population density was recorded from 4,680 to 26,260 cells^{-1}. Minimum (4,680 cellsl^{-1}) was recorded during monsoon (November) season and the maximum (26,260 cellsl^{-1}) was recorded during the summer (June) season. At Station 2, Zooplankton population density varied from 11,260 to 53,250 cellsl^{-1}. Minimum (11,260 cellsl^{-1}) was recorded during monsoon (December) season and the maximum (53,255 cellsl^{-1}) was recorded during summer (June) season. At Station 3, Zooplankton population density varied from 6,840 to 36.420 cellsl^{-1}. Minimum (6,840 cellsl^{-1} was recorded during monsoon (November) season and the maximum (36,420 cellsl^{-1}) was recorded during the summer (May) season. In general, minimum and maximum Zooplankton population densities were recorded during monsoon and summer seasons respectively at all the stations.

Zooplankton diversity index (H') at Station 1 was minimum (2.76 bits/ind.) during monsoon season in December and the maximum (3.24 bits/ind.) during the Premonsoon season in August. At Station 2, minimum (3.61 bits/ind.) was recorded during post monsoon season in February and the maximum (5.26 bits/ind.) during the summer season in May. At Station 3, it was minimum (3.06 bits/ind.) during monsoon season in October and the maximum (4.39) during post monsoon season in January.

Minimum (0.57) zooplankton species richness was recorded during monsoon in November and the maximum (1.82) during summer in May at Station 1. Minimum (0.79) species richness was recorded during monsoon in October and the maximum (3.36) during summer in April at Station 2. Minimum (0.63) species richness was recorded during monsoon in December and the maximum (2.76) during summer in April at Station 3. In general, all the three stations recorded maximum values of zooplankton spcies richness during summer season.

Station 1 registered minimum (0.64) value of zooplankton species evenness during premonsoon (September) season and the maximum (1.90) during the summer (June) season. Station 2 registered minimum (0.84) value of species evenness during premonsoon (August) season and the maximum (1.00) during the summer (May) season. Station 3 registered minimum (0.76) value of species evenness during post monsoon (March) season and the maximum (1.00) during the summer (June) season. In general, maximum values of zooplankton species evenness, at all the stations, were recorded during summer season.

Zooplankton dominance index was minimum (6.22) during summer (May) season and the maximum (24.42) during monsoon (November) season at Station 1. Dominance index was minimum (10.66) during premonsoon (September) season and maximum (34.89) during summer (April) season at Station 2. Dominance index was minimum (8.47) during summer (May) season and maximum (32.06) during post monsoon (January) season at Station 3.

Zooplankton functions as intermediate link in the pelagic food-web. They transfer energy derived from the phytoplankton to the higher trophic levels. Investigation on the species composition, population density and community structure of the zooplankton is necessary to assess the potential fishery resources of a place. The rate of zooplankton production can be used to estimate the exploitable fish stock, while the population density of fish / eggs/ larvae will provide an index to define the breeding ground (Tiwari and Nair, 1991 & 1993). Species composition and distribution of zooplankton have been well studied from some tropical estuaries of India (Ananthan, 1990; Saraswathi, 1993; Krishnakumari and Goswami, 1993; Reddy, and Reddy 1994 and Santhakumari, 1999 and Vijayalakshmi et al., 1998).

Further higher population density as well as more number of copepoda species were observed when the salinity regime was high and relatively stable as reported by Mitra *et al*, (1990) from the Mandarmani creek of West Bengal. In addition, temperature, pH, DO, phytoplankton population density and gross primary productivity also exhibited a positive correlation with the zooplankthon population density at all the stations.

Low population density of Zooplanktons was observed during the monsoon season at all the stations. Occurrence of heavy flood during the monsoon season has changed the salinity regime and the environmental variables which in turn decreased the zooplankton density along with the phytoplankton population density.

Moreover uneven distribution of species density during this season revealed by the evenness index was also noticed due to the lowering of salinity and increased turbidity in the environment. Similar observations were also made by chandramohan *et. al,* (1999) from Kakinada Bay and Nair *et. al,* (1999) from Arabian Sea. Thus, high Zooplankton population density has been observed during the summer season and the low density was observed during the monsoon season due to the decisive role played by the monsoon flood as suggested by

santhakumari (1999) and Madhupratab (1987 & 1999). Variations in plankton abundance during other seasons could be attributed to the interaction of different environmental parameters. (Pillai,1994).

