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Zooplankton Diversity in River Thamiraparani, Kanyakumari District, Tamilnadu, India

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Abstract

Studies on zooplankton population of river, Thamiraparani water, Kanyakumari District, Tamilnadu from February 2009 to January 2010 was made to assess the zooplankton diversity. The quantitative evaluation of the variation in river water showed high quantity of zooplankton throughout the study period and rotifers formed dominated group than other groups of organisms. Results revealed the presence of various zooplanktons at large numbers in all four selected stations. The indices such as Shannon – Wiener index, Simpson index, Margalef's index, Menhinick index, Jaccard index, Sorensen index, Borger – Parker index of dominance were analyzed to assess zooplankton diversity in river water.

Keywords

Zooplankton, Diversity index, Thamiraparani river.

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1. INTRODUCTION

The diversity and distribution of zooplankton in any aquatic ecosystem mainly depend on the physico-chemical properties of water [1]. The nutrient and physico-chemical parameters of water body play significant role in governing the production of plankton which is the natural food of many species of fishes, especially zooplankton constitute important food source of many carnivorous and omnivorous fishes and also support the protein for the rapid growth of larval carps. Zooplankton respond immediately to aquatic environmental factors such as color, pH, taste and odour of freshwater for their life cycle, and are therefore used as indicators of pollution in a particular ecosystem. The dominance of zooplankton in shallow water bodies by cladocera, rotifers, and copepods varies according to the degree of pollution in the particular environment [2]. Hence, zooplankton can reflect the condition of aquatic environment and can be used to assess overall health. In any aquatic environment, the quantitative and qualitative and abundance of zooplankton in a river are of great importance for successful aquaculture management, as they vary from one geographical location to another and river to river within the similar ecological conditions and the same geographical location [3]. The report on ecology of zooplankton population from different parts of India is available [4]. The seasonal variations in diversity of zooplankton in a perennial freshwater lake and reservoir of the Tamil Nadu, India are reported [5]. The seasonal variation of plankton and their

relationship with physico-chemical parameters of water in Krishna Sager Lake, Burdwan, West Bengal was studied [6]. The availability of food resources in the aquatic ecosystem directly affects the abundance of phytoplankton. Moreover, zooplankton density and diversity mainly depends on the inter-specific predation by invertebrates. Cladocerans, rotifers, copepods are considered to be important species for measurement of biomass production, population density, grazing and nutrient degradation in freshwater ecosystem [7]. Diversity indices were used as very important tool by ecologist to monitor community structure in terms of evenness, richness or total number of existing individuals [8]. Eutrophication of freshwater ecosystems can significantly alter the structure of zooplankton communities. Changes in the aquatic ecosystem by anthropogenic pollution are a cause of growing concern and require monitoring of the waters and organisms inhabiting in freshwater environment. The structure and composition of zooplankton community were significantly affected by eutrophication [9]. Zooplankton do not only form an integral part of the lentic community but significantly contribute the biological productivity of the fresh water ecosystem. In recent years, many researchers analysed the zooplankton population in the freshwater ecosystem [10].

2. MATERIALS AND METHODS

2.1. Zooplankton collection

Zooplankton samples were collected monthly from the four stations of the river Tambraparani for a period of one year, February 2009 to January 2010. The collections were made early in the morning by using a standard plankton net (No. 25) with 30 cm mouth diameter and length of 1 m. 100 litre of water was filtered and the filtrate was put into clean labelled plastic containers. The volume of the concentrate was adjusted to 25 ml and it was preserved immediately with 4% formalin for further analysis.

2.2. Study Area

The present study was carried out in four different stations of Thamiraparani river, flowing along the southern Western Ghats (8° 31'27.1"N and 77'19.5.90"E). This river has two major tributaries with the Pechiparai Dam and Perunchani Dam respectively built across them at Kodayar and Paralayar. There are many tributaries for the Kodayar river of which Chittar river I and Chittar II, with their dams, are the major ones. The origin of Thamiraparani river is the Western Ghats and the river confluences with Arabian sea near Thengapattanam, about 56 km west of Kanyakumari town. The study area includes the Pechipparai Dam and four sampling stations were selected from MuthuKuzhivayal to Kuzhithurai in Kanyakumari District, Tamilnadu for assessing the water quality and to register the occurrence of phytoplankton, zooplankton and fishes, in Kodayar river the major tributary of River Thamiraparani.

