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Zooplankton Community Structure During the Different Seasons of a Year in a Fresh Water System in Tamil Nadu, India

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A B S T R A C T

The biotic component of an aquatic ecosystem is strongly related to diversity, abundance and seasonality of zooplankton. They play an important role in an aquatic food chain as they are consumed by most fishes and other organisms. Hence the present study was aimed at analyzing the zooplankton community structure during the different season of a year in a fresh water system at Ayilapettai, Tiruchirappalli District in Tamil Nadu, India. A total of 26 zooplankters would be identified belonging to four groups. Of these four groups, Rotifer dominated (15 species) followed by Copepoda and Cladocera (4 species each) and Ostracoda (3 species). Of the three seasons, the highest group count was recorded in the summer season. Individually, rotifers, cladocerans and copepods recorded highest counts during the summer season. While ostracods recorded their highest counts during the winter/rainy season. The abundance and diversity appeared to increase with diversity values. The growth and composition of zooplankton were defendant on physic chemical variables, nutrients and local environmental conditions.

***Key words*:** Fresh water system, Physico-Chemical variables, Zooplankton, Community structure

Fresh water ecosystems provide vital resources for humans and are the sole habitat for a rich, endemic and sensitive biota which constitute a larger part of our biosphere [1]. In an aquatic system, zooplankton are one of the best indicators of water quality [2] as they react to changes in water quality by changing their species composition, abundance and by morphological abnormalities [3]. Zooplankton is an important component of the aquatic systems that are involved in the transformation of organic matter and energy fluxes [4]. Zooplankton plays an important role in an aquatic food chain as they are consumed by most fishes and other organisms [5].

The biotic component of an aquatic system is strongly related to diversity, abundance and seasonality of zooplankton [6]. Zooplankton diversity and density has been reported to vary depending on the availability of nutrients, stability of water and it physico chemical properties and local environmental conditions [7-8]. Hence the present study was aimed at assessing the zooplankton diversity in A fresh water Pond situated at Ayilapettai in the outskirts of Tiruchirappalli District, Tamil Nadu, India, during the three seasons of the year.

MATERIALS AND METHODS

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Physico-chemical variables

Water samples were drawn from surface and bottom and stored in separate polyethylene bottles for later analyses in the laboratory. While some physico-chemical variables [dissolved oxygen (DO), hydrogen-ion- concentration (pH), free carbon dioxide (free CO_2), phenolphthalein alkalinity (PPA) and methyl orange alkalinity (MOA)] were analyzed in the field itself, the others were analyzed in the laboratory. Duplicate samples of all variables were taken and analyzed and the average values taken.

The atmospheric, surface and bottom water temperatures were measured using a mercury thermometer calibrated to 100 °C. Atmospheric temperature was measured in shade, while surface water temperature was analyzed by taking the surface water in a container and then measuring it. Bottom water temperature was recorded by using a Friedinger's water sampler. The water level of the pond was measured using a graduated rope provided with weight at one end. The measurement was done on every sampling day at a particular spot. The transparency of the water column was measured using a Secchi's disc method [9]. Free carbon dioxide (free CO_2) alkalinity (phenolphthalein and methyl orange) and total dissolved solids (TDS) were determined according to Saxena [10], while pH was measured with a digital pH pen (Hanna) and electrical conductivity using a water analysis kit. Nutrients like phosphate, silicate, ammonia-nitrogen, nitrite-nitrogen, sulphate, calcium and magnesium were estimated according to APHA [11]. Nitrate-nitrogen (NO_3-N) was estimated after Mackereth [12] and chloride after Strickland and Parsons [13]. While oxidizable organic matter,

nitrogenous organic matter and suspended solids were done following APHA [14], Trivedy and Goel [15], biological oxygen demand (BOD) was estimated following the procedure of Sawer and Bradney [16] and chemical oxygen demand (COD) as per Moore *et al.* [17].

Zooplankton analysis

The zooplankton net was of 270 mesh sieve (pore diameter 20-30 µm). The zooplankton was fixed immediately with 4% formalin for further microscopic analyses. The counting of zooplankton was done using a Sedgwick-Rafter cell [18]. Identification of plankters was done after Clegg [19], Edmondson [20], Hutchinson [21], Michael [22], Pennak [23], APHA [11], Sridharan [24]. After identification of plankters, useful indices of species structure in communities as detailed by Odum [25] were also calculated.