Maximum species diversity of zooplankton was recorded during summer. This was further facilitated by the occurrence of high zooplankton population density during this season. But during the monsoon season, the freshwater flow played a key role in altering the hydro biology of the marine and estuarine environments and caused a reduction of species number, thereby decreasing the density and diversity. This can be corroborated with the observations of Lara – Lara *et. al,* (1990) from Columbia estuary. Similar results have been reported by kumar (1991) from parangipettai waters, Nandan and Azis (1994) form kadinamkulam estuary and Goswami and Padmavathi (1996) from Goa waters.

Species diversity of Zooplankton of the estuarine environment was generally high and there was a progressive decrease in Zooplankton diversity from the estuarine environment to the nearshore environment, which maintained a higher density and evenness. In general, speneral, species diversity coincided with species richness and diversity increased with increasing richness of species as suggested by Govindasamy et. al, (1997) and Chandramohan et al. (1999).

Maximum evenness was recorded during the summer season at all the stations. Population density, Species diversity and Species richness values were high during the summer season along with high values of evenness index, suggesting the equal distribution of species during this season at all the stations. Maximum values of species dominance index were recorded during the monsoon season at all the stations revealing the unequal distribution of species. During the summer season when the zooplankton population density, Species diversity and species richness were maximum, the dominance index was low, suggesting the even distribution of the species

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Table 1 Phytoplankton observed during July 2009 – June 2010 at station 1

Parameters	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Annual Average
Phyto. Density	26240	18080	12920	14860	10110	8800	0	0	0	0	41440	23850	13.025
Sp. Diversity	3.12	2.9	2.54	2.48	2.66	2.80	0	0	0	0	3.02	3.93	1.956
Sp. Richness	1.83	1.44	1.2	1.12	0.93	1.27	0	0	0	0	2.06	1.9	0.979
Sp. Evenness	0.6	0.56	0.5	0.62	0.53	0.48	0	0	0	0	0.54	0.66	0.374
Dom. Index	18.04	14.92	16.16	12.11	11.08	10.64	0	0	0	0	6.82	10.81	8.381
GPP	0.53	0.85	0.88	0.54	0.48	0.33	0	0	0	0	0.17	0.26	0.336

Table 2 Phytoplankton observed during July 2009 – June 2010 at station 2

Parameters	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Annual Average
Phyto. Density	38880	42440	23990	18640	16230	22220	26860	1.3	0	0	48.8	24.7	128.37
Sp. Diversity	3.98	4.21	4.06	3.34	3.96	4.08	4.97	28.5	29.5	31.5	33.5	32.5	32.47
Sp. Richness	3.16	3.08	2.61	2.83	2.19	2.26	1.92	28.5	29.5	30.5	32	32	30.41
Sp. Evenness	0.82	0.86	0.19	0.88	0.8	0.780	0.84	23.4	28.92	30.07	32.67	30.87	19.92
Dom. Index	32.12	20.68	18.82	24.19	22.22	20.64	39.08	5.87	3.38	2.97	3.08	1.96	4.64
GPP	1.09	0.76	0.91	0.64	0.18	0.82	0.56	7.7	7.9	8.2	8.4	8.6	7.95

Table 3 Phytoplankton observed during July 2009 – June 2010 at Station 3

Parameters	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Annual Average
Phyto. Density	30070	24640	27040	22020	16400	11400	19670	28860	23230	40480	48160	36980	27.412
Sp. Diversity	4	3.62	3.46	3.22	3.08	3.46	3.26	3.86	3.94	4.83	4	4.44	3.76
Sp. Richness	2.06	1.46	1.68	1.23	1	1.46	2	1.98	2.26	2.82	2.64	2.96	2.027
Sp. Evenness	0.7	0.68	0.72	0.76	0.62	0.68	0.72	0.77	0.81	0.8	0.68	0.76	0.725
Dom. Index	12.84	14.92	10.96	18.94	22.16	18.18	20.12	23.23	18.62	12.26	8.22	10.08	15.877
GPP	0.42	0.86	0.5	0.44	0.68	0.13	0.56	0.89	0.06	1.20	1.19	1.1	0.67

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