2.3. Biological analysis

Zooplankton species identification was carried out using standard protocol and guidelines [11].

2.4. Diversity indices

Zooplankton population was subjected to various indices like, Shannon – Weiner index, Simpson Dominance index of diversity, Margalef index, Menhinick's index, Jaccard's index, Sorensen's index, Berger – Parker index in dominance and Hill diversity numbers were analyzed.

2.4.1. Shannon – Weiner index

$H = - Pi \log 2 Pi$

Where, H = Shannon – Weiner index

$$Pi = \frac{ni}{N}$$

= Sum Species diversity was calculated following Shannon – Weiner index (H) which depends on both the number of species present and the abundance of each species.

ni = Number of individuals of each species in the sample.

N = Total number of individuals of all species in the sample.

2.4.2. Simpson's diversity indices

Simpson's diversity index is used to measure biodiversity. Simpson diversity index takes into account the abundance of each species and number of species present as well.

$$D = \Sigma \frac{ni\,(ni - 1)}{N\,(N - 1)}$$

Where, ni = the total number of individuals of a particular species.

N = The total number of individuals of all species.

2.4.3. Margalef index

$Ma = S - 1 / Ln\ N$

Where,

'S' is the number of species

'N' is the number of individuals in the sample.

2.4.4. Menhinick's index

$$D = \frac{s}{\sqrt{N}}$$

where s equals the number of various species represented in the sample, and N equals total number of individual organisms in your sample.

2.4.5. Jaccard's Index:

$$S_j = \frac{a}{a + b + c}$$

Where,
S*j*= Jaccard's similarity coefficient,
a, b, c = presence-absence matrix

2.4.6. Sorensen similarity index

$$S_S = \frac{2a}{2a + b + c}$$

SS = Sorensen's similarity coefficient

2.4.7. Berger-Parker index of dominance:

Berger-Parker's index of dominance is simply the proportion of the most common species in the community or sample:

$D_{BP} = p_{max}$

2.4.8 Hill's diversity numbers

N*a*=1∑−−√(*a*−1)*pai*

3.1. RESULTS

3.2. Seasonal variation of zooplankton availability in Thamiraparani river

The abundance of zooplankton in three different seasons (premonsoon, monsoon and post monsoon) from all four stations was presented in Table 1-4. In station I, cladocerans was the dominant group (136 ± 12 individuals), which population further increased during monsoon season (209 ± 123 individuals) and post monsoon season (167 ± 17 individuals). Rotifer population was maximum (145 ± 6) during monsoon season and copepodans population was high during post monsoon season (147 ± 6). The ostracod population was maximum during pre-monsoon season (54 ± 4) and ciliate population was high during monsoon season (76 ± 7). In station II, copepods were the dominant species (153 ± 19) during pre-monsoon season, its population further increased as 212 ± 4 in monsoon season and 195 ± 6 in post monsoon season, respectively. In this station II, the maximum number of individuals was registered from rotifera, cladocera and copepod during monsoon season and was 256 ± 14, 230 ± 13, 212 ± 14, respectively. However, ostrocoda population was maximum during post monsoon season (58 ± 3) and ciliates population was maximum during pre-monsoon season (52 ± 6). In station III, copepodan population was high (168 ± 14) and the availability of cladocerans were low (117 ± 10) during pre-monsoon season. Copepodans remained dominant group during monsoon season and its population was 287 ± 12. In post monsoon season also, copepodan group remained dominant (243 ± 16) and low number of individuals (71 ± 5) was registered from ciliate groups. In station IV, during pre-monsoon season copepod population was 208 ± 29 and low number of individuals were registered from ostracoda group (37 ± 2). A large number of individuals was observed from copepods (414 ± 33 and 360 ± 17) during monsoon season and post monsoon season respectively (Fig. 1a and b).