RESULTS AND DISCUSSION

The various physico chemical variables that were analyzed during the three seasons of the year are presented in (Table 1). As evident from the data, the atmospheric temperature in the vicinity of the pond was found to range from 25.5 °C (winter/rainy season) to 29.5 °C (Summer season) with an overall average of 28.45 °C during the period of study. Water temperature also followed the pattern of atmospheric temperature ranging from 23.5 °C (winter/rainy season) to 26.5 °C (summer season) with an overall average of 24.85 °C during the period of study. Water temperature also was always on the lower side when compared to atmospheric temperature. pH was alkaline throughout ranging from 7.33 (rainy/winter season) to 8.2 (summer season) with an average of 7.76 during the period of study. Salinity on the other hand, was found to vary from 1.8 ppt (winter/rainy season) to 3.2 ppt (summer season) with an average of 1.76 ppt during the study period. Dissolved oxygen levels ranged from 5.3 to 6.7 mg/l with an average of 6.06 mg/l. The minimum DO level was noticed in summer and the maximum in winter/rainy season. Total Dissolved Solids oscillated between 163 mg/l and 182 mg/l (average of: 170.33 mg/l) with the minimum level recording in winter/rainy season and the maximum in the summer season. Electrical conductivity ranged between 162 µmhosm/cm (summer) to 178 (pre summer) with an average of 170 µmhosm/cm.

Table 1 Physico-chemical characters of water - pond

Parameters	Units	Pre-summer season	Post-summer season	Winter/Rainy season	Overall average	F-value
Atmospheric temperature	°C	27.5±0.24	29.5±0.64	25.5±0.42	28.45	3.2
Water temperature	°C	24.5±0.56	26.5±0.52	23.5±0.32	24.83	2.3
pH		7.8±0.26	8.2±0.70	7.33±0.26	7.76	8.3
Salinity	%	2.4±0.66	3.2±0.68	1.8±0.46	2.46	12.4
DO	mg/l	6.2±0.07	5.3±0.78	6.7±0.45	6.06	7.8
TDS	mg/l	166±0.98	182±0.50	163±0.52	170.33	11.6
EC	µmhosm/cm	1.78±0.78	1.62±0.46	1.72±0.26	1.70	11.6

Table 2 List of zooplankton collected from the selected pond

S. No.	Name	Pre-summer season	post-summer season	winter/rainy season
1	*Brachionus angularis*	+	+	+
2	*Brachionus calyciflorus*	+	+	+
3	*Brachonus quadridentatus*	+	+	+
4	*Keratella procura*	+	+	+
5	*Brachionus folculus*	-	+	+
6	*Filinia longiseta*	-	+	-
7	*Notholca acuminata*	-	+	-
8	*Asplanchna seboldi*	+	+	+
9	*Cephalodella forficula*	+	+	-
10	*Colurella adriatica*	+	+	-
11	*Lecane bidentata*	+	+	-
12	*Lecane depressa*	-	+	+
13	*Lepadella patella*	-	+	-
14	*Notomata copeus*	+	-	-
15	*Trichocerca tigris*	+	+	-
		II. Copepoda		
16	*Heliodiaptomus viduus*	+	+	+
17	*Eucyclops speratus*	+	+	-
18	*Mesocyclops hyalinus*	+	+	+
19	*Mesocyclops leuckarti*	-	+	+
		III. Ostracoda		
20	*Cypris protubera*	+	+	+
21	*Eucypris bispinosa*	-	-	+
22	*Cyprinus nudus*	+	+	+
		IV. Cladocoda		
23	*Diaphanosoma sarsi*	+	+	+
24	*Daphnia carinata*	+	+	-
25	*Ceriodaphnia cornuta sars*	+	+	+
26	*Moina micrura*	+	+	+

Thus, the present study reveals that atmospheric temperature water temperature, pH, salinity and TDS registered the same pattern of recording minimal levels during winter/rainy season and maximal levels during the summer season. On the other hand, DO recorded minimal levels in summer and maximum levels in winter/rainy season. However, EC recorded minimal level in summer and maximal level in pre summer season.

The various zooplankter's that were recorded during the period of study are recorded in (Table 2). A total of 26 zooplankters belonging to four groups (Rotifera, Copepoda, Ostracoda and Cladocera) were identified. Among the various groups, Rotifera was represented by 15 species belonging to 11 genera. The genus *Brachionus* was represented by 5 species and the genus *Lecane* was represented by 2 species. The remaining species were represented by a single genus.

A season wise comparison revealed that the summer season recorded 14 of the 15 rotiferan species. The species that was not recorded in the summer season was *Notomata copeus*. Pre summer season recorded 9 rotiferan species and the winter/ rainy season recorded only 7 species. Thus, rotifer in general appeared to prefer the summer season. Rotiferan density (Table 3) reveals that the maximum rotiferan count was indeed recorded in the summer season followed by the pre summer and there by the winter/rainy season. Nevertheless, there were 5 perennial species (*B. angularis, B. calyciflorus, B. qadridentata, Keratella procura* and *Asplanichna seboldi*) that were recorded in all the three seasons of the year.

Table 3 Population density of zooplankton - pond

Plankton class count	Pre-summer season (i/l)	Summer season (i/l)	Winter/Rainy season (i/l)	Overall average (i/l)	F-value
Rotifera	1860±0.78	2843±0.64	2185±0.28	2296	44.5
Cladocera	1183±0.68	1496±0.42	1056±0.46	1245	62.4
Copepoda	1027±0.64	1236±0.76	989±0.64	1084	24.2
Ostracoda	638±0.76	842±0.64	927±0.72	802	82.4
Total count	4708	6417	5157	5427	

Copepoda were represented by 4 species belonging to 3 genera during the period of study. Of these, 2 species were perennial (*Heliodiaptomus viduu* and *Mesocyclops hyalinus*). Copepoda also recorded the highest counts during the summer season followed by pre summer and winter/rainy season.

Cladocera was also represented by 4 species each belonging to a different genus. Of the 4 species, again 2 species were perennial (*Diaphanosoma sarsi* and *Ceriodaphnia cornuta*). Cladocera also recorded their highest counts during the summer season followed by pre summer and winter/rainy season.

Ostracoda was represented by 3 species of which 2 were perennial (*Cypris protubera* and *Cyprinus nudus*). Ostracoda recorded their highest counts during the winter season followed by summer and pre summer season.

A perusal of literature reveals that the density and diversity of zooplankton vary according to the immunological characteristics and the trophic state of fresh water bodies [26]. Nevertheless, many workers have recorded rotifers as the predominant group of zooplankton found in a majority of fresh water systems constituting more than 60% of the zooplankton [27-30]. Thus, the present study is in line with the observation of other workers. In the present study, the genus *Brachionus* was the dominant form among rotifers similar instances of *Brachionus* being the dominant genera among rotifers were also observed by others [31-32]. According to Sladecek [33], the genus *Brachionus* is considered as an index of eutrophic waters while Nogueira [34] suggested that abundance of *Brachionus* is a biological indicator of eutrophication. Nevertheless, Sampaio *et al.* [35] regarded *B. calyciflorus* as an indicator of eutrophication. Based on these observations, the system under study can be classified as eutrophic.

Cladocerans and Copepods were also found to dominate during the summer season. The system recorded the presence of *Heliodiaptomus, Mesocyclops, Daphnia* and *Moina*. According to Dhanasekaran *et al.* [36]. The presence of these species in the system suggests that the system is eutrophic [37-40].

Table 4 Diversity indices of zooplankton - pond

Plankton group	Diversity indices	Pre-summer season (i/l)	Summer season (i/l)	Winter/Rainy season (i/l)	F-value
Rotifera	Dominance D	1.60	1.81	1.20	2.4
	Shannon H	0.212	0.284	0.174	6.4
	Evenness eH/s	2.30	2.42	2.06	3.6
	Margalef R1	0.64	0.7	0.46	5.2
Cladocera	Dominance D	1.62	1.80	1.26	2.5
	Shannon H	0.22	0.28	0.12	0.8
	Evenness eH/s	1.46	1.64	1.23	0.9
	Margalef R1	0.64	0.82	0.26	2.6
Copepoda	Dominance D	1.34	1.44	1.22	3.4
	Shannon H	0.72	0.84	0.64	3.2
	Evenness eH/s	1.26	1.46	1.14	6.78
	Margalef R1	0.64	0.84	0.54	5.64
Ostracoda	Dominance D	0.26	0.32	0.36	2.24
	Shannon H	1.26	1.54	1.64	6.36
	Evenness eH/s	0.72	0.76	0.94	8.78
	Margalef R1	0.62	0.40	0.70	6.2

Among the zooplankton, the group Ostracoda recorded the lowest counts [41-42]. In the present study, Ostracods recorded their highest count in the winter/rainy season [30]. According to Dhanasekaran *et al.* [36] the presence of *Cypris sp* indicate eutrophication. Based on the report, the system under study can also be termed as eutrophic.

The various indices of zooplankton diversity are presented in (Table 4). In the present study, the abundance and density appeared to increase with the diversity values. According to Odum [43] diversity is directly related to abundance or equitability. Among the various groups, Ostracods recorded the lowest density. Species diversity is reported to be influenced by the functional relationships between the trophic levels as suggested by Sivakumar and Altaff [44]. According to Odum [43], the amount of predation greatly affects the diversity of prey population.

In general, the summer season recorded the highest density and diversity. During summer, the high temperature enhances the rate of decomposition due to which the water becomes enriched with nutrients which would have resulted in abundance of food as suggested by Sitre [30]. In addition, the physico-chemical variables (Table 5) and quality of nutrients also play an important role in distribution patterns and species composition of plankton [45]. All these factors would have influenced the diversity and density of zooplankton. However, Welch [46] suggested that fluctuation in plankton population is a general phenomenon in fresh water impoundments.

Table 5 The relationship between physico-chemical characters and zooplankton - pond

Parameters	R	R^2	Correlation
Atmospheric temperature	0.94	0.76	Positive
Water temperature	0.92	0.84	Positive
pH	0.48	0.34	Positive
Salinity	0.66	0.48	Positive
DO	0.38	0.28	Positive
TDS	0.98	0.76	Positive
EC	0.72	0.92	Positive

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