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Biodiversity of Zooplankton in Theroor Wetland Ecosystem, Kanyakumari, India

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ABSTRACT

Aquatic ecosystems is most vulnerable with zooplankton and there is lot of research has been carried out in recent years due to their importance. However, there is cape in the research of zooplankton composition, richness, evenness and diversity in selected study areas. In the present study we investigated the zooplankton communities in the Theroor wetland ecosystem during March-2015 to February-2016. Totally 44 numbers of zooplankton species were identified in three selected stations. Among the six zooplankton groups, rotifera being dominant followed by copepod. The species richenss, eveness and total biodiversity of zooplankton in the selected study area revealed that the water quality and environmental parameters made a significant influence on the spatial variability inthe distribution of zooplankton species, abundance and biomass.

Keywords Zooplankton, Biodiversity, Wetlands, Kanyakumari, Species richness.

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INTRODUCTION

Wetland ecosystems are considered to be the ecological barometers in determining the health of a city. They play an important role in the social ecology of the region in which they are located. They are the primary shelter for aquatic biodiversity including aquatic flora, fauna and other microorganisms. Thus, the above discussed actions have seriously affected the survival of wetlands and have also posed serious threat to the flora and fauna supported by them, especially on plankton diversity.

Being the primary consumers and a direct source of food to for the other aquatic animals they quickly respond to changes in the environment. These taxonomic phyla which includes rotifer, copepod, cladocera, protozoa, ostracocod and insecta of aquatic fauna are very sensitive to environment especially for physical, chemical and nutrient changes. So, it is very essential to understand the water quality, food chain, food web, primary consumers assessment in these wetland resources which are considered till date to be the potential source of organic production for the entire living organisms. Thus, many ecologists made an assessment on zooplankton diversity in fresh water ecosystem and they suggested through their research works have laid emphasis on importance of zooplankton and their attribution that controls growth of living organisms in aquatic ecosystems (Nirmal Kumar *et al.* 2011, Honggang *et al*. 2012, Sabina *et al*. 2016, Kar and Kar 2016,Verma and Prakash 2020).

As of today, wetland surface waters are most vulnerable to pollution due to its easy accessibility for disposal of pollutants and wastewaters. The structural changes in species communities, population dynamics, distribution patterns have become more important to evaluate the situation existing in the aquatic ecosystem. So, study on species communities in any aquatic systems is very important as it assist to understand the life of living organisms and helps in monitoring the conditions congenial for their life in the environment, they live in. As zooplankton plays an integral role and serves as bio indicators it is selected in the present study as a well-suited tool for assessing the current status of Theroor wetland water.

MATERIALS AND METHODS

Collection and identification of plankton samples

Three stations were sampled seasonally from (March 2015- February 2016). The plankton samples were collected during every month first week during morning hours (6.00 – 10.00 AM). The area selected for the present study (Theroor wetland) was investigated for a period of for one complete year for zooplankton diversity, their relative abundance at selected stations between 6 am to 10 am. Each samples (3replicates) was collected by filtering 150 L of water through plankton net by horizontal/ vertical haul and stored in 300 ml polythene bottle and 10% of lugol's iodine added to it and few drops of glycerin were added to it and was kept overnight for better sedimentation and 5% of neutral buffer (10 ml) formalin (aqueous solution of formaldehyde). The supernatant plankton free water was removed using pipette and sample concentrate settle were further enumerated and identification under binocular microscope attached ultra-scan used keys and monographs of and results were represented in number organisms/1.

Morphological characterization

For quantitative estimation of zooplankton the modified Sedgwick rafter method and it was estimated to the calculation Edmondson (1963),Trivedy and Goel (1986), Manickam *et al.* (2012). From each concentrated samples 1ml of quantitative sub sample of zooplankton was examined in Sedgwick rafter chamber under 400X magnification. The samples analysis and picture were captured with ultra-scan attached binocular microscope.

Taxonomic identification

Detailed taxonomic identification classification and description was done with the help of Olympus microscope having different magnifications following the methods described by Edmonson (1963), Sehgal (1983), Battish(1983), Sharma(1999),Venkataraman (1999).

Calculation

$$N = n \times v/V$$

Where,

N = Total number of plankton cells / L,
n = Average number of plankton cells in 1 ml of sample,
v = Volume of plankton concentrate,
V = Total volume of water filtered (L).

Diversity analysis of plankton samples

The diversity analysis of zooplankton of Theroor wetland in Kanyakumari District was analyzed by calculating different diversity indices (DI). Shannon Weiner's Index (H′), Simpson richness index (D′) and Evenness index (E′) was calculated by using diversity software package (PAST–Palaeontological Statistics Ver. 2.00) according to Shannon and Wiener(1949), Simpson (1949), Pielou (1966).

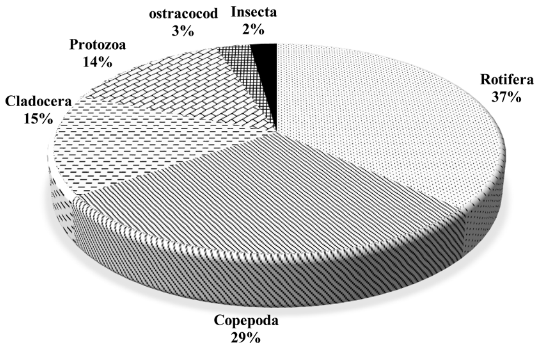

Fig. 1. Percentage composition of zooplankton inTheroor wetland waters.

RESULTS

The results on quantitative analysis of zooplankton in selected sites showed Rotifera and copepod maximum, followed by Copepoida, Cladocera, Protozoa, Ostracocod and Insecta through the study period during all the seasons at all stations Fig.1. Over all the total population density of zooplankton (including all classes) was maximum during summer season, followed by pre-monsoon, post-monsoon and minimum during monsoon.

Species composition

The zooplankton samples collected from Theroor wetland was analyzed for one year (March 2015-February 2016). During the one year study period a total of 44 zooplankton in water sample comprised of 11 species of Copepoda, 9 species of Cladocera, 1 species of Ostracocod, 4 species of Protozoa, 17 species of Rotifera, 2 species of Insecta respectively. Zooplankton was observed to be maximum during summer followed by pre- monsoon season, post- monsoon and minimum during monsoon season while station wise Stn.3 recorded maximum zooplankton followed by Stn. 2 and Stn.1.

Percentage composition

Percentage composition of zooplankton recorded were Rotifera (36.62%) Copepoda (28.76%), Cladocera (15.54%), Protozoa (13.96%), Ostracocod (2.86%) and Insecta (2.26%).The zooplankton of all the 3 stations comprised of Rotifera, Copepoda, Calodocera, Protozoa, Ostracocod and Insecta Fig. 2. Maximum value of Rotifera (33.99%, 55.52%, 46.3%), recorded at Stn.1, Stn.2 and Stn.3, While and the minimum value (27%, 26.23%, 28.2%), of Rotifera was recorded at all the selected stations (Stn.1, Stn.2 and Stn.3) during the study period respectively.

Highest and lowest value of Copepoda recorded at Stn.1 (20.4% - 1.9%5), Stn.2 (24.28%-6.71%), and Stn.3 (28.95%-8.5%), are shown in Fig.1. Maximum 21.69% value was recorded during summer, while minimum 11.37% value of percentage composition was recorded during monsoon. During the present investigation highest percentage of Cladoceran species (18.71%), (17.35%) and (21.69%) and lowest (11.37%), (10.92%) and (13.16%) composition of cladoceran species are recorded at Stn.1, Stn.2 and Stn.3 respectively.

During the study period at maximum percentage of protozoans Stn.1 (17.46%), Stn.2 (17.38%) and at Stn.3 (17.65%) of Protozoans recorded are (10.43%) at Stn.1 (10.91%) at Stn.2 of minimum (11.51%) at Stn.3 was recorded. Maximum (17.65%) was recorded at Stn.3 during summer, while minimum (10.91%) was recorded at Stn.1 during monsoon.
In the present investigation maximum percentage composition Ostracoda was recorded at Stn.1, Stn.2 and Stn.3 were (5.68%, 5.13% and 6.8%) and minimum value of (1.21%) in Stn.1; (1.2%) in Stn.2 and (2%) in Stn.3.Range of percentage composition at Stn.1 (18.4%-1.46%); Stn.2 (13.16%-3%) and Stn.3 (11.94%- 24%) of Insecta was recorded during present investigation. Among the stations maximum percentage composition of zooplankton was recorded during summer season at Stn.3 while minimum percentage composition of zooplankton was recorded in monsoon season at Stn.1 respectively.

Population density

Population density zooplankton recorded during the study period ranged between (15900 ± 135.45–3066 ± 24.05 Org/L) at Stn.1 (22300 ±145.15–3333±26.15 Org/L) in Stn.2 and (105333 - 2866 ± 26.44 Org/L) in SIII. The maximum (105333) diversity was record-

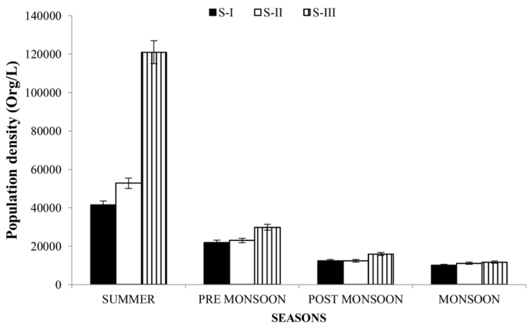

Fig. 2. Population density of zooplankton in Theroor wetland waters.

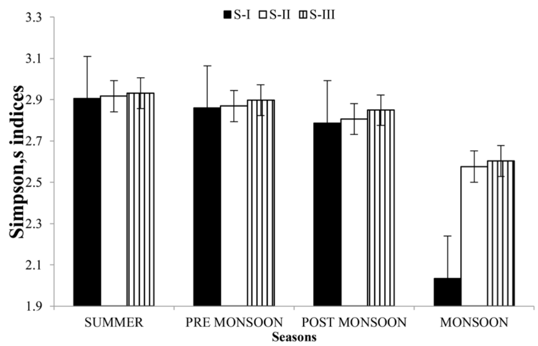

Fig. 4. Species richness of zooplankton inTheroor wetland waters.

ed during summer in Stn.3 and minimum (15900 ± 135.45cell Org/L) diversity was recorded during monsoon at Stn.1. Thus, the peak value of phytoplankton was recorded during summer and lower value during in monsoon season in the present investigation respectively (Fig. 2).

Species diversity

On analysis of species diversity of zooplankton it was noticed to range between (5.144±0.48-4.211±0.55) at Stn.1; (5.250±0.84–4.433±0.66) at Stn.2 and (5.375±0.38-4.421±0.76) at Stn.3. The minimum (4.211±0.55) diversity was recorded during monsoon in Stn.1, whereas the maximum value (5.375±0.38) was noticed during summer in Stn.3 (Fig. 3).Overall the maximum value of species diversity was noted

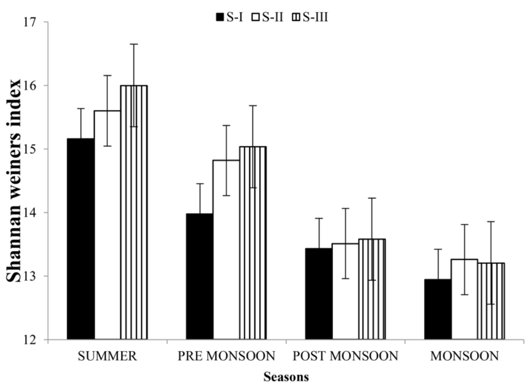

Fig. 3. Species diversity of zooplankton inTheroor wetland waters.

in summer followed by pre-monsoon season, post-monsoon at Stn.3 and minimum value recorded by monsoon season at Stn.1 during the study period.

Species richness

Species richness of zooplankton recorded at three different stations ranged between (0.971±0.07-0.342±0.08) at Stn.1 (0.973±0.13 - 0.851±0.11) at Stn.2 and (0.979±0.14 - 0.863±0.13) at Stn.3. During the study period among the selected stations high species richness value (0.979±0.18) for zooplankton was recorded during summer season at Stn.3 and lowest species richness value (0.342±0.08) was recorded in monsoon season at Stn.1 (Fig. 4).

Species evenness

The range of species evenness of zooplankton at Stn.1 (0.994 ± 0.15 - 0.832 ± 0.16); Stn.2 (0.995 ± 0.18 -0.912 ± 0.17) and Stn.3 (0.997 ± 0.18 -0.974 ±0.15) was also recorded. Among the stations maximum (0.997 ± 0.18) evenness value of zooplankton plankton was noted at Stn.3 during summer season while minimum (0.832 ± 0.16) evenness value of zooplankton was observed at Stn.1 during monsoon season (Fig. 5).

DISCUSSION

Plankton diversity can be used to study tropic status and fisheries resource potential as they are directly correlated. So, next to phytoplankton, zooplankton

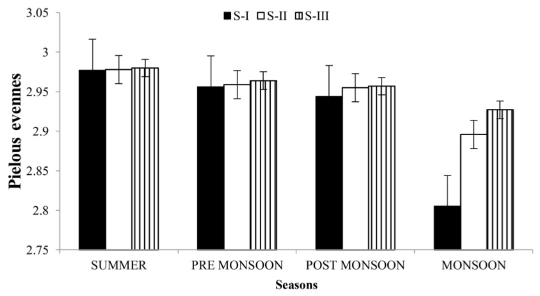

Fig. 5. Species evenness of zooplankton in Theroor wetland waters.

the primary consumers of food chain too play a vital role in balancing the aquatic environment as they are second in tropic level as primary consumers and also contribute to the next tropic level (Aarti *et al.* 2013). Basically, zooplankton are small protozoans or metazoans (e.g. crustaceans and other animals) that feed on other plankton ecologically include the foraminifera's, radiolarians and dinoflagellates which are cosmopolitan in nature as they inhabit all freshwater habitats of the world. Zooplankton plays a major role in recycling nutrients as well as cycling energy within their respective environment. The fresh water zooplankton comprises Protozoans, Rotifers, Cladocerans, Copepods and Ostracods. Zooplankton also have vital role in lake food webs because they regulate the populations of phytoplankton by consuming them (Wetzel 1995) and also they form important food for fish, predators and they also graze heavily on algae, bacteria, protozoan and other invertebrates.

Being an intermediate link between phytoplankton and fish and also as secondary producers in aquatic environment the zooplankton community contains both herbivores and carnivores, the latter belonging to the tertiary producer, or even to some higher level of production. It plays a vital role as a major linking organism in the energy transfer at secondary level in aquatic food webs between autotrophs and heterotrophs (Deivanai *et al.* 2004). However, in aquatic system whether it is lentic or lotic phytoplankton and zooplankton are important biological characteristic that depends on certain parameters like light penetration, temperature, nutrient enrichment, toxic substances, mixing of water, parasites, herbivores and heterotrophic microorganism activities influences the phytoplankton growth (Reynolds *et al.* 1987). Thus identification of zooplankton species in food webs is more essential part in managing aquatic bodies and assessing diversity of zooplankton in water bodies can be used to indicate chronic water pollution problem. In addition primary producers, the phytoplankton, primary consumers the zooplankton and benthic organisms are highly sensitive including fish and other aquatic species and as a result whole tropic level of aquatic system drastically declines (Radhakrishnan and Sugumaran 2010).

Ecologically zooplankton, is the assemblage of various microscopic or non-microscopic aquatic animals that depends on water current for movement which formulates the base of food chain and food web in all aquatic systems. According to Park and Shin (2007), zooplankton is one of the most important biotic components influencing all the functional aspects of all freshwater ecosystems such as food chains, food webs and energy flow. Zooplankton community often exhibits quick and dramatic changes in response to the changes in the physicochemical properties of the aquatic environment so it is considered as indicators of environmental quality and water contamination levels in lakes, rivers, therefore, these are very important for fish culture (Sharma 1983, Berzins 1987, Saksena 1987, Mikschi 1989, Akbulut 2004, Bhora and Kumar 2004). Thus, in association zooplankton richness, abundance, seasonal variation and diversity can also be used for the assessment of water quality and for pisciculture management practices. With this regards a few studies were conducted on phytoplankton and zooplankton communities of different fresh water systems by earlier researchers (Duttagupta *et al.* 2004,Bhuiyan and Gupta 2007, Das and Dutta 2011,Dalal and Gupta 2013, Gupta and Devi 2014). As Theroor wetland is also a wetland of pisciculture importance and zooplankton are the major feed for fish fauna in the present study period qualitative and quantitative estimation of zooplankton was carried out form (March 2015-February 2016).

Thus during the present investigation totally 44 zooplankton species was identified from all three stations representing six groups namely Rotifera (17 species), that plays a significant role in aquatic food chain and thereby constituting an important food item of fishes, Copepoda (11 species) that serve as food to several fishes that occupies major position in ecological pyramids followed by Cladocera (9 species); Protozoa (4species), Insecta (2species) and Ostracods (1species) that provides a good food for aquatic organisms. Higher number of zooplankton genera than our findings has also been confirmed by Rajashekhar *et al*.(2010) who on seasonal analysis found total of 24 species of which, 10 species belongs to Rotifera, 6 to Cladocera, 5 to Copepoda and 3 to Ostracoda. They recorded that Rotifera was the dominant group among the zooplankton species which is similar to our present findings while lower number of zooplankton genera assessed during current study has also been supported by Hossain *et al*. (2006), Rahman and Hussain (2008), Roy *et al.* (2010), Das *et al.* (2011).

Approximately 110 Ostracods species are known from the inland waters bodies of the Indian subcontinent (Patil and Gouder 1989) which hold key position in food chain and energy transformation (Uttangi 2001) which was in agreement with observations of researcher like Wudneh (1998), Dejen *et al.* (2004), Imoobe and Akoma (2008), Rajagopal *et al.* (2010) recorded 47 taxa which includes 24 Rotifers, 9 Copepods, 8 Cladocerans, 4 Ostracods and 2 Protozoan. About 120 species of free-living freshwater Copepods are known from India (39) and about 600 species of freshwater Cladocerans occur through the world (Korovchinsky 1997) of which 110 species have been recorded from India (Uttangi 2001). Protozoan diversity in various inland water bodies of India studied by various planktonoligist who revealed the presence of only few species which was in accordance to our present protozoan status. Sivakami(Sivakami 1996) recorded the presence of only one protozoan in an aquatic systemand was also able to record the presence of two protozoans in another aquatic ecosystem. Similarly, Pathak and Mudgal (2004), Kiran *et al*. (2007) were able to record the presence of two species of protozoans while, Srivastava (2013) was able to record only one species in a water body of North India.Ciliateprotozoans is less and usually depends on the trophic state, season and depth of the water column (Sivakami 1996, Pace 1986, Beaver and Havens 1996).

During the present investigation sample collected from all the three stations comprised of Rotifera (36.62%) which is noted to be the most prominent zooplankton during the study period was represented by taxonomic dominance of rotifers species *Brachionus forficula* sp., *B.falcatus* sp. Rotifers were found to be maximum during summer and minimum during monsoon. The next dominant group observed in the study area was Copepod (28.76%) represented by most abundant species were *Heliodiapto musviduus, Thermo cyclopes, Calanoid* and *Cyclopoid. Copepods* were found to be maximum during summer and minimum during monsoon. Following the rotifers and copepods Cladocera (15.54%) was abundant species and among Cladocerans the most abundant species were *Bosminal ongirostris, Alonella lineollata* and *Daphnia magna*. Maximum Cladocera was recorded in summer and pre-monsoon while minimum in monsoon. In the study stations and during the study period the dominant Protozoa species (*Paramecium cadatum, Vorticella companula, Arcella*) was observed to be maximum during summer and minimum during monsoon. During the study period 3 species of Ostracods were recorded namely *Cyclocypris globosa, Cyprissub globosa* and *Stenocypris fontinalis.*

Thus from the present qualitative and quantitative analysis of zooplankton population maximum zooplankton was recorded during summer followed by pre- monsoon which may be due to favorable temperature, availability of nutrients, availability of food in the form of bacteria, nanoplankton and suspended detritus while in monsoon it was quantified low due to the factors like water temperature, dissolved oxygen, turbidity and transparency that play an important role in controlling the diversity and density of plankton.

Zooplankton density refers to variety within the community as they are often an important link in the transformation of energy from producers to consumers due to their large density, drifting nature, high group or species diversity and different tolerance to the stress. The present investigation of population density of zooplankton observed during the study period at selected three study stations recorded maximum at Stn.3 (105333± Org/L) during summer seasons and minimum at Stn.1 (3066±24.05 Org/L) during monsoon season. The maximum population of zooplankton in summer was attributed by favorable temperature and availability of food in the form of bacteria, suspended detritus while minimum in monsoon due to the physico-chemical factors like water temperature, dissolved oxygen and transparency which plays an important role in controlling the density and also may be due to the dense mats of floating macrophytes which heavily restrict the availability of light and supply of nutrients and input of organic and inorganic waste material due to human interference The density declined in the month of July i.e. during monsoon was due to disturbance due to rains and due to clarity in water and less suspended solids zooplanktons were largely consumed by fish fry population. Several reported results were supported that the zooplankton abundance, richness and evenness was a supporting factor for the current zooplankton status of Theoor wetland (Edmondson 1965, Akbulut 2004, Mulani *et al*. 2009, Jayabhaye and Madlapure 2006, Patel *et al*. 2013, Srivastava 2013).

Zooplankton diversity is one of the most important ecological parameters as these are the intermediate link between phytoplankton and fish and plays a key role in cycling of organic materials in an aquatic ecosystem. The result of zooplankton species diversity during the one year study period among the three stations maximum value (5.375±0.38) was recorded at Stn.3 while minimum value (4.211±0.55) at Stn.1. Seasonally maximum value (5.375±0.38) was noted during summer followed by pre monsoon season while minimum value (4.211±0.55) was recorded in monsoon during the study period. Low diversity of species and low richness of zooplankton during monsoon period was due to reflection of environmental stresses. Species richness of zooplankton recorded from water sample lies in the range between (0.979 ±0.14- 0.863 ±0.13) at Stn.3 and (0.971±0.07- 0.342 ±0.08) at Stn.1. Thus maximum richness was observed during summer in Stn.3 while minimum at Stn.1.

Species evenness of phytoplankton recorded was in the range between (0.998 ±0.11- 0.984 ±0.14) at Stn.3 and (0.994±0.13 - 0.977 ± 0.09) at Stn.1. Maximum value of species evenness was recorded in summer season and minimum value was noted in monsoon season. According to Welch (1952) the diversity and density or distribution of plankton is mainly affected by wind flow, inflowing streams, dilution, qualitative variation of water, physico chemical alteration of water, depth of water, shoreline, current plankton swarms and action of predators and diurnal migration of plankton. These reasons support the present status of zooplankton diversity in the selected study area.The overall view of in this study chapter reveals that the fluctuation of phytoplankton and zooplankton occurs distinctly in the study area and normally in rainy season. The less population during the study period may be due to the dilution factors and which in turn leads to less photosynthetic activity by primary producers. But in summer stability of water body, availability of nutrients, favorable temperature, light penetration, clarity of water and availability of more food due to decomposition of organic matter may favor the abundance, rich density, evenness of phytoplankton and high number of zooplankton might be due to less predators.

CONCLUSION

The present study reveals the basic information of the distribution and diversity of zooplankton. It would form a useful tool for further ecological assessment and monitoring of the aquatic conditions prevailing in the environment. Hence for preventing deterioration of the wetland appropriate remedial measures should be taken by the public work management. Local inhabitants should also minimize or preventing washing of clothes, bathing and other human activities. Biomonitoring of wetland waters with socio-economic reviews might provide clues for identifying the pollution sources coupled with environment awareness. Hence measures should be taken by researchers to minimize the inland aquatic pollution by generating biotic data for the decision maker to take effective conservation steps and for sustainable utilization of this wetland ecosystems.

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