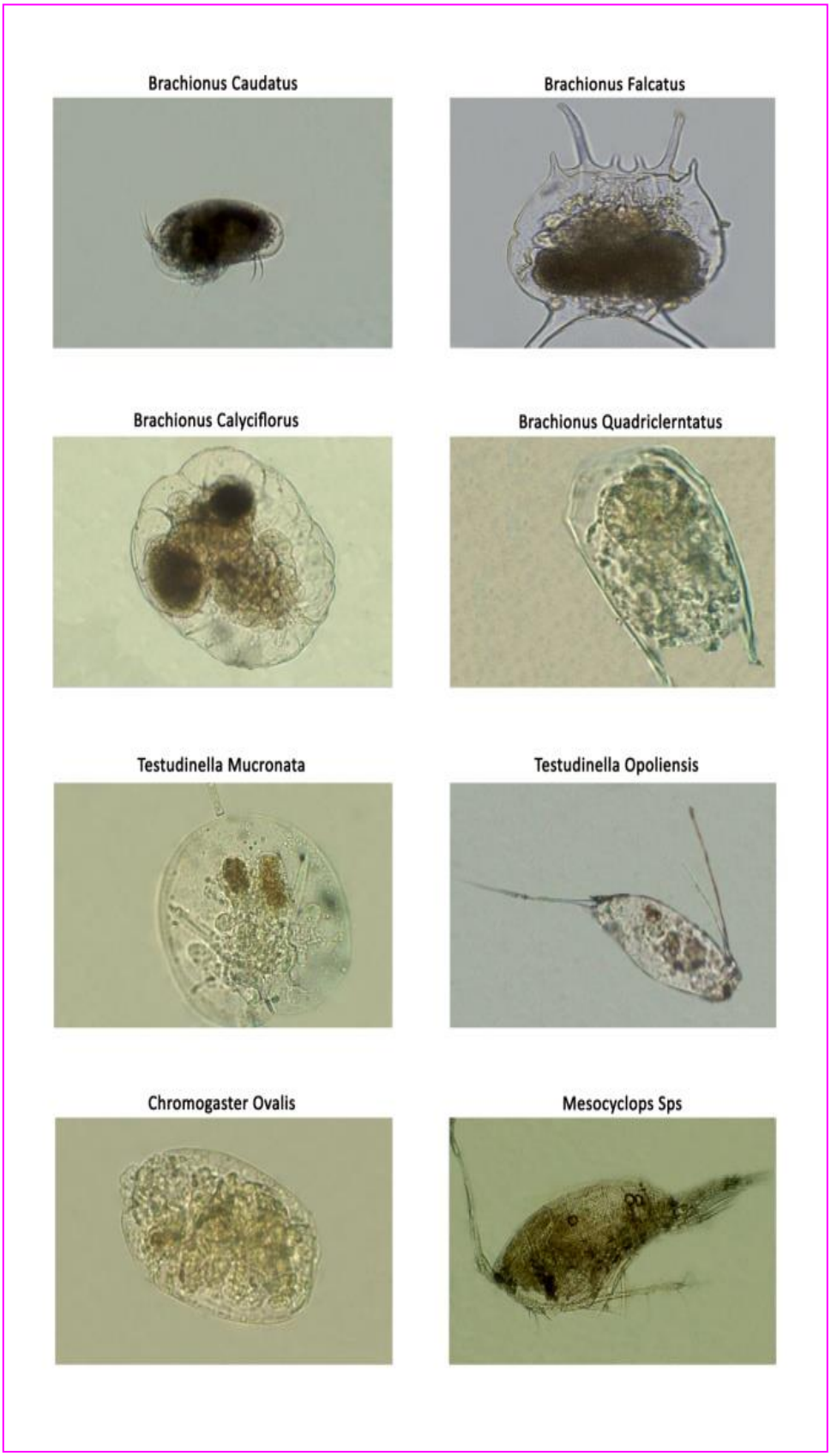

Fig. 1a. Identified Zooplankton from the study area during the study period

Fig. 1b. Identified Zooplankton from the study area during the study period

3.8. Diversity indices

The indices such as Shannon – Wiener index, Simpson index, Margalef's index, Menhinick index, Jaccard index, Sorensen index, Borger – Parker index of dominance were carried out and presented in Table 12. Species in station I, totally 396 number of individuals were observed during premonsoon season, which increased as 556±18 during monsoon season and further decreased as 525±18 during post monsoon. Shannon diversity index ranges from 1.52 to 2.11, and was maximum during post monsoon season. Simpson diversity index was maximum in station I (0.74) during monsoon season. Magalef richness varies from 0.63 to 0.66 and high value was obtained in station I and Berger-Parker index was ranges from 0.30 – 2.31. The Jaccard index was calculated as -1 and the Sorrensen's index was 1. In station II, number of individuals was found to be high during monsoon season (769 individuals). The average population size at this station II varies from 101.2 to 153.8 individuals. Shannon diversity index was maximum during premonsoon season (2.15) and was low during monsoon season (1.96). Simpson's diversity index was maximum (0.28) during monsoon season. Margalef richness index varies from 0.60 to 0.64 and Menhinick index was high during premonsoon season. The Berger-Parker index of dominance was 0.30, 0.33 and 0.31 during pre-monsoon, monsoon and post monsoon season, respectively.

