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Seasonal Variations in Diversity and Dynamics of Zooplankton in Kuttanad River

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Abstract Kuttanad is one among the unique wetland ecosystem in the country where human impact is severe which alter the structure, function, composition and services of the ecosystem. The present study has been conducted to analyse the zooplankton community structure of Kuttanad river. Kerala, India. Water samples were collected between 7.00 am and 9.00 am every month from January to December 2015. The months were divided into different seasons such as summer (January, February and March); pre monsoon (April, May and June); monsoon (July, August and September) and post monsoon (October, November and December). The average of monthly data was taken for representing the seasonal data. The seasonal fluctuations in the diversity and dynamics of zooplanktons comprised of 46 species belonging to Protozoa (11 sps.), Rotifera (16 sps.), Cladocera (12 sps.) and Copepoda (7 sps.). The larvae and other forms were also considered. Cladocerans showed dominance both in number and diversity, followed by Copepods, Rotifers and Protozoa. This study also reveals that different groups of zooplanktons have their own peak periods of density, which is affected by the seasonal variations. The difference in the number of zooplankton species in this study may be attributed to the time of sampling and the dynamic nature of aquatic systems.

Keywords Kuttanad, Veeyapuram, Thiruvanvandoor, Zooplankton.

Introduction

Aquatic life depends directly or indirectly on planktonic populations. Zooplanktons are cosmopolitan minute aquatic animals, non-motile or very weak swimmers, contribute significantly to biological productivity of freshwater ecosystem, serve as good indicators of changes in water quality and helpful for ameliorating polluted waters. Zooplanktons also help to determine the quantum of fish stock and the failure of fishery resources. Hence, the zooplankton communities, based on their quality and species diversity, are used for assessing the productivity of fishery resources, fertility and health status of the ecosystem. The zooplankton community is represented by het-

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erogeneous groups of organisms of varying size and belonging to different phyla of animal kingdom. Over 70% of total zooplankton constituted by primitive crustaceans belonging to the order, Copepoda of the phylum, Arthropoda. The order Copepoda comprised of three sub-orders viz., Calanoida, Cyclopoida and Harpacticoida [1]. Any study concern with ecological community structure is dependent on accurate information on the distribution and abundance of the species making up the community. Investigations of freshwater zooplankton community structure have significant potential for assessing aquatic ecosystem health. Their dominance and seasonality are highly variable in different water bodies according to nutrient status, age, morphometry and other locational factors. Therefore changes in aquatic environment accompanying anthropogenic pollution are a cause of growing concern and require monitoring of surface waters and organisms inhabiting them.

The famous rice bowl of Kerala has now become the poison bowl, mainly due to intensive agricultural practices, unscientific establishment of various developmental projects and the sheer lack of proper sanitary facilities and waste water management. Due to rapid industrialization and human population growth the chences of an aquatic system being polluted are great. The physico-chemical characteristics are greatly affected due to discharge of domestic, industrial effluents and several other factors during day in and day out. The effluents of distillery units have been found quite obnoxious creating the serious problem of water pollution, leading to the damage of the flora and fauna of the water bodies. The near total absence of a comprehensive study involving plankton in Kuttanad waters and the progressive bio deterioration in and around Kuttanad, the need of a scientific and eco-friendly approach, need for revitalizing the agriculture as well as the fishery potential. Hence, the present study was carried out to understand the diversity and seasonal variation of zooplanktons in Kuttanad river system.

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Materials and Methods

Study area

Kuttanad, the land of agriculture is a unique wetland of Kerala, (lat 9º8´, 9º52´ and long 76º19´, 76º44´), a highly complex ecosystem with a total area of about 1157 sq km comprising 66,048 ha of wetlands, 31,086 ha of dry garden lands, and 18,623 ha of backwaters known as Vembanad Lake. The two deltaic formation, one at the confluence of the three river systems namely–Achenkovil, Pampa and Manimala, and the other of the Meenachil River, constitute the core area of Kuttanad, which is a recent sedimentary formation. Most of the land in this area is paddy field which is subjected to agricultural operations twice or thrice a year. The land scape includes six agro-ecological zones namely, Upper Kuttanad, Lower Kuttanad, North Kuttanad, Lake lands, Vaikom and Purakkad Kari. Most of the areas in Kuttanad are water logged almost throughout the year. The garden lands are one meter above the sea level which is formed by the deposition of alluvium. The wet lands 0.5 to 2m below the sea level are reclaimed for rice cultivation. Two areas were selected for the present study. They were as follows.

Veeyapuram

In this station the Achencovil River meets and merges with Pampa river in Alappuzha district and 6 km East of Harippad town. It is located at latitude 9º 19´ 29.07´ N and longitude 76º27´ 54.31´ E with an elevation of 6 ft above MSL.

Thiruvanvandur

In this station the Manimala River meets and merges with Pampa river in Alappuzha district. It is located at latitude. Coordinates: 9º20´ 35.56´´ N and longitude 76º 34´ 43.47´´ E with an elevation of 6 ft. above MSL.

Sampling and analysis

Water samples were collected between 7.00 am and 9.00 am every month from January to December 2015. The months were divided into different seasons such as summer (January, February and March); per mon-

Table 1. Density and percentage-zooplankton species collected from Kuttanad rivers. *Average of three sample values in each months in a season; SI=Station I-Veeyapuram; SII=Station II-Thiruvanvandoor.

	Seasons/Stations							
	Summer		Pre Monsoon		Monsoon		Post Monsoon	
Zooplankton	S I	S II	S I	S II	S I	S II	S I	S II
Protozoa								
Amoeba	2	2	4	3	1	3	2	3
Arcella	3	4	4	2	2	3	4	3
Bursaria	2	2	2	4	3	4	1	4
Chillodenella	2	3	4	2	1	2	4	2
Diffugia	2	3	2	3	3	0	3	3
Paramecium	2	3	3	4	4	4	3	4
Slentor	3	1	3	2	3	1	3	3
Spirostomum	2	3	3	2	2	0	2	2
Total	18	21	25	22	19	17	21	24
Percentage	11.92	13.72	17.24	15.71	19.59	20.24	11.93	13.56
Rotifera								
Ascomorpha	1	2	1	1	1	1	3	4
Asplanchna priodonta	3	1	3	0	3	0	3	2
Branchionus angularis	0	3	2	2	1	2	2	2
Branchionus calyciflorus	6	5	2	3	0	2	2	3
Branchionus caudatus	3	2	1	2	1	2	1	2
Branchionus falcatus	1	4	4	1	3	0	4	1
Cocconeis	0	0	2	2	2	2	0	2
Diacranophorus	1	4	4	1	2	1	4	2
Keratelia quadrata	0	5	3	2	3	2	3	2
Keratella tropica	1	0	2	1	2	1	2	1
Lecane bulla	3	3	1	3	0	1	1	3
Philodina	4	0	2	4	1	2	2	4
Pterodina	2	4	1	2	2	1	1	2
Sinantheria	0	2	3	1	1	2	3	2
Testudinella patina	3	1	0	3	2	1	0	3
Trichocerra rattus	4	0	1	2	1	0	3	2
Total	32	36	31	30	23	20	34	37
Percentage	21.19	23.53	21.38	21.43	23.71	23.81	19.32	20.90
Cladocera								
Ceriodaphnia cornua	4	3	4	5	2	1	6	7
Daphnia carinata	5	4	5	4	1	2	5	6
Bosmina longirosiris	2	3	5	3	2	1	6	6
Bosmina fatalis	3	2	3	5	1	1	5	5
Moina micrura	1	2	4	5	1	2	5	5
Chydorus ventricosus	4	4	4	4	2	3	6	6
Alona quadrangularis	5	3	5	3	2	1	5	5
Alona rectangular	4	4	4	4	4	2	6	4
Alona verrucosa	5	3	5	5	1	1	5	5
Macrotrix spinosa	4	6	4	6	4	2	6	6
Cypris	4	4	5	4	4	1	5	4
Calanus	5	6	5	6	1	2	6	6
Total	46	44	53	54	25	19	66	65
Percentage	30.46	28.76	36.55	38.57	25.77	22.62	37.50	36.72
Copepoda								
Mesocyclops leuckarti	5	5	3	3	3	3	6	5
Mesocyclops hyalinus	5	6	5	6	5	3	6	7
Trophocyclops prascinus	6	4	5	4	3	5	8	7
Eucyclops serrulatus	7	6	3	4	3	4	6	7

Table 1. Continued.

Zooplankton	Seasons/Stations							
	Summer		Pre Monsoon		Monsoon		Post Monsoon	
	S I	S II	S I	S II	S I	S II	S I	S II
Microcyclops varicans	8	7	7	5	4	3	9	6
Filipinodiaptomus insulanus	7	8	5	5	3	5	8	8
Total	44	41	32	31	23	25	51	48
Percentage	29.14	26.80	22.07	22.14	23.71	29.76	28.98	27.12
Larvae								
Nauplius	3	2	2	1	3	1	1	1
Zoea	2	4	0	0	1	0	0	0
Mysis	1	0	1	0	0	0	1	0
Nymph	3	3	1	1	0	0	1	1
Others	2	2	0	1	3	2	1	1
Total	11	11	4	3	7	3	4	3
Percentage	7.28	7.19	2.76	2.14	7.22	3.57	2.27	1.69
Grand Total	151	153	145	140	97	84	176	177

soon (April, May and June); monsoon (July, August and September) and post monsoon (October, November and December). The average of monthly data was taken for representing the seasonal data. For qualitative and quantitative studies of zooplankton 100 liters of surface water was passed through the plankton net number 120µ. The collected samples were preserved in 4% formalin solution, observed, identified and counted with the help of Sedgwick Rafter Cell method [2]. Average 5 to 10 counts for each sample were taken and results were expressed in number of organisms/liter. The data obtained were subjected to standard statistical analysis. One way analysis of variance (ANOVA) followed by Duncan's multiple range test was performed to determine whether the plankton density altered significantly by different seasons.

Results and Discussion

Zooplankton of Kuttanad river consist of 42 species belonging to Protozoa (8sps), Rotifera (16sps.), Cladocera (12 sps.) and Copepoda (6sps.). The relative abundance of zooplankton population in the two selected stations was given in (Table 1). Maximum number of zooplankton was recorded in the post monsoon season in both the stations. The trend was pre monsoon > summer > post monsoon > monsoon. Variation in composition, density and dynamics of zooplankton community were given below.

Protozoa

The protozoan species identified in the two stations of Kuttanad were *Amoeba, Arcella, Bursaria, Chillodenella, Diffugia, Paramecium, Slentor* and *Spirostomum*. Maximum number was noted in station I during pre-monsoon season (25 N/L). In station II maximum number was noted in the post monsoon season (24 N/L). The percentage was more in the monsoon season in both the stations as 20.24% (station I) and 19.59% (station II) (Table 1).

Rotifera

The Rotifera population identified from the two stations during the present study were represented by 16 species. The species were *Ascomorpha, Asplanchna priodonta, Branchionus angularis, Branchionus calyciflorus, Branchionus caudatus, Branchionus falcatus, Cocconeis Diacranophorus, Keratella quadrata, Keratella tropica, Lecane bulla, Philodina, Pterodina, Sinantheria, Testudinella patina* and *Trichocerra rattus*. Quantitative analysis during the period of study showed that the *Branchionus* exhibit maximum diversity of species, represented by 4 species; *Keratella* represented two

species. From all other only a single species were recorded. Maximum number was recorded in station II (37 N/L) in the post monsoon period and the minimum number of 20/L was recorded in the monsoon period. The percentage of rotifers in station I was in the order 23.71% > 21.19% > 21.38% > 19.32% in monsoon, summer, pre monsoon and post monsoon respectively (Table 1).

Cladocera

The Cladoceran population identified in the present study were represented by 12 species (*Ceriodaphnia cornua, Daphnia carinata, Bosmina longirosiris, Bosmina fatalis, Moina micrura, Chydorus ventricosus, Alona quadrangularis, Alona rectangular, Alona verrucosa, Macrotrix spinose, Cypris* and *Calanus*). Quantitative analysis during the period of study showed that *Alona* exhibited maximum diversity of species. Among the family Bosminidae; *Bosmina longirostris* and *B. fatalis* were recorded. From all other families only a single species were recorded. Maximum number of cladoceran recorded in the post monsoon period in both the stations (Table 1).

Copepoda

The Copepod population identified consist of 6 species as *Mesocyclops leuckarti, Mesocyclops hyalinus, Trophocyclops prascinus, Eucyclops serrulatus, Microcyclops varicans* and *Filipinodiaptomus insulanus.* Copepoda exhibit highest peak during post monsoon season (Table 1).

Larvae and other forms

The larvae identified from Kuttanad river during the present study are nauplius, zoea and mysis with a maximum number of 11 N/L. The nymph and other forms are also included in it. The percentage varied between 1.69% and 7.28% (Table 1).

Zooplanktons are microscopic organisms that are suspended in water and are ecologically important and their abundance as well as variation determine water quality and status of water bodies [3]. Systematic enumeration of plankton is of great biological significance to understand the limnobiotic dynamics of aquatic ecosystem [4, 5]. Zooplankton forms an important component of secondary production and occupy a central position between autotrophs and other heterotrophs, form an important link in aquatic food webs [5]. Truely planktonic animals in freshwater are dominated by *Rotifera, Cladocera* and *Copepods*. Moreover, the zooplankton communities, based on their quality and species diversity, are used for assessing the productivity of fishery resources, fertility and health status of the aquatic ecosystem as zooplankton are rich in the essential amino and fatty acids, docosa hexacnoic acid (DHA) and eicosa pentanoic acid (EPA). Zooplankton provides fish with nutrients since fish require proteins, fats, carbohydrates, mineral salts and water in the right proportion.

Planktonic protozoans are group of unicellular ciliated or flagellated organisms. They feed on either picoplankton or nano flagellates or small nano phytoplanktons according to their size. Heterotrophic nano flagellates are more abundant than ciliates in freshwater body. The ecological role of protozoa in the transfer of bacterial and algal production to successive trophic levels is important as they are the food source for micro invertebrates. As predators, they prey upon unicellular or filamentous algae, bacteria and micro fungi. Protozoa are both herbivores and consumers in the decomposer link of the food chain. They also control bacteria populations and biomass to some extent [6]. The rotifers are being considered as the most important soft bodied invertebrates and are the most sensitive bio indicators of water quality and their presence may be used as a reference to the physicochemical characteristics of water [7]. They play a significant role in aquatic food chain and thereby constitute an important food item to fishes. Taxonomic dominance of rotifers was reported in several water bodies. This pattern is common in tropical and sub tropical freshwater, whether in lakes, ponds, reservoirs, rivers or streams [8]. The dominance of Rotifera and the genus *Brachionus* was not unexpected as both the latter and former have been reported by various workers [9—11] as the most dominant zooplankton group in aquatic ecosystems. The high population density of the rotifera could be attributed to their parthenogenetic reproductive patterns and short developmental rate under favorable

conditions, their morphological variations called cyclomorphosis and adaptations, their ability to feed on different food types as well as their preference to warm waters [12]. In summer, the absence of inflow of water brings stability to the water body. The availability of food is more due to production of organic matter and decomposition. These factors contribute for high species density. Cladocerans are popularly called as "water flea" prefers to live in deep water and constitute a major item of food for fish, thus play a major role in food chain and energy transformation and the maximum population of cladocera may be due to favorable temperature and availability of food, while the factors like temperature, turbidity and transparency play an important role in controlling the diversity and density of Cladocera [2]. In this study, cyclopoid copepods were dominant over calanoid copepods. Copepoda exhibit highest peak during the post monsoon season. It can be explained as the result of settling of rainwater and return of favorable condition. The minimum number was found in monsoon season may be due to environmental variation.

The high population density and biomass of zooplankton was traced to the high population of the phytoplankton food source which were highly abundant within the river during the different seasons. In most of the aquatic ecosystem different zooplankton groups acts as one of the major primary consumer as a result, their diversity, abundance and seasonality affects the other biotic components there in. The zooplankton population of the concerned habitat was found to be dominated by cladocerans both in number and diversity followed by copepods and rotifers. Therefore the present study on qualitative and quantitative changes occurring in the riverine ecosystems is necessary in order to understand and preserve the biodiversity.

Conclusion

Zooplanktons are good indicators of changes in water quality, because they are strongly affected by environmental conditions and responds quickly to change in environmental quality. Hence, qualitative and quantitative study of zooplanktons is of great importance. The zooplankton analysis showed that, the total zooplankton density was more in summer season. The difference in the number of zooplankton species in this study and other studies may be attributed to the natural conditions of water bodies and time of sampling. FAO [13] had earlier reported that distributions of zooplankton vary from place to place and year to year due to the dynamic nature of aquatic systems.

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