

Original Research Article

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Seasonal Variations of Zooplankton Community in Selected Ponds at Lake Kolleru Region of Andhra Pradesh, India

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ABSTRACT

Zooplankton holds a key position in the food web as it was directly related to the consumption of organic energy produced by phytoplanktonic photosynthesis and then by transforming it to the higher trophic levels of heterotrophs such as fish. Some zooplankton population disappeared at a specified period and reappeared during other period. This disappearance may be due to the fact that some species occur in spores, under favorable conditions spore germinate and appear as zooplankton. Plankton diversity and physicochemical parameters of water are important criteria for evaluating the suitability of water for culture practices. Therefore, structure of different fish food organisms assumes greater significance to fisheries management. Indiscriminate exploitation of Lake Kolleru has been evidently resulted in the depletion of fish fauna and it leading to folding and other negative consequences at surrounding area. In this study, we tried to assess zooplankton richness, evenness and diversity to observe the state of pond water in the study area. A total number 16 species recorded with 9 Rotifera, 3 Cladocera and 4 Copepods. In the rotifers the genus *Brachionus* is the dominant group.

Keywords

Biodiversity,
Zooplankton,
Perennial ponds,
Physicochemical
parameters.

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Introduction

Water is one of the most natural resources for all the living organisms, whether unicellular or multi cellular, since it is required for various domestic purposes irrigation, power generation and industries. In a freshwater system, the zooplankton forms are important group and constitute basic link of the food chain. Planktons are very sensitive to the environment they live in and any alteration in the environment leads to the changes in the plankton communities in terms of tolerance abundance, diversity and dominance in the habitat (Mathivonam, 2007). The planktonic study is a very useful tool for the assessment

of water quality in any type of water body and also contributes to an understanding of the basic nature and general economy of the water body. Plankton occurs in all natural water as well as in artificial impoundments like ponds, tanks, reservoirs, irrigation canals, etc. Plankton being the primary producer from the lowest trophic level in the food chain of fresh water ecosystem and plays a key role in fish culture. The number and species of plankton serves to determine the quality of water body. The structure of aquatic community is important in monitoring the water quality. The density and diversity of

the plankton are greatly influenced by the different physicochemical parameters of water (Wetzel, 1975). Species composition of the plankton community is an efficient indicator of water quality. Zooplankton consist of Protozoans, Cladocera, Copepod, Rotifers, etc. which may serve as indicators of water quality. The zooplanktons play an important trophic level in the aquatic ecosystem as they constitute the most important link in the energy transfer between phytoplankton and higher aquatic fauna (Iloba, 2002). In ecologically zooplankton is one of the most important biotic components influencing all the functional aspects of an aquatic ecosystem such as food chains, food webs, energy flow and cycling of matter (Park and Shin, 2007).

Aquatic biodiversity is threatened primarily by human abuse and management of both living resources and the ecosystem that support them. Most of the ponds are getting pollution due to domestic waste, sewage, industrial, aquatic and agricultural effluents. The requirement of water in all lives, from microorganisms to human beings is a serious problem of present day because of water resources have reached to a point of crisis due to unplanned urbanization, industrialization and other manmade activities. Many biotic and abiotic processes contribute to variability in plankton diversity in aquatic ecosystems. Seasonal requirement of plankton assemblages are closely linked to seasonal changes in temperature, external hydraulic, nutrient loads and light availability (Malten *et al.*, 1991), other process acting on as time periods on days to week, like meteorological and hydrological events (Guillermo, 2009) and also pollution stress on them (Raja *et al.*, 2008). Zooplankton diversity responds rapidly to changes in the aquatic environment. Several zooplankton species are served as bio indicators (Ahmad *et al.*, 2011, Mola, 2011). A number of studies have been carried out on

ecological condition of freshwater bodies in various parts of India (Singh *et al.*, 2002; Smith *et al.*, 2007; Rajagopal *et al.*, 2010), but coastal Andhra Pradesh particularly Kolleru area the ecological studies of freshwater body is very scanty. However, information on relation between physicochemical parameters and planktonic fauna is very limited (Ahmad and Siddiqui, 1995, Choudhary and Singh, 1999). So the present investigation attempts to study the zooplankton species richness, diversity and evenness, in relation between physicochemical parameters in a perennial pond at Lake Kolleru area.

Materials and Methods

Study area

Lake Kolleru in Andhra Pradesh is an important natural shallow freshwater lake formed as a basin between the gradually growing deltas of rivers Godavari and Krishna. It is situated between a latitudes 16° 32' and 16° 47' N and Longitudes 81° 4' and 81° 22' E. The present study pond situated near Budamaru near Kaikaluru. The pond is shallow (depth 0.90 to 1.78m) covering an area of about 2.5 ha. The source of replenishment is sewage from surrounding area. Pond contains mostly sand, loose mud, decayed litter deposit.

Collection of samples

The pond survey was carried out from August 2012 to July 2013. Water samples were collected from periodically every fortnight of the selected pond during the early hours between 8.00 to 10.00 am. The data was articulated seasonally as northeast monsoon (December-February); summer (March-May); southwest monsoon (June-September) and post monsoon (October-November). The plankton samples were collected by filtering by 50 liters of water through standard

plankton net (77 meshes bolting sink) and concentration samples fixed in 5% of formalin.

Physicochemical analysis

Temperature was recorded with centigrade thermometer. The pH of water samples was measured by using pH meter. The remaining physicochemical parameters of water were done according to standard methods (APHA, 1985).

Biological analysis

Zooplankton species identification was done by the help of standard reference (Alfred *et al.*, 1973). The quantitative analysis of planktonic organisms was carried out using Sed Wick Rafter plankton counting cell in according to Welch (1948). Shannon-Weaver's species diversity index: This was proposed by Shannon and Weaver (1949) as measure of information and their diversity across the different pond sampled. Shannon-Weaver (H) is commonly used to characterize species diversity in a community. This index account for both abundance and evenness of the species presents. The proportion of species (P_i) is calculated and then multiplied by the natural logarithm of this proportion ($\log(P_i)$).

As per the formula given by Shannon and Weaver (1949):

$$H = -\sum(n_i/N)\log(n_i/N)$$

Or

$$H = -\sum P_i \log(P_i)$$

Whereas,

H = Shannon's -Wiener's index of species diversity in individuals.

n_i = Total number of individuals.

N = Total number of individuals of all species.

P_i = Importance of probability for each species (n_i/N).

Results and Discussion

Physicochemical parameters of water body serves as measure of water quality. Changes in the source of water and rainfall affect physicochemical parameters of water, which also affects the biomass of the aquatic organisms. The physico-chemical parameters of water were given in table 1.

The physico-chemical parameters of zooplankton communities together form a comprehensive ecosystem and there is interaction between the zooplankton and phytoplankton. These interactions are directly or indirectly subjected to the complex influences (Basawarajeshwari, *et al.*, 2015). Zooplankton was represented by Rotifera, Cladocera and Copepods. Among the plankton Rotifer was dominated and followed by Copepods and Cladocerans. In the Rotifera five genera and nine species were observed. Among the Rotifera genus *Brachions* is the dominant group.

In the Copepods represent three genera and four species and also Cladocerans found 3 genera and 3 species. During the study period quantitative and qualitative variations of zooplankton was observed (Table 2). Zooplankton richness observed in the both monsoon periods whereas lowest number in the summer and post monsoon period. Similar results observed by (Mukherjee, 2011). In the ecosystem, zooplankton plays a main role as they consume the primary producers (phytoplankton) and form a major food source for tertiary producers.

Zooplankton considered as the basic principle natural fish food for young and some adults of organisms, which support fish production (El-Serafy *et al.*, 2009). The zooplankton assemblage inhabiting freshwater, mostly comprises representative of protozoa, Coelenterata, Rotifera, Gastrotricha, Bryozoa and Arthropoda. The zooplanktons often respond immediately to environmental changes because most of the species have short generation times. Epifanio and Garvine (2001) studied by the variations of their spatial distribution, based on different factors.

The higher population density of the zooplankton is during the both monsoon periods while low population density observed in the summer and post monsoon. Among the plankton Rotifera is dominated. The zooplankton populations dominated by rotifers in the wet season are observed by Egborge (1981).

The high population density in the monsoon period may be as a result of abundant food sources from the runoff. Rocha *et al.*, (1999) reported that the increase of primary production (phytoplankton) is accompanied by increase in zooplankton abundance. Muylaert *et al.*, (2003) observed that the zooplankton abundance frequently reach their peak during the wet season in ponds. Besides food source, low predation rate by fish during wet season caused by plankton increased breeding activity, could support by high population density of zooplankton (Ikpi *et al.*, 2013).

In the present observations of the Shannon-Weaver's index of the species in individuals of plankton in the pond fauna was recorded. The diversity index of zooplankton in different seasons in the different seasons in the study area was given in table 2. The species diversity index value are 1.640 (N.E. Monsoon), 1.293 (Summer), 1.408 (S.W.

monsoon) and 1.633 (Post-monsoon). The biodiversity of monsoon higher in the monsoon period both northeast and southwest monsoons followed by post monsoon. Where minimum values recorded in the summer.

High density of zooplankton diversity during monsoon period may be attributed to inflow of rainy water and favorable environment conditions. Ikpi *et al.*, (2013) reported that the seasonal variation in zooplankton condition could larger be due to the Rotifera which normally constitute major food items of larger zooplankton.

The air temperature ranged from 22-34°C and highest temperature recorded in the month of April, 2016. Temperature is one of the important environment factors, since it is influencing the distribution of fauna and flora. Gaikwad (2008) reported that water temperature 13.5 - 32°C is to be suitable for the development of the planktonic organisms. Rainfall ranged between 1.64 to 489.6 mm and rain did not occur during months of December 2012, January 2013 and March 2013. Rainfall is the important cyclic phenomena in tropical countries.

In the present results the peak values of rainfall were recorded in the month of July, 2013(middle of south west monsoon) and lowest recorded in the month of February, 2016. The India is influenced by two monsoon i.e. south west monsoon and northwest monsoons. Transparency ranged between 28-34 cm and highest reading recorded month of August 2015, due to the distribution effect of rains and sediment settlement after south west monsoon season.

The lowest value of reading observed during summer (March, April, and May, 2013) which might be due to evaporation of water in the pond, which may cause concentration of dissolved solids at high temperature.

Table.1 Physico-chemical parameters of the pond water in different months at study area

Study Period	Tem	Tr.	DO	pH	TA	TH	NO ₂	NO ₃	OP	Ir.
Aug.2015	26	34	5.9	7.4	165	176	0.039	0.41	0.51	0.38
Sep. 2015	28	28	5.9	7.6	155	125	0.028	0.56	0.61	0.42
Oct. 2015	23	30	5.6	8.0	145	165	0.063	0.42	0.46	0.38
Nov. 2015	24	32	5.8	8.6	150	120	0.064	0.56	0.53	0.43
Dec. 2015	24	32	4.5	7.8	160	115	0.076	0.48	0.67	0.36
Jan. 2016	23	30	5.0	8.8	135	145	0.073	0.53	0.57	0.28
Feb. 2016	22	32	4.4	8.2	150	190	0.068	0.60	0.63	0.32
Mar.2016	25	29	4.0	7.5	165	175	0.098	0.42	0.72	0.36
Apr.2016	26	33	4.0	7.6	175	155	0.056	0.48	0.59	0.51
May2016	30	33	4.1	7.8	170	145	0.074	0.43	0.48	0.30
Jun. 2016	30	28	5.2	8.2	155	165	0.076	0.51	0.42	0.38
Jul. 2016	32	32	5.6	8.0	140	155	0.063	0.53	0.58	0.36

Tem: Temperature (°C); Tr.: Transparency (cm); DO: Dissolved Oxygen (mg/l); pH: Hydrogen ion concentration; TA: Total Alkalinity (mg/l as CaCO₃); TH: Total hardness (mg/l as CaCO₃); O₃: Nitrate (mg/l); NO₂: Nitrite (mg/l); OP: Orthophosphates (mg/l); Ir.: Iron (mg/l).

Table.2 Biodiversity indexes of zooplankton in different seasons in the study area

ZOOPLANKTON PECIES	N.E. Monsoon (ni/N) log ni/N	Summer (ni/N) log ni/N	S.W. Monsoon (ni/N) log ni/N	Post Monsoon (ni/N) log ni/N
Rotifera				
<i>Brachionus caudatus</i>	-0.154	-0.154	-0.153	-0.132
<i>B. falcatus</i>	-0.146	-0.094	-0.147	-0.103
<i>B. calyciflorus</i>	-0.152	-0.134	-0.155	-0.154
<i>B. forficula</i>	-0.046	-0.060	-0.053	-0.053
<i>B. angularis</i>	-0.035	-0.027	-0.040	-0.067
<i>Filinia longiseta</i>	-0.052	-0.058	-0.064	-0.107
<i>Polyarthra remata</i>	-0.007	-0.007	-0.013	-0.015
<i>Hexathra</i> Sp.	-0.013	-	-0.009	-0.015
<i>Keratella tropica</i>	-0.109	-0.090	-0.087	-0.142
Total	-0.714	-0.624	-0.721	-0.788
Cladocera				
<i>Ceriodaphnia cornuta</i>	-0.158	-0.104	-0.158	-0.156
<i>Moina micrura</i>	-0.158	-0.155	-0.117	-0.154
<i>Diaphanosoma excisum</i>	-0.152	-	-0.155	-0.154
Total	-0.468	-0.259	-0.43	-0.464
Copepodes				
<i>Mesocyclops</i> Sp.	-0.148	-0.142	-0.065	-0.117
<i>M. varicans</i>	-0.145	-0.038	-0.057	-0.024
<i>Heliodyptomus cinctus</i>	-0.031	-0.079	-0.074	-0.128
<i>Diaptomus</i> Sp.	-0.107	-0.151	-0.061	-0.112
Total	-0.431	-0.41	-0.257	-0.381
H= -Σ(ni/N) log ni/N	1.640	1.293	1.408	1.633

Abbreviations: N.E: North East; S.E: South West.

Dissolved oxygen was observed in-between 4 to 5.9 mg/l and lowest recorded in month of September, 2012 (south west monsoon). Lower dissolved oxygen values obtained during dry season could probably due to higher temperatures during summer months. Dissolved oxygen distribution provides a good index of productivity and quality of environment. High oxygen consumption is indicative of higher photosynthetic efficiency and plankton production. Rajgopal (2010) reported that the abundance of phytoplankton which enriched water with high dissolved oxygen during photosynthesis. Dissolved oxygen is a sole of the physicochemical parameters of the water which need to keep the organisms alive and health of the water body of ecosystem (Madhusudhana and Krishna, 2013).

The pH value ranged between 7.4-8.6 lowest recorded in the month of August (south west monsoons) whereas highest recorded in the month of January (North East monsoon). High value of pH may cause of low level of water and high photosynthesis resulting in high production of free CO₂ during the equilibrium towards alkaline side (Siddamalayya and Pratima, 2008). Tanner (2005) reported that the pH range between 6.0 - 8.5 indicate median productive nature of reservoir and above 8.5 goes to highly productive. In the present, study months of January and November goes to above 8.5 pH which indicates that the water is a highly production of zooplankton population. Total alkalinity of present results is in between 120 to 162 mg/l. Maximum recorded in the month of April whereas minimum in the month of December. Similar results observed by Narasimha Ramulu and Benarjee (2013) at Nagaram tank of Warangal. The total hardness of water fluctuation ranged from 135-178 (mg/l). Maximum recorded in the month of April and minimum recorded in the month of February. The minimum during the

month of February may be due to deposition of Calcium and Magnesium salts in that season (Narsimha Ramulu and Benarjee, 2013).

Nitrogen is essential for leaving organisms as an important constituent of proteins, including genetic material. Plants and microorganisms convert inorganic nitrogen to organic forms. In the environment inorganic nitrogen occurs in a range of oxidation status as Nitrate (NO₃) and Nitrite (NO₂), the ammonium ion (NH₄⁺) and molecular Nitrogen (N₂). It is under goes biological and non-biological transmission in environment as part of nitrogen cycle. In the present study Nitrite in-between 0.028-0.098 mg/l; Nitrate in-between 0.41 to 0.60 mg/l and Ammonia goes to 0.31 to 0.64 mg/l in the culture pond.

Iron is an important element for almost all living species. Its environmental impacts on physiological and ecological aspects of aquatic organisms are focus on limnological studies (Xing and Liu, 2011). The variations of Iron profoundly influence the structure and function of aquatic ecosystem (Shaked *et al.*, 2004). In the present study Iron ranges from 0.28 to 0.51 mg/l lowest record in the month of January and (0.28) and highest recorded in the month of April, 2013.

According to Sousa *et al.*, (2008) changes in water quality of water body have significant effect on structure of zooplankton assemblages that can potentially affect the functioning of ecosystem. Seasonal distribution of the population structure of zooplankton in connection with physicochemical parameters Sarkar and Chaudhary (1999). Hence, Zooplankton communities of numerous water bodies have been used as indicators for the status of the ecosystem (Jeppensen *et al.*, 1999; Ramchandra and Solanki, 2007) and related with the concentration of total nitrogen, total

phosphorus, algal biomass and the density and size of individuals (Giselle and Bruce, 2007). The variability observed in the distribution of zooplankton is due to abiotic parameters. In the aquatic ecosystem plankton play a critical role not only in converting plant food to animal food but also serves as source of food for their organisms (Rajashekhar *et al.*, 2010). In the present study indicated that a total of 16 zooplankton species were recorded in the study ponds comprising of 9 rotifera, 3 cladocera and 4 copepods. Rotifera showed highest number of species and genus *Brachionus* is dominant group among rotifera. Bharti *et al.*, (2014) reported that the abundance of rotifer species such as *Brachionus* indicates nutrient rich water body which may undergo the state of eutrophication. The present preliminary study conducted that the various zooplankton composition. Rotifera constitute higher species abundance, the overall diversity index shows eutrophic nature. Further, detailed investigation through regular monthly sampling with more quantitative analysis to conform the exact status of water body is required which would help to conserve the zooplankton diversity and water quality.

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