Table 1. Comparison of Diversity indices of zooplankton of Thamiraparani river at three different season at station I.

Diversity index	Season		
	Pre monsoon	Monsoon	Post monsoon
No. of Zooplankton groups	5	5	5
Numerical abundance	396	558	525
Avg. population size	77.2	111.6	105
Shanon -Weiner index	1.52	2.08	2.11
Simpson Index	0.23	0.74	0.25
Margalef richness index	0.66	0.63	0.64
Menhinick Index	0.25	0.21	0.22
Jaccard Index	-1	-1	-1
Sorrensen Index	1	1	1
Berger-Parker index	0.34	0.37	0.31

Table 2. Comparison of Diversity indices of zooplankton of Thamiraparani river at three different season at station II.

Diversity index	Season		
	Premonsoon	Monsoon	Post monsoon
No. of Zooplankton groups	5	5	5
Numerical abundance	506	769	666
Avg. population size	101.2	153.8	133.2
Shanon -Weiner index	2.15	1.96	2.08
Simpson Index	0.24	0.28	0.26
Margalef richness index	0.64	0.6	0.61
Menhinick Index	0.18	0.19	0.18
Jaccard Index	-1	-1	-1
Sorrensen Index	1	1	1
Berger-Parker index	0.3	0.33	0.31

Table 3. Comparison of Diversity indices of zooplankton of Thamiraparani river at three different season at station III.

Diversity index	Season		
	Pre monsoon	Monsoon	Post monsoon
No. of Zooplankton groups	5	5	5
Numerical abundance	736	848	588
Avg. population size	147.2	169.6	117.6
Shanon -Weiner index	2.31	2.21	2.12
Simpson Index	0.2	0.23	0.26
Margalef richness index	0.61	0.59	0.63
Menhinick Index	0.18	0.17	0.21
Jaccard Index	-1	-1	-1
Sorrensen Index	1	1	1
Berger-Parker index	0.24	0.34	0.41

Table 4. Comparison of Diversity indices of zooplankton of Thamiraparani river at three different season at station IV.

Diversity index	Season		
	Premonsoon	Monsoon	Post monsoon
No. of Zooplankton groups	5	5	5
Numerical abundance	499	766	586
Avg. population size	99.8	153.2	117.2
Shanon -Weiner index	2.04	1.81	1.7
Simpson Index	0.28	0.36	0.42
Margalef richness index	0.64	0.6	0.63
Menhinick Index	0.22	0.18	0.21
Jaccard Index	-1	-1	-1
Sorrensen Index	1	1	1
Berger-Parker index	0.42	0.54	0.61

In station III, the total number of individuals analysed were 736, 848 and 588, respectively during pre-monsoon season, monsoon season and post monsoon season respectively. The average population size was maximum during monsoon season (169.6). Shannon index was maximum during premonsoon season (2.31) and further decreased as 2.21 and 2.12 during monsoon and post monsoon season respectively. Simpson index was found to be high during post monsoon season and Margalef richness index was high during this post monsoon season (6.3). The Menhinick index was calculated as 0.21 during post monsoon season. Berger-Parker index of dominance was 0.24, 0.34 and 0.41, during pre-monsoon, and post monsoon season, respectively. In station IV, the number of individuals observed was 499, 766 and 586 during pre-monsoon season, monsoon season and post monsoon season, respectively. Shannon index was calculated as 2.04 during pre-monsoon season and decreased as 1.81 and 1.7 during monsoon and post monsoon season. Simpson's index was found to be maximum during post monsoon season. Margalef richness index ranges from 0.60 to 0.64 and Menhinick index was maximum (0.22) during premonsoon season. Berger – Parker index of dominance was 0.42, 0.54 and 0.61 during premonsoon season, monsoon season, and post monsoon season, respectively.

4.1. DISCUSSION

Rotifers play a critical role in the trophic tiers of freshwater impoundments and serve as living capsule of nutrition [12]. Taxonomic dominance of these *Brachionus* sp. has been reported in various water bodies. In the present study, rotifers population was found to be high during monsoon season in all stations. Anad, its population was comparatively high during post monsoon season. The increased population was reported during summer months also. This result was according the observations made previously. The number of rotifers increased in summer which may be due to the higher population of bacteria and organic matter of dead and decaying vegetation [13]. The

dominance of rotifer population in freshwater system which was due to its preference for warm waters. Since the rotifers have short life cycle they increase in abundance rapidly under favourable environmental conditions [14]. Sinha and Sinha [15] reported high rotifer population in summers because of high temperature, higher values of chlorides, nitrates and phosphates in summer season. *Brachionus calciformis* was frequently observed during all stations and this species is considered to be the indicators of eutrophication. The large number of rotifer in the ecosystem may be attributed to its dependence on detrital matter and phytoplankton for it nutritional source. Dominance of Cladocerans among zooplankton as recorded in the present study is in accordance with earlier finding [16].

In the present study, cladocera represented by 5 families 5 genera and 5 species. Baig and Khan [17] earlier described the availability of four genera of Cladocera family. Manickam et al. [5] have recently reported the presence of seven species of Cladocera in the Haledharmapuri lake in Dharmapuri District, Tamilnadu. Sivakumar and Altaff [18] reported seven species of Cladocera from the fresh water environment, Dharmapuri District, Tamil Nadu. In the present study, cladocera population was found to be maximum during monsoon season. Manickam et al. [5] observed the variation of cladocerans population on the basis of food availability. The species *Ceriodaphnia cornuta* occurred almost all stations. In Thigra Reservoir in Gwalior (M. P.), cladocera was identified as the minor zooplankton group. In the present study, *Ceriodaphnia cornuta* was found to be high in this river. This result was in accordance the observation made with other freshwater systems. Balakrishna et al. [19] reported that the genus *Ceriodaphnia* was the most important zooplankton in oligotrophic lakes especially the species *Ceriodaphnia cornuta. Moina micrura*, *C. sphaericus*, *L. acanthocercoides* and *S. crystalline* were second, third, fourth and fifth dominant species respectively. In the present study, totally five species of ostracoda were recorded. The ostracoda population was high in station IV and station I. However, these organisms were not found in the other stations. It was previously reported that the availability of ostracoda population was high during the monsoon month at Haledharmapuri Lake, Dharmapuri Town [5]. Sunkad and Patil [20] reported maximum Ostracoda population in summer season at Fort Lake in Belgaum (Karnataka). This result was in accordance the observations made by Kedar et al. [21] in Rishi freshwater lake of Washim district. This result has also been observed by Sukand and Patil [20] in Fort Lake of Dharwad district. In the freshwater ecosystem, zooplankton population varies monthly. Heavy rainfall might be due to the critical reason for this fluctuation [22]. The dominance of rotifers and copepodes over the other groups of zooplankton observed in the present study has also been reported earlier in various rivers [23].

In the present investigation, the Ostracoda fluctuated monthly and this result was in accordance the observations made with Shekhar et al. [24]. Sousa et al. [25] reported changes in water quality of aquatic environment have significant effect on structure of zooplankton population that can potentially affect the functioning of freshwater ecosystem. The distribution of zooplankton population in a particular ecosystem is also affected by physicochemical parameters. Copepods breed throughout the year, can tolerate wide fluctuations in environmental conditions. Hence the copepod population was high in the present investigation.

Various indices such as Shannon - Wiener index, Simpson index, Margalef's index, Menhinick index, Jaccard index, Sorensen index, Borger – Parker index of dominance were applied to analyse the zooplankton population. Species diversity indices of zooplankton population are highly useful to analyse the quality of freshwater with respect to domestic, municipal and industrial pollution [26]. Balloch et al. [27] stated that the diversity index (Shannon's) to be a suitable indicator for water quality assessment. Mukherjee [28] reported that the higher species richness was characterized by larger food chain. Zooplanktons are generally registered as the bioindicators in freshwater ecosystem. Hence, the studies on zooplankton with special reference to the diversity will help to monitor the health of freshwater ecosystem. In the present study, an attempt was made to analyse the diversity of zooplankton from Tambraparani river from Feb 2009 to Jan 2010. The qualitative observation revealed that totally 42 species of zooplankton belonging to rotifera, cladocera, copepod, ostracoda and ciliate. Among zooplankton groups, rotifera, cladocera, copepod was very common in this river. Ostracoda and ciliate were recorded in very less quantity. The increase in biodiversity is a good indication of the very healthier environment and low density of zooplankton suggested dominance of fewer species because of sewage environmental stress. The zooplankton groups such as rotifer, cladocera and copepod were the major groups. The zooplankton analysis was carried out in four different stations along the river Tambraparani. Results revealed

varieties of zooplankton diversity. In station I, Shannon diversity index was maximum (2.11) during post monsoon season and minimum (1.52) in pre monsoon season. However, Shannon diversity index was maximum during premonsoon season in all other three stations and the indices were 2.15, 2.31 and 2.04 respectively, in Station II, III and IV. The Simpson's index was calculated in the range between 0.20 and 0.74 during pre-monsoon season in station III and monsoon season in station I. The Menhinick index value was found to be maximum (0.25) during premonsoon season in station I and minimum (0.17) during monsoon season. Margalef richness was analysed to be maximum (0.66) during the premonsoon season in station I and minimum (0.59) during monsoon season in station III. Berger-Parker index of dominance of zooplankton varies from 0.24 to 0.61 in station III and IV. The low degree of dominance index was observed in premonsoon season and high degree of dominance index was registered during post monsoon season. Analysis of zooplankton community structure revealed that Shannon – Wiener diversity index was maximum (2.31) during pre-monsoon season, Simpson index in monsoon season (0.74), Margalef richness (0.66) and Menhinick index (0.25) in premonsoon season, Berger – Parker index (0.61) was observed in post monsoon season. Simpson, Margalef and Menhinick index were high in station I. This is because of unpolluted water in this station.

CONCLUSION

Zooplankton is one of the necessities to evaluate fresh water reservoir in respect to their ecological and fisheries status. The qualitative analysis of zooplankton from the freshwater ecosystems revealed the presence of Rotifera predominantly. The dominance of zooplankton species is highly variable in different stations of river according to nutrient levels, predator and other environmental factors which then affects the other biotic components of the ecosystems